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Master Curricula

development and implementation

at Lviv Polytechnic National University - LPNU

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Summary: Deliverable series “Master Curricula” presents the curricula process of the 2nd level Master developed for the Ukraine and Georgian Universities according to the Bologna process standards within the SmaLog project. This deliverable reports curricula developed and implemented at Lviv Polytechnic National University - LPNU. After a short introduction, the deliverable describes the local conditions, needs and the results of the international reviews on which the curricula have been built. The deliverable provides the structure in term of modules, the expected learning outcomes, the reference publications and materials required to deliver the Master.

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1 Introduction

Within the framework of the Erasmus+ - Capacity Building in the Higher Education programme the Master in smart transport and logistics for cities project (SmaLog in the following) has been selected for funding. The project started in October 2017 and will end in October 2020.

The consortium is composed of four EU universities, four Ukraine and two Georgian universities, and one institute of advanced studies, namely Department of Enterprise Engineering "Mario Lucertini" of the University of Rome Tor Vergata (the project coordinator), the Research Centre on Transport and Logistics of "Sapienza" University of Rome, Department of Transport Systems and Logistics of the O. M. Beketov National University of Urban Economy in Kharkiv, Department of Transport Technologies of the Lviv Polytechnic National University, Department of Automobiles and Transport Technologies of the Zhytomyr State Technological University, Department of Transport Systems and Road Safety of the National Transport University, Department of Logistics of the Georgian Technical University, Business and Management Faculty of the Batumi State Maritime Academy, Faculty of Transport of the Silesian University of Technology, the Department of Transport Services Market of the Institute of Market Problems and Economic& Ecological Research of the National Academy of Sciences of Ukraine, Department of Mechanical Engineering of the Hochschule Wismar, University of Applied Science: Technology, Business and Design. Two associate partners are also involved: OOO "System Service" and Batumi Autotransport Ltd. The Ukrainian and Georgian Universities are defined as "Local Universities" for the purposes of the report.

During the proposal stage, the analysis carried out in cooperation with Ukrainian and Georgian Universities and stakeholders highlighted that there is a need to strengthen the role of research to start managing transport and logistics, exploiting the opportunities offered by information systems in Ukraine and Georgia. For this reason, the SmaLog project aims to transfer to Ukraine and Georgia the most recent knowledge and good practices developed in the European Union in the field of smart transport and logistics for cities and Local Universities are the key actors to start this process.

Starting from these concepts and knowledge developed by the European partners, the project aims to:

- develop and test in Ukraine and Georgia a 2-year University Master according to the Bologna process standards;

- "Train the Trainer" supporting Local academics in defining and delivering the Masters;
- provide each Ukrainian and Georgian University with a laboratory dedicated to smart transport and logistics for cities;
- disseminate through newsletters, events, workshops and seminars the importance of research in the field of smart transport and logistics for cities;
- set up a national coordinated network of Universities, public bodies, private companies and NGOs on smart transport and logistics for cities involving Local Universities in the wider European network of research centres.

With reference to the definition of effective and useful Master curricula on smart transport and logistics, two preconditions are required to reach these aims. On the one hand, there is a need to clearly understand local conditions and needs both in terms of research and teaching on the topic in question. On the other, the need is to review and analyse the most relevant and recent experiences and tools in the field of smart transport and logistics for cities available at international level. This analysis was carried out and several important aspects were highlighted. First, the Local University system guarantees an adequate level for designing, managing and analysing smart transport and logistics.

Besides, there are some gaps. First, there is a problem of isolation from the international research world that leads to:

- a need to update contents and methods of the modules for students by using the experience of leading European Universities;
- a need of improving approaches in transport research using European practices acquired during training and internships;
- a need of specialized technical equipment and software products PTV Vision Traffic Suite, AnyLogic University Researcher, Copert street level and ets. for quality Master's degree training and research.

According to the results recalled above, the new Masters programmes will be defined accordingly as a 2/1.5 years and 120/90 ECTS credit Masters with transparent quality assured contents in accordance with the Bologna process that will allow the course to be recognised within the Lisbon Convention and on a par with the European Area of Higher Education.

User Needs Analysis carried out at local level highlighted some interesting aspects. First of all, while Masters on Transport topics are already available in Ukraine and Georgia there is no specific Master in smart transport and logistics for cities and all the local partners agreed that research on such a topic is not fully implemented at the local level.

Finally, according to local partners, there is a lack of practical or laboratory ‐ based activities in the Masters courses. In some Masters, there are no practical or laboratory activities whatsoever, whilst in others they are not extensive and need to be improved.

To avoid administrative barriers, some local academics suggest revising/extending an existing Masters programme rather than setting up a new Masters programme. This is a major opportunity since it will allow the delivery of the Master from the second year of the project and local needs can be captured in greater depth, exploiting the skills and competences of current teaching and research staff.

In order to improve the employment opportunities at local level of the Masters' graduates, the academics from local technical universities suggest focusing first on technical and practical skills, on the use of innovative software programmes and on the international overview of the courses.

A last aspect underlined by the international review is the importance of taking into account the newest approaches on transport system management and control.

These results have been used as inputs in the present series of deliverables whose main objective is to define the Masters Curricula both for Technical and Economic Universities in Ukraine and Georgia.

This Deliverable is organized as follows. Chapter 1 is the current chapter (Introduction). Chapter 2 describes the general structure, objectives and contents of the Master in smart transport and logistics for cities according to the original application, and normative/law constraints in partner countries (PCs) for EU recognition. Chapter 3 details the SmaLog Masters describing: master objectives, profile of the Master graduates, Masters Curricula, Programme structure and Equipment and material. The last section, Chapter 4, presents conclusions.

2 General structure, objectives and contents of the Masters

In order to define the general structure, objectives and contents of the Masters it is important to look at the conclusions and recommendations received during ad-hoc meetings carried out during application design and the first months after the project started. These recommendations will be used to draft the structure, objectives and contents of the Masters.

With regard to the structure of the Masters, according to the Bologna process the new Masters Programme will be defined accordingly as a two - year 120-credit Masters with transparent quality assured content that will allow the course to be recognised within the Lisbon Convention and on a par with the European Area of Higher Education (EAHE).

Concerning the contents of the Master the recommendations give many important inputs. First, there is a problem of isolation of Local Universities. To overcome this isolation there is a requirement to:

- Update contents and methods of courses for students with the most recent international experience;
- Update research topics in the field of smart transport and logistics for cities with the most recent international experience;
- Involve Local Universities in the international research networks;
- To meet these needs, the Masters curricula will be based on the most recent and most effective training courses on smart transport and logistics existing worldwide or on research projects carried out worldwide in recent years;
- Participation of stakeholders in the development and implementation of the Master program focused on the needs of the Ukraine Western region market in the Master's degree in "Smart Transport and Logistics for Cities";
- Participation of employers and the University administration in the implementation of the Master program "Smart Transport and Logistics for Cities".

Recommendations highlight a problem related to the low level of technical equipment and reference material in the current laboratories in terms of hardware, software and publications and it is important to set up SmaLog laboratories with adequate and updated equipment to this effect.

These laboratories will have a twofold use since they will be used, on the one hand, to improve the

quality of the education and, on the other, to support research.

To improve the employment opportunities of the Masters' graduates at local level it is very important to hold relevant laboratory, practical and field activities in the Masters and to include in the curricula the use of the most advanced software related to transport and logistics. For this reason, the Masters curricula will include practical activities, laboratory activities and field activities. Moreover, the final thesis, envisaged for each Master student, will be geared to research and practical activities rather than desk analysis.

Lviv Polytechnic National University - LPNU

Provision of training of highly qualified specialists in specialty 275 "Transport technologies", specialization "Smart transport and logistics for cities", able to:

- implement smart transport in city transport systems,
- make decisions on development of transport systems and logistics in cities,
- assess traffic impacts on persons and freight,
- estimate the effectiveness of city transport systems and also to prepare students for further employment in their chosen specialty,

guided the implementation process of Master curriculum at Lviv Polytechnic National University.

The curriculum mainly focuses on education in the field of smart urban transport merging cultural, scientific and labour market needs. The educational-research programme is based on results of current knowledge of smart transport and logistics in cities, urban passenger transport, traffic flow simulation, road traffic management, freight transportation, management of traffic flows in city centres, impact of persons and environment on safety and stability of city logistics and also the effectiveness of city transport systems. The above programme is geared to enhancing professional skills and providing the framework for further professional and scientific career.

Educational-research has four professional branches: passenger transportation in cities; freight transportation and logistics in cities; traffic flow management; smart transport.

3 SmaLog at Lviv Polytechnic National University

3.1 Masters objectives and profile of the Masters graduates

The Masters degree in “Smart transport and logistics for cities” is developed within the branch of knowledge 27 “Transport”, specialty 275 “Transport technologies”.

3.2 Programme structure

The masters course lasts two years for a total of 120 ECTS. According to the Law of Ukraine “On Education” and the Order of the Ministry of Education and Science of Ukraine No. 1/9-126 when developing curricula, the following rules are taken into consideration (Table 1):

- 1/3 hours – class work, 2/3 hours - independent study;
- Max 75% - compulsory discipline, Min 25% - free student choice;
- The curriculum consists of two parts - Obligatory and Elective.

Table 1 – Curricula developed at LPNU

#	Module	Type of training	Semester	Semester control	The scope of work					Distribution of hours by class				Horn and graphics work	Control work	Chair
					Credit	Hours										
					ECTS	*Total*	*Audit work*	*MK*	*Independent work*	*Lectures*	*Laboratory*	*Practical*	*Weekly*			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Total per speciality:				120	3600	870		2730	420	135	315		1	4	
	Compulsory academic disciplines				82	2460	465		1995	225	75	165		1	2	
	Selective speciality disciplines :				38	1140	405		735	195	60	150			2	
	1. Professional disciplines of specialization				120	3600	870		2730	420	135	315		1	4	
	0400: Smart Transport and Logistics for Cities				90	2700	540		2160	270	75	195		1	3	
	1.1. Compulsory academic disciplines				82	2460	465		1995	225	75	165		1	2	
	1.1.1. General training cycle				3	90	30		60	15		15			1	
1	Economic Efficiency of City Transport Systems		3	test	6	180	60		120	30		30	2/4/2		1/12	TT
	1.1.3. Cycle of training preparation				79	2370	435		1935	210	75	150		1	1	
2	Intelligent Transport and Urban Logistics		1	Exam	7	210	60		150	30		30	2/4/2			TT
3	Traffic Flow Simulating and Management		1	Exam	6	180	75		105	30	30	15	2/5/1			TT
4	Human and Environmental Impacts, Safety and Sustainability (P.1)		1	Exam	5	150	30		120	15		15	1/2/1			TT

#	Module	Type of training	Semester	Semester control	The scope of work					Distribution of hours by class				Horn and graphics work	Control work	Chair
					Credit	Hours										
					ECTS	*Total*	*Audit work*	*MK*	*Independent work*	*Lectures*	*Laboratory*	*Practical*	*Weekly*			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
5	Intelligent Transport Systems		2	Exam	6	180	75		105	30	15	30	2/5/2			TT
6	Human and Environmental Impacts, Safety and Sustainability (P.2)		2	Exam	5	150	45		105	30		15	2/3/1			TT
7	Traffic Flow Management in the City Centre (P.1)		2	Exam	5	150	60		90	30	15	15	2/4/1		1/12	TT
8	City Passenger Transport		3	Exam	6	180	60		120	30	15	15	2/4/1			TT
9	Traffic Flow Simulating and Management	KP	1	test	3	90			90							TT
10	City Passenger Transport	KP	3	test	3	90			90							TT
11	Educational-research Internship	Int	4	test	4,5	135			135							TT
12	Masters Thesis-Related Internship	Int	4	test	6	180			180							TT
13	Fulfilment of Masters Thesis		4		18	540			540							TT
14	Defence of Masters Thesis		4		1,5	45			45							TT
	1.2. Discipline at the student's choice				8	240	75		165	45		30			1	
	1.2.5. Educational disciplines of other educational programmes				8	240	75		165	45		30			1	
15	1. Discipline to choose		2	test	3	90	30		60	15		15	1/2/1		1/12	KGSD
16	Intellectual Property		2	test	3	90	30		60	15		15	1/2/1		1/12	MAM
17	Role of Religion in Modern Society		2	test	3	90	30		60	15		15	1/2/1		1/12	KF

#	Module	Type of training	Semester	Semester control	The scope of work					Distribution of hours by class				Horn and graphics work	Control work	Chair
					Credit	Hours										
					ECTS	*Total*	*Audit work*	*MK*	*Independent work*	*Lectures*	*Laboratory*	*Practical*	*Weekly*			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	Philosophical Problems of Sciencie Knowledge		2	test	3	90	30		60	15		15	1/2/1		1/12	KF
19	2. Subjects to Choose		2	Exam	5	150	45		105	30		15	2/3/1			TT
20	2.1. Integrated Transport System in City Logistics		2	Exam	5	150	45		105	30		15	2/3/1			TT
21	2.2. Bus Rapid Transit		2	Exam	5	150	45		105	30		15	2/3/1			TT
	0401: PART 0401				30	900	330		570	150	60	120			1	
	1.2. Discipline at the student's choice				30	900	330		570	150	60	120			1	
	1.2.3. Cycle of professional training				30	900	330		570	150	60	120			1	
22	Social and Ecology Efficiency of City Transport Systems		1	Exam	6	180	60		120	30		30	2/4/2			TT
23	Freight Transportation Simulation		2	Exam	6	180	75		105	30	30	15	2/5/1			TT
24	Smart Transport and Logistics for Cities Project		3	Exam	6	180	60		120	30		30	2/4/2			TT
25	Traffic Control		3	test	6	180	60		120	30		30	2/4/2		1/12	TT
26	Traffic Flow Management in the City Centre (P.2)		3	Exam	6	180	75		105	30	30	15	2/5/1			TT

(*) ECTS. For the determination of the ECTS it is agreed that 1 ECTS is equivalent to 30 hours of work.

3.2.1 Obligatory part

The compulsory part counts 82 ECTS and includes - General training cycle, Cycle of professional training, Research (scientific) component. Table 2 reports the modules of the project, which are included in the compulsory part.

Table 2 – Modules of the project which are included in the obligatory part

Code of the module	Module	ECTS credits	Form of final control
1	2	3	4
1. General training cycle			
OC 1.1.	Economic efficiency of urban transport systems	6	Test
Total per cycle:		3	
2. Cycle of professional training			
OC 2.1.	City passenger transport	9	Exam
OC 2.2.	Intelligent transport and urban logistics	7	Exam
OC 2.3.	Traffic flow simulating and management	9	Exam
OC 2.4.	Intelligent transport systems	6	Exam
OC 2.5.	Traffic flow management in the city centre (part 1)	5	Test
Total per cycle:		39	
3. Research (scientific) component			
OC 3.1.	Human and environmental impact, safety and sustainability (part 1)	5	Test
OC 3.2.	Human and environmental impact, safety and sustainability (part 2)	5	Exam
OC 3.3.	Educational research internship	4.5	Test
OC 3.4.	Masters thesis-related internship	6	Test
OC 3.5.	Fulfilment of masters thesis	18	
OC 3.6.	Defence of masters thesis	1.5	State attestation
Total per cycle:		40	
Total for obligatory components:		82	

3.2.2 Elective part

The elective part counts 38 ECTS and includes - General training cycle, Cycle of professional training. Table 3 reports the modules of the project, which are included in the elective part.
To obtain the master degree the student has to obtain 120 ECTS. More details can be found at:

- http://lp.edu.ua/education/majors/IEMT/3.275.03.04/52/2018/ua/full (UA)
- http://lp.edu.ua/en/education/majors/IEMT/3.275.03.04/52/2018/en/full (Eng)

Table 3 – Modules of the project which are included in the elective part

1. General training cycle			
SC 1.1.	Intellectual Property	3	Test
Total:		3	
Professional disciplines of specialization			
SC 2.1.	Social and ecology efficiency of urban transport systems	6	Exam
SC 2.2.	Smart transport and logistics for cities project	6	Exam
SC 2.3.	Traffic control	6	Test
SC 2.4.	Traffic flow management in the city center (part 2)	6	Exam
SC 2.5.	Freight transportation simulation	6	Exam
Total:		30	
Elective components of other educational-scientific programmes			
SC 4.1	Integrated Transport System in City Logistics	5	Test
Total:		5	
Total for elective components:		38	

3.3 Educational objectives

3.3.1 Programme competencies

Integral competence:

Ability to solve complex tasks and problems in certain branches of professional activity or in the study process which provides for the pursuance of research and/or implementation of innovations and is characterized by uncertainty of conditions and requirements.

General competencies:

- Ability to initiate, develop and perform individually or in national (international) group projects on improvements in transport operations.
- Ability to organize group work and also motivate and manage its work.
- Ability to search, process and analyze information from different sources with the help of modern information and communication technologies.
- Ability to determine economic factors and provide the quality of conducting operations during the development and realization of complex actions and projects in compliance with the conditions of work, regulations of civil defence and environmental protection.

- Ability to communicate with a professional and general audience, present information in oral, printed or other forms in the native or foreign language on a professional level.
- Ability to use in practice different theories in the field of study, effectively using general teaching concepts.
- Ability to pursue research within a narrow specialization, detect problems, set tasks and solve them using appropriate methods of scientific research.

Professional competencies:

- Ability to study and manage the functioning of integrated transport systems.
- Ability to determine and implement promising directions of transport process simulation.
- Ability to use modern technologies of freight forwarding activity.
- Ability to perform project analysis for innovative and investment projects.
- Ability to manage supply chains and logistic centres.
- Ability to manage freight transportation by transport mode.
- Ability to manage passenger transportation by transport mode.
- Ability to research and control the movement of vehicles.
- Ability to manage the reliability and effectiveness of transport technologies by transport mode.
- Ability to use modern navigation methods in transport technologies by transport mode.

Professional competencies of speciality:

- Ability to use smart transport and logistics in cities.
- Ability to conduct an assessment of transport systems in city infrastructure.
- Ability to operate traffic flows in cities.
- Ability to operate movement on sections of a transport network.
- Ability to simulate route systems.
- Ability to use information technologies in traffic flow management.
- Ability to provide consolidation of freight flows.
- Ability to use multimodal transit systems.
- Ability to design smart transport and logistics systems in cities.

- Ability to conduct an assessment of reliability and safety of city logistics.
- Ability to research the psychology of movement and the influence of a person on transport system reliability.
- Ability to research and manage traffic flows in city centres.
- Ability to determine the effectiveness of city transport systems.
- Ability to determine the influence of transport on the environment.

For special (professional, subject) competencies:

- Improvement of approaches and methods for research and management of integrated transport systems.
- Justification of reasonability of measures for transport technology improvement with the use of simulation of transport processes. Conduct an assessment of effectiveness of chosen measures.
- Justification of the reasonability of implementation of modern technologies of freight forwarding services.
- Improvement of the approaches and methods for conducting the commercial, technical, social, ecological, institutional, financial and economic analysis during development of innovative and investment projects.
- Analysis and justification of the implementation of modern methods, to have the ability to conduct an analysis and calculation of economic operating rates of supply chains and logistic centres.
- Use of the informational resources for improving the supply chain modelling.
- Elaboration of measures for management of freight transportation using simulation of processes of freight transportation by transport mode.
- Elaboration of the measures for management of passenger transportation using simulation of processes of freight transportation by transport mode.
- Analysis and justification of the expediency of applying scientific recommendations and modern methods of vehicle movement management.
- Skills to investigate the theoretical and experimental models of management of reliability and effectiveness of transport technologies by transport mode.
- Justify the expediency of applying modern methods of navigation in transport technologies

by transport mode.

Skills:

- To analyse and develop methods of research into transport processes.
- To simulate material and transport flows.
- To find optimal solutions of application of smart transport and logistics in cities.
- To estimate the effectiveness of city transport systems.
- To analyse and simulate traffic flows in city centres.
- To estimate and forecast the parameters of material and human flows.
- To estimate existing and develop progressive methods of traffic flow management.
- To forecast and design systems of smart transport in cities.
- To forecast the development of the transport services market.
- To estimate the influence of people and environment on the safety and stability of city logistics.

Communication:

- Ability to communicate including oral and written communication in Ukrainian and English;
- Ability to carry out explanatory and awareness-building work among different groups and segments of the population with the aim of using smart transport and logistics in cities;
- Ability to describe the results of scientific research on smart transport and logistics in publications in national and foreign specialized publications.

Autonomy and responsibility:

- Ability to adapt to new situations and make decisions on one's own;
- Awareness of the necessity of life-long learning with the aim of enhancing knowledge already acquired and acquiring of new professional knowledge;

- Responsibility for ongoing work and achievement of set aims whilst adhering to the requirements of professional ethics.

3.3.2 Modules

The Tables below report the modules of the SmaLog degree.

Table 4 – Professional modules of the Masters programme

Module	
Economic efficiency of urban transport systems	Table 5
City passenger transport	Table 6
Intelligent transport and urban logistics	Table 7
Traffic flow simulating and management	Table 8
Intelligent transport systems	Table 9
Traffic flow management in the city centre (part 1 and 2)	Table 10
Human and environmental impact, safety and sustainability (part 1 and 2)	Table 11
Social and ecology efficiency of urban transport systems	Table 12
Smart transport and logistics for cities project	Table 13
Traffic control	Table 14
Freight transportation simulation	Table 15
Integrated Transport System in City Logistics	Table 16

Table 5 –Economic efficiency of urban transport systems

Title	Economic efficiency of urban transport systems
Number of ECTS	6 ECTS
Year and semester	2nd year, 3rd semester
Lecturer	Associate Professor Volodymyr Kovalyshyn
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	To obtain the knowledge and skills regarding smart transportation and logistics for cities. Objective: to define the challenges in urban transportation systems, namely passenger transportation, freight transportation, traffic taking into consideration intelligent transportation systems and new technologies. Competences: to analyze and justify modern techniques concerning transportation processes in cities etc; Learning outcomes: improvement of approaches and methods for research and control of the operation of integrated transport systems in cities, namely freight, passenger transportation etc;
Contents	Effective pricing policy. Factors affecting transportation demand. Weighted tariff system. Improvement of transport system infrastructure. Improving the quality of public transport. Investment attractiveness of public transport. Scripts of development of transport systems.
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Системологія на транспорті: Підручник: У 5 кн. – К.: Знання України, 2005 – Кн. IV:

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Support tools	R-project MS Office (Excel, Word, PowerPoint)

Table 6 – City passenger transport

Title	City passenger transport / City passenger transport Project
Number of ECTS	6 ECTS/3 ECTS
Year and semester	2nd year, 3rd semester
Lecturer	Associate Professor Mykola Zhuk
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	To acquire the knowledge concerning methods of formation and modelling of city passenger flows, assessment of quality of functioning of city transport systems (PTV Vision) Methods of modelling urban passenger correspondence using PTV Vision software products. Determination of passenger travel time in the route system using PTV Vision. Coordination of various types of public transport using VISUM. Customize individual vehicle redistribution options in VISUM. Ability: - to manage passenger transportation by type of transport; - to simulate route systems.
Contents	**Passenger Transportation Management** Strategies for demand management for transport services. Models of transport demand. Coordination of various types of public transport using VISUM. Distribution of trips by type of transport and analysis of the choice of the mode of transport. Factors influencing the performance of urban passenger transport. Customize individual vehicle redistribution options in VISUM. Manage the route. High-speed transport. **Human Factor in Passenger Transportation** Laws of perception of the driver of road conditions. Influence of planning features of routes on the driver's condition. Dynamics of changes in the ability to work during a working day. Ways to increase the reliability of work on the basis of the use of patterns of perception of the driver of road conditions. Influence of traffic conditions on the psycho-physiological state of the passenger. Determine the attractiveness of routes using fuzzy logic. **Routing Systems Simulation** Factors determining the demand for transportation. Methods of formation of passenger flows. Methods of modelling urban passenger correspondence using PTV Vision software products. Optimization models of city transport system formation. Determination of passenger travel time in the route system using PTV Vision. Methodology for assessing the quality of functioning of city transport systems.
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Ortúzar S, J. D. D. and Willumsen, L. G. (2001). Modelling transport. Chichester New York, J. Wiley. 3. Nuzzolo, A. and Lam, W. H. K. (eds. 2017), Modelling Intelligent Multi-Modal Transit Systems, CRC Press, Taylor & Francis Group, Boca Raton (FL, USA) 4. DG MOVE. European Commission: Study on Urban Freight Transport. FINAL REPORT. MDS Transmodal Limited in association with Centro di ricerca per il Trasporto e la Logistica (CTL), 2012. 5. Slinn M., Matthews P., Guest P. Traffic Engineering Design Principles and Practice. Second edition.

	— Elsevier Butterworth-Heinemann, 2005. 241 p.
Support tools	PTV Vision MS Office (Excel, Word, PowerPoint)

Table 7 – *Intelligent transport and urban logistics*

Title	Intelligent transport and urban logistics
Number of ECTS	7 ECTS
Year and semester	1st year, 1st semester
Lecturer	Associate Professor Mykola Zhuk
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	1. Improving approaches and methods for studying and managing the operation of integrated transport systems. 2. To analyze and substantiate the application of modern methods, have the ability to analyze and calculate the economic performance of the chain of supply and logistics centres. Using information resources to simulate supply chains. 3. To have skills in research of theoretical and experimental models of reliability management and efficiency of transport technologies by type of transport. 4. Analyze and develop transport research methods 5. To find optimal solutions for the application of intelligent transport and logistics in cities. 6. To predict and design smart city transport systems.
Contents	Analysis of transport networks. Functional principles of intelligent transport application. Network models and their use in urban logistics. Application of individual components of ITS. Methods of management of intelligent transport. Distribution strategies. Structure and functionality of the logistics network. The problem of arcing routing algorithms for accurate and approximate routing problems. Definition of logistic networks. Multi-level inventory management.
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Stock J, Lambert D (2001), Strategic Logistics Management, McGraw-Hill 3. Sussman, J. S. Perspectives on Intelligent Transportation Systems (ITS) [Текст] / Joseph S. Sussman. – Springer, 2005. – 229 p. 4. Chopra S., Meindl P., (2010) Supply chain Management. Strategy Planning Operation" 5. Ceder, A. (2015) Public Transit Planning and Operation: Modeling, Practice and Behavior, Second Edition - CRC Press Book. 6. Mogre, R. Intelligent Transportation Systems: A Private Organizations Perspective [Текст] / Riccardo Mogre. LAP Lambert Acad. Publ., 2010. – 156 p. 7. Hyndman, R. B. and Athanasopoulos, G. (2018) Forecasting: principles and practice. https://www.otexts.org/book/fpp2. 8. Support tools R - R Project for Statistical Computing MS Office (Excel, Word, PowerPoint).
Support tools	R-project PTV Visum Pupil world camera MatLab Statistica Mobile Mapping Systems MS Office (Excel, Word, PowerPoint)

Table 8– *Traffic Flow Simulating and Management*

Title	Traffic Flow Simulating and Management
Number of ECTS	6 ECTS
Year and semester	1st year, 1st semester
Lecturer	Sc.D., Prof. Yevhen Fornalchyk, Associate Professor Volodymyr Hilevych
Teaching method	Classroom teaching

Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	• Ability to organize group work and also motivate and manage its work. • Ability to search, process and analyze information from different sources with the help of modern information and communication technologies. • Ability to communicate with a professional and general audience, present information in oral, printed or other forms in the native language or in a foreign language on a professional level. • Ability to use in practice different theories in the field of study, effectively using general teaching concepts. • Ability to pursue research within a narrow specialization, detect problems, set tasks and solve them using appropriate methods of scientific research. • Ability to study and manage the functioning of integrated transport systems. • Ability to determine and implement promising directions of transport process simulation. • Ability to research and control the movement of vehicles. • Ability to use the modern methods of navigation in transport technologies by means of transport • Ability to use smart transport and logistics in cities. • Ability to conduct an assessment of transport systems in a city infrastructure. • Ability to operate traffic flows in cities. • Ability to operate the movement on sections of transport network. • Ability to simulate route systems. • Ability to use information technologies in traffic flow management. • Ability to perform the designing of systems of smart transport and logistics in cities.
Contents	While studying this discipline, the student acquires theoretical and practical knowledge and skills in developing and organizing traffic flow schemes, including: regulated and unregulated intersections. It is based on the results of laboratory work and course project, conducting individual studies on modelling these processes on computers. It discusses in detail the various modeling options using the the VISSIM software product and defines the main indicators of traffic flow efficiency of the intersection. The whole complex of such information meets the requirements of current norms, standards and methods of traffic safety organization.
Text books	1. Sy`stemologiya na transporti / Za zag.red. M.F.Dmy`try`chenka.- Kny`ga 1: Osnovy` teoriyi sy`stem i upravlinnya / Ye.V.Gavry`lov, M.F.Dmy`try`chenko, V.K.Dolya ta in.- K.: Znannya Ukrayiny`, 2005.-344 s. 2. Cascetta, E. (2009). Transportation Systems Analysis. Models and Applications. Springer. doi: https://doi.org/10.1007/978-0-387-75857-2 3. Semenov V.V. Matematy`cheskoe modely`rovany`e dy`namy`ky` transportnых potokov megapoly`sov / V.V.Semenov. Prepry`nt #34 Y`PM y`m. M.V.Keldыsha RAN- M., 2004.- 44 s. 4. Majorov N. N. Modely`rovany`e transportny`x processov: Uch. posob. / N. N.Majorov, V.A. Fety`sov.- M.:Transport, 2013.-164 s. 5. König, A., Grippenkoven, J. (2019). Modelling travelers' appraisal of ridepooling service characteristics with a discrete choice experiment. European Transport Research Review, 12 (1). doi: https://doi.org/10.1186/s12544-019-0391-3 6. Fornal`chy`k Ye.Yu. Upravlinnya dorozhnim ruxom na regul`ovany`x perexrestyax u mistax / Ye.Yu.Fornal`chy`k, I.A.Mogy`la, V.E.Trushevs`ky`j, V.V.Gilevy`ch/ Monografiya za zag.red.prof. Ye.Yu.Fornal`chy`ka.-L`viv:Vy`d-vo L`vivs`koyi politexniky`,2018.-236 s. 7. Khisty C.J., Lall B.K. (2002) Transportation Engineering. An Introduction. Third Edition. Prentice-Hall. 8. Sinha K.C., Labi S. (2007) Transportation Decision Making: Principles of Project Evaluation and Programming. Wiley.
Support tools	PTV Vissim, Algorithms and methods of mathematical statistics, Algorithms and methods for processing the results of video observation, Synthesis of domestic and foreign information sources, Radar for traffic data collection

Table 9– Integrated Transport Systems

Title	Integrated Transport Systems
Number of ECTS	6 ECTS
Year and semester	1st year, 2nd semester
Lecturer	Associate Professor Mykola Zhuk, Associate Professor Volodymyr Hilevych

Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	1. To simulate multimodal transport networks; 2. To forecast state variables and behaviour of transport network users; 3. To simulate multimodal transport networks in real time; 4. To support users in the multimodal network; 5. To design and manage multimodal intelligent transport systems operatively; 6. Improve the parameters of the demand and supply model.
Contents	ITS planning. Services for ITS users. Network models and their use in transport engineering. Forecast of network status variables. New technologies of ITS. Systems for monitoring, collecting and sending information about vehicles. Elements of the vehicle-infrastructure, user-control centre. Real-time transport network forecasting. Specification, calibration and testing of ITS models. Examples of application of ITS models.
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Ortuzar S, J. D. D. and Willumsen, L. G. (2001). Modelling transport. Chichester New York, J. Wiley. 3. Sussman, J. S. Perspectives on Intelligent Transportation Systems (ITS) [Текст] / Joseph S. Sussman. – Springer, 2005. – 229 p. 4. Ceder, A. (2015) Public Transit Planning and Operation: Modeling, Practice and Behavior, Second Edition - CRC Press Book. 5. Mogre, R. Intelligent Transportation Systems: A Private Organizations Perspective [Текст] / Riccardo Mogre. LAP Lambert Acad. Publ., 2010. – 156 p. 6. Hyndman, R. B. and Athanasopoulos, G. (2018) Forecasting: principles and practice. https://www.otexts.org/book/fpp2. 7. Support tools R - R Project for Statistical Computing MS Office (Excel, Word, PowerPoint).
Support tools	PTV Visum, Pupil world camera, MatLab, Statistica Mobile Mapping Systems

Table 10 – *Traffic flow management in the city centre (part 1 and 2)*

Title	Traffic flows management in the city center (part 1 and 2)
Number of ECTS	5 ECTS / 6 ECTS
Year and semester	1st year, 2nd semester / 2nd year, 3rd semester
Lecturer	Associate Professor Volodymyr Kovalyshyn, Assistant Oleh Hrytsun
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Aim	1. To appoint the necessary technical means of traffic organization when designing or reconstructing objects of traffic control; 2. To study the state of the level of road safety using qualitative, quantitative and topographical analysis of road traffic events; 3. Study traffic parameters; 4. To select the optimal conditions for managing transport processes in order to ensure the maximum efficiency of these processes at a given level of safety.
Contents	Network models and their use in transport engineering. Static modelling of traffic flows in the city centre: supply models (zoning, multimodal transport charts and network). Origin-Destination matrices; elements of random utility models; ways to select models; designation of models. Forecast of network status variables. Systems for monitoring, collecting, developing and sending information to a vehicle or to an infrastructure, and a user management centre. Elements of time series and stochastic processes, elements of further methods of forecasting. Real-time transport network forecasting. Appointment in real time, reverse appointment in real time. Delivery of model of estimation parameters. Estimation of the origin-destination matrix . Assessment of model requirements.
Text books	1. М.М. Жук, І.В. Коник, Ю.Я. Ройко, Б.М. Дівеєв, Р.Б. Рогальський. Дослідження дорожнього руху на вулично-дорожній мережі міста: практикум до виконання лабораторних робіт. – Львів.: НУ «ЛП», 2007. – 39 с. 2. E. Cascetta. Transportation Systems Analysis - Models and Applications (http://www.springer.com/it/book/9780387758565). 3. Forecasting: principles and practice by Rob J Hyndman (Author), George Athanasopoulos (Author)

	(https://www.otexts.org/book/fpp). 4. Applied Time Series Analysis with R. Wayne A. Woodward, Henry L. Gray, Alan C. Elliott (https://www.crcpress.com/Applied-Time-Series-Analysis-with-R-Second-Edition/Woodward-Gray-Elliott/p/book/9781498734226). 5. Е.В. Гаврилов, М.Ф. Дмитриченко, В.К. Доля, О.Т. Лановий, І.Е. Линник, В.П.Поліщук. Організація дорожнього руху. – К.: Знання України, 2005. – 452с. 6. Кременец Ю.А. Технические средства организации дорожного движения: Учебник для вузов / Ю.А. Кременец, М.П. Печерский, М.Б. Афанасьев. – М.: ИКЦ «Академкнига», 2005. – 280 с. 7. І.А. Вікович, М.М. Жук, Ю.Я. Ройко. Організація дорожнього руху. – Львів.: НУ «ЛП», 2006. – 162с. 8. Знаки дорожні. Загальні технічні умови. Правила застосування : ДСТУ 4100-2002 – [Чинний від 03 червня 2002]. – К. : Держстандарт України, 2002. – 63 с. 9. Розмітка дорожня. Технічні вимоги. Методи конролювання. Правила застосування : ДСТУ 2587-2010. – К. : Держстандарт України, 2010. – 70 с. 10. Світлофори дорожні. Загальні технічні вимоги, правила застосовування та вимоги безпеки : ДСТУ 4092-2002. – К. : Держстандарт України, 2002. – 21 с. 11. В.В. Сильянов, Э.Р. Домке. Транспортно-эксплуатационные качества автомобильных дорог и городских улиц. – М.: ИЦ «Академия», 2008. – 352с. 12. http://www.didattica.uniroma2.it/informazioni/index/insegnamento/174920-Teoria-Dei-Sistemi-Di-Trasporto-1-2.
Support tools	*PTV Visum, PTV Vissim, R-project, AnyLogic* *Statgraphics* *MS Office*

Table 11– Human and Environmental Impacts, Safety and Sustainability (part 1 and 2)

Title	Human and Environmental Impacts, Safety and Sustainability (part 1 and 2)
Number of ECTS	5 ECTS / 5 ECTS
Year and semester	1st year, 1st semester / 1st year, 2nd semester
Lecturer	Assistant Professor Taras Postranskyy
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Aim	1. Ability to start, develop and perform individually or in national (international) group projects on improvement operations in transport. 2. Ability to organize group work and also motivate and manage its work. 3. Ability to use modern freight forwarding technologies . 4. Ability to research and control the movement of vehicles 5. Ability to use smart transport and logistics in cities. 6. Ability to conduct an assessment of transport systems in a city infrastructure. 7. Analyze and justify expediency of applying scientific recommendations and modern methods of vehicle movement management. 8. Analyze and simulate traffic flows in city centres. 9. Ability to describe the results of scientific research on smart transport and logistics in publications in national and foreign specialized publications.
Contents	While studying this discipline, the student acquires theoretical and practical knowledge and skills in studies of traffic indicators and forecasting their changes in time. Also covered are documentary studies and modelling of movement in specialized software environments, as well as methods of measuring traffic flow. Analyzed methods for assessing the physiological indicators of the vehicle`s driver. Students using computer technology can research the indicators of the driver`s functional state.
Text books	1. Sy`stemologiya na transporti. Texnologiya naukovy`x doslidzhen` i texnichnoyi tvorchosti [Gavry`lov E. V., Dmy`try`chenko M. F., Dolya V. K. ta in.] ; za red. M. F. Dmy`try`chenka. – K. : Znannya Ukrayiny`, 2007. – 318 s. – (5 kn./ Gavry`lov E. V., Dmy`try`chenko M. F., Dolya V. K. ta in.; kn. 2). 2. Sy`stemologiya na transporti. Organizaciya dorozhn`ogo ruxu [Gavry`lov E. V., Dmy`try`chenko M. F., Dolya V. K. ta in.]; za red. M. F. Dmy`try`chenka. – K. : Znannya Ukrayiny`, 2007. – 452 s. – (5 kn./ Gavry`lov E. V., Dmy`try`chenko M. F., Dolya V. K. ta in.; kn. 4). 3. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 4. Ortu?zar S, J. D. D. and Willumsen, L. G. (2001). Modelling transport. Chichester New York, J. Wiley.

	5. Hyndman, R. B. and Athanasopoulos, G. (2018) Forecasting: principles and practice. https://www.otexts.org/book/fpp2 6. Ceder, A. (2015) Public Transit Planning and Operation: Modeling, Practice and Behavior, Second Edition - CRC Press Book. 7. Sy`stemologiya na transporti. Ergonomika / [ Gavry`lov E. V., Dmy`try`chenko M. F., Dolya V. K. ta in.] ; pid red. M. F. Dmy`try`chenka. – [5-ta kny`ga] – K. : Znannya Ukrayiny`, 2008. – 256 s. 8. Polishhuk V. P. Teoriya transportnogo potoku : metody` ta modeli organizaciyi dorozhn`ogo ruxu / V. P. Polishhuk, O. P. Dzyuba. – K. : Znannya Ukrayiny`, 2008. – 175 s.
Support tools	*PTV Visum, PTV Vissim* *CardioSens Complex* *NeuroCom Complex* *MS Office*

Table 12 – Social and ecology efficiency of urban transport systems

Title	Social and ecology efficiency of urban transport systems
Number of ECTS	6 ECTS
Year and semester	1st year, 1st semester
Lecturer	Associate Professor Volodymyr Kovalyshyn
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	1. To improve approaches and methods for conducting commercial, technical, social, environmental, institutional, financial and economic analysis in the development of innovative and investment projects. 2. To have skills in research of theoretical and experimental models of management of reliability and efficiency of transport technologies by types of transport. 3. To substantiate expediency of applying modern methods of navigation in transport technologies by type of transport.
Contents	Basic functions of the transport system. Improvement in public transport supply. Reduced travel time. Improved transportation comfort. Alternatives to mobility for all residential areas of cities. Legal basis of environmental activity. Influence of the transport system on the level of environmental pollution. Assessment of the harmful effects of cars on the environment. Regulation of rational development and land use. Efficiency of design decisions in the areas of intelligent transport and logistics for cities.
Text books	1. Екологія та автомобільний транспорт / [Гутаревич Ю. Ф., Зеркалов Д. В., Говорун А. Г. та ін.]. – Київ: Арістей, 2006. – 291 с. 2.Форнальчик Є. Ю., Демчук І. А. Аналіз стану із забрудненням автомобільною технікою повітряного простору міста Львова// Проблеми і перспективи розвитку автомобільної галузі. Матеріали Всеукраїнської науково-практичної конференції молодих учених та студентів, Донецьк, 2011, с. 248-250. 3.Форнальчик Є. Ю., Демчук І. А. Рівні технічного стану автомобілів та екологічної безпеки// Материалы Международной Научно-Практической конференции. Транспортные проблемы крупнейших городов, Харьков, 2012, с. 34-37. 4. Dablanc, L. (2007) Goods transport in large European cities: Difficult to organize, difficult to modernize. In Transportation Research Part A 41 (3), Elsevier, 280 – 285 5. Zhou M., Wang D., Li Q., Yue Y., Tu W., Cao R. (2017). Impacts of weather on public transport ridership: Results from mining data from different sources. Transport. Res. Part C: Emerg. Technol. 75. P. 17–29. 6. Розрахунок шуму та викидів CO2 в транспортній мережі міста Львова [Електронний ресурс] / Мазур В. В., Мельник М. Р. Режим доступу: http://ena.lp.edu.ua:8080/handle/ntb/4338. 7. Дідковський В.С. Порівняльний аналіз визначення шумових характеристик транспортних потоків / Дідковський В.С., Заєць В.П., Самійленко Н.О // Акустические прибори системы. – 2010. – с. 149-154. 8. Линник І. Е. Прогнозування екологічного стану автомобільних доріг / І. Е. Линник // Містобудування та територіальне планування. - 2014. - Вип. 53. - С. 288-296. - Режим доступу: http://nbuv.gov.ua/UJRN/MTP_2014_53_36. 9. Павлова І. О. Дослідження складових транспортного потоку на вулично–дорожній мережі міста / І. О. Павлова, І. С. Мурований // Міжвузівський збірник «Наукові нотатки». – Луцьк, 2011. – № 32. – с. 295 – 302.

	10. Методика розрахунку викидів забруднюючих речовин у повітря автотранспортом, який використовується суб'єктами господарської діяльності та іншими юридичними особами всіх форм власності. Затверджено наказом Держкомстату України від 6 вересня 2000 р. №293 із змінами і доповненнями, внесеними наказом Державного комітету статистики України від 13 січня 2004 р. №15. 11. http://www.emisia.com/.
Support tools	Copert, R-project, Copert Street Level MS Office (Excel, Word, PowerPoint)

Table 13 – Smart transport and logistics for cities project

Title	Smart transport and logistics for cities project
Number of ECTS	6 ECTS
Year and semester	2nd year, 3rd semester
Lecturer	Assistant Professor Taras Postranskyy
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	To obtain the knowledge and skills regarding smart transportation and logistics for cities. Objective: to define the challenges in urban transportation systems namely passenger transportation, freight transportation, traffic taking into consideration intelligent transportation systems and new technologies. Competences: to analyze and justify modern techniques concerning transportation processes in cities etc; Learning outcomes: improvement of approaches and methods for research and control of the operation of integrated transport systems in cities, namely freight, passenger transportation etc;
Contents	**Stakeholder analysis and the role of the public sector:** Differences between types of urban area. Road congestion. Conflict between UFT and pedestrians. Environmental pollution. Economic efficiency in urban distribution. **The urban freight and passenger transport markets in Ukraine and the EU** Retail (including e-commerce). Courier and post. Construction. Waste Regulatory measures. Market-based measures. Land use planning measures. Infrastructure measures. New technologies. Management and other measures. **European policy on urban transport** Efficient deliveries. Low emission vehicles. Intelligent Transport Systems. Night deliveries. Intermodal transfer facilities. Sustainable Transport Strategies. City Logistics in urban areas. Traffic and Environmental Impacts. Electrification of Public Transport in cities. Information systems for supporting network users. **Transport System in an ITS Context** Network models and their use in transport. Static simulation of transport network. Traffic flow theory. Demand models. Elements for the Evaluation and Comparison of Transportation System Projects **Intensive applications of ICT** Intensive applications of ICT and Intelligent Transportation Systems. Methods and tools of ICT and ITS for supporting planners and travellers in the management and fruition of multimodal networks. Logical and functional architecture with particular attention to smart cities. ITS in urban freight transport and traffic (Freight transport management systems: fleet management systems and tracking & tracing systems, access control systems, traffic management and information systems)
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Ortúzar S, J. D. D. and Willumsen, L. G. (2001). Modelling transport. Chichester New York, J. Wiley. 3. Nuzzolo, A. and Lam, W. H. K. (eds. 2017), Modelling Intelligent Multi-Modal Transit Systems, CRC Press, Taylor & Francis Group, Boca Raton (FL, USA) 4. DG MOVE. European Commission: Study on Urban Freight Transport. FINAL REPORT. MDS Transmodal Limited in association with Centro di ricerca per il Trasporto e la Logistica (CTL), 2012. 5. City Logistics Research. A Transatlantic Perspective. Summary of the First EU-U.S. Transportation Research Symposium. Transportation Research Board of the National Academies, Conference Proceedings 50, 2013, 98 P. (p. 18)

	6. The Seventh Framework Programme for R&D, Theme 3 "Information and Communication Technologies". Smart freight transport in urban areas. Available at http://www.smartfreight.info . 7. Khisty C.J., Lall B.K. (2002) Transportation Engineering. An Introduction. Third Edition. Prentice-Hall. 8. Sinha K.C., Labi S. (2007) Transportation Decision Making: Principles of Project Evaluation and Programming. Wiley.
Support tools	PTV Visum Pupil world camera Analysis methods Mobile Mapping Systems MS Office (Excel, Word, PowerPoint)

Table 14– Traffic control

Title	Traffic control
Number of ECTS	6 ECTS
Year and semester	2nd year, 3rd semester
Lecturer	Associate Professor Yuriy Royko
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	To obtain the knowledge and skills regarding smart transport. Objective: to define the challenges in urban transportation systems namely passenger transportation, freight transportation, traffic taking into consideration intelligent transportation systems and new technologies. Competences: to analyze and justify modern techniques concerning transportation processes in cities. Learning outcomes: improvement of approaches and methods for research and control of integrated transport systems operations in cities, namely freight, passenger transportation, etc;
Contents of part 1 Information Technologies in Traffic Managements	Road traffic monitoring systems Traffic intensity, traffic speed in real time. Traffic management decisions in real time. Methods of road traffic research. Methods of registration of on-road vehicles. Video monitoring of traffic. Traffic management centres. Road traffic control Systems control speed road traffic, speed measurement. Road speed limit enforcement. Automatic number-plate recognition. Vehicle recognition identification. Electronic toll collection systems. Traffic control systems to help monitor the movement and flow of vehicles on the road network. Control and guide for drivers Road signs, road surface marking, information to drivers and pedestrians. Online information for car park usage, pedestrian crossing usage, areas of low and high congestion, frequency, location and cause of road works. Network and traffic management systems ITS for the road network. Monitoring methods and technologies. Urban traffic management Classification of vehicle safety systems Classification of electronic vehicle safety systems. Electronic systems used in road vehicles: engine electronics, transmission electronics, chassis electronics. Passenger comfort. Infotainment systems. Active safety of vehicles Anti-lock braking system, electronic stability control, chassis assist, intelligent speed adaptation, brake assist, traction control, collision warning avoidance, adaptive or autonomous cruise control system. Passive safety of vehicles Passenger safety cell, deformation zones, seat belts, loadspace barrier-nets, air-bags, laminated glass, correctly positioned fuel tanks, fuel pump kill switches. Crash test car. Modern traffic safety systems

	System to prevent crashes caused by fatigue. Monitoring of the functional state of the driver. Sobriety detectors. Driver assistance systems that help the driver detect obstacles and drive a vehicle. Autonomous car. Safety of vehicles in the future. Classification of satellite navigation systems Civil and military uses. Global navigation satellite systems (GPS, GLONASS, Galileo, BeiDou-2). Regional navigation satellite systems (BeiDou-1, NAVIC, QZSS). Principles of satellite navigation systems operation Basic elements of satellite navigation. Working principles. Coordinate system. The system of time. Navigation radio signals. Navigation. Factors that affect the accuracy of positioning. Means for increasing the accuracy of positioning. Monitoring of vehicle traffic parameters by satellite navigation. Transport management using satellite navigation systems Features of application of navigation systems on transport. Features of navigation systems. Information support for navigation systems. Control of transport operations using navigation systems. Selection of traffic routes. Simulation of transport parameters by means of satellite navigation systems.
Text books	1. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. Springer. 2. Ortúzar S, J. D. D. and Willumsen, L. G. (2001). Modelling transport. Chichester New York, J. Wiley. 3. Nuzzolo, A. and Lam, W. H. K. (eds. 2017), Modelling Intelligent Multi-Modal Transit Systems, CRC Press, Taylor & Francis Group, Boca Raton (FL, USA) 4. DG MOVE. European Commission: Study on Urban Freight Transport. FINAL REPORT. MDS Transmodal Limited in association with Centro di ricerca per il Trasporto e la Logistica (CTL), 2012. 5. City Logistics Research. A Transatlantic Perspective. Summary of the First EU-U.S. Transportation Research Symposium. Transportation Research Board of the National Academies, Conference Proceedings 50, 2013, 98 P. (p. 18) 6. The Seventh Framework Programme for R&D, Theme 3 "Information and Communication Technologies". Smart freight transport in urban areas. Available at http://www.smartfreight.info . 7. Khisty C.J., Lall B.K. (2002) Transportation Engineering. An Introduction. Third Edition. Prentice-Hall. 8. Sinha K.C., Labi S. (2007) Transportation Decision Making: Principles of Project Evaluation and Programming. Wiley.
Support tools	PTV Visum Pupil world camera Mobile Mapping Systems

Table 15 – Freight Transportation Simulation

Title	Freight Transportation Simulation
Number of ECTS	6 ECTS
Year and semester	1st year, 2nd semester
Lecturer	Full Prof. Yevhen Fornalchyk
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	1. Improving approaches and methods for research and management of the operation of integrated transport systems. 2. Justification of feasibility of measures for improving freight transportation systems taking into account logistics using simulation. Evaluate the effectiveness of selected activities. 3. To analyze and substantiate expediency of applying scientific recommendations and modern methods of freight transportation management . 4. To have skills in research of theoretical and experimental models for managing reliability and efficiency of transport technologies by type of transport. 5. To substantiate expediency of application of modern navigation methods in managing freight traffic.
Contents	Urgency of modeing freight transportation processes. Cargo and cargo turnover. Features of freight transportation. Modelling the process of cargo transportation planning. Application of mathematical methods in the organization of cargo transportation. Reliability of the logistics system of cargo

	delivery. Methods of forming freight transport models. Modelling freight traffic in international traffic. Organization and management of principal centralized cargo transportation. Transport safety.
Text books	1. Tavasszy, L. and De Jong, J. (eds; 2014), Modelling Freight Transport, Elsevier, ISBN: 978-0-12-410400-6, 2014 2. Ben Akiva, M., Hilde Meersman and Eddy Van de Voorde (eds.; 2013), Freight Transport Modelling, Emerald Group Publishing Limited. 3. Rodrigue, J.P. (2013). The Geography of Transportation Systems. Routledge - Taylor & Francis Group. 4. Nuzzolo, A., Crisalli, U. and Comi, A. (2015). An aggregate transport demand model for import and export flow simulation. In Transport 30 (1), DOI:10.3846/16484142.2013.820215, Francis & Taylor, 43-54 5. Nuzzolo, A., Crisalli, U. and Comi, A. (2013). Ex-ante assessment of road transport emissions: application to the Italian case. In External costs of transport systems: theory and applications – Selected papers, U. Crisalli, E. Cipriani and G. Fusco (eds.), Franco Angeli Editore, Milan, chapter 14, 210 – 224. 6. Russo, F., Vitetta, A. and Comi, A. (2009). Estimation of target time distribution for agri-food products by road transport. In Schedule-Based Modeling of Transportation Networks: Theory and Applications, N. H. M. Wilson and A. Nuzzolo (eds.), DOI: 10.1007/978-0-387-84812-9_14, Springer Science + Business Media, 267 – 283. 7. Ben-Akiva M., de Jong G. (2008), The Aggregate-Disaggregate-Aggregate (ADA) Freight Model System, in Ben-Akiva M., Meersman H., & van der Voorde E., Eds., Recent Development in Transport Modelling –Lessons from freight sector , chapter 7, Emerald Group Publishing Ltd. 8. Polimeni, A., Russo, F., Vitetta, A., (2010). Demand and routing models for urban goods movement simulation. *European Transport* , 46, pp. 3 – 23. 9. Nuzzolo, A., Comi, A., (2014). City Logistics Planning: Demand Modelling Requirements for Direct Effect Forecasting. *Procedia - Social and Behavioral Sciences*, Volume 125, 20 March 2014, pp. 239 – 250. 10. Nuzzolo, A., Comi, A., (2015). Modelling challenges to forecast urban goods demand for rail. *Transport Problems*, 10 (4). pp.75 – 90.
Support tools	*PTV Visum* *AnyLogic* *Statgraphics* *MS Office*

Table 16 – Integrated Transport Systems in City Logistics

Title	Integrated Transport Systems in City Logistics
Number of ECTS	5 ECTS
Year and semester	1st year, 2nd semester
Lecturer	Associate Prof. Volodymyr Hilevych
Teaching method	Classroom teaching
Examination procedure	Written and Oral
Project foreseen	Individual project
Aim	To obtain the knowledge and skills regarding the analysis of urban freight transport and city logistics management. **Competence** Ability to research and manage city logistics. **Learning outcomes** After studying the course the students will be able: ✓ to improve approaches and methods for studying and managing integrated transport systems operations. ✓ to develop measures on cargo transportation management using modelling of freight transportation processes by mode of transport. ✓ to substantiate necessity of measures on improving transport technologies with the use of transport process modelling. To evaluate the effectiveness of selected activities.

Contents of part 1 Principles of Urban goods movements	**Principles of Urban goods movements** (Infrastructure problems, Goods transportation and traffic problems, Delivery periods, Urban freight transport sustainability, General typology of last-mile deliveries). **E-commerce** (Trends, performances, infrastructures and delivery structure). **Distribution centres and warehouses** (The scope of the warehousing problem in the city area, Rational location determination, The scenarios of location in case of transport modes, City transit impacts). **Identification of actors and choice dimensions** (Characteristic of the goods transportation actors, Definition of utility function, Transport service and modal choice utility functions, Probability of mode choice). **Shopping mobility: surveys** (Definition of methods for revealing shopping mobility activities). **Freight distribution: surveys** (Definition of methods for revealing freight distribution mobility activities). **Urban Goods movements: integrated modelling** (The Urban Goods movement in city transit, Constraints to urban goods movement). **Routing and schedule models** (General statement of city freight transportation routing, Iterated Nearest Insertion Algorithm, Genetic Algorithm, The vehicle routing and scheduling problem with time windows). **Impacts of the integrated transport system** (Identification of relevant impacts, Identification and estimation of impact indicators of ITS, Computation of users' surplus changes, Benefit-cost analysis, Revenue-cost analysis). **City logistics measures** (Urban goods movements and its actors, Material infrastructure measures, Immaterial infrastructure measures, Equipment measures, Governance measures). **Freight distribution: surveys** (City logistics planning objectives, Formulation and ex-ante assessment of alternative planning scenario, Direct effect target and outcome indicators).
Text books	1. Eiichi Taniguchi, Russell G. Thompson(2001) City Logistics: Network Modelling and Intelligent Transport Systems, 264 2. Cascetta, E. (2009). Transportation Systems Analysis: Models and Applications. 2nd edition. Springer. 760 p 3. Nuzzolo, A., Comi, A., (2014). City Logistics Planning: Demand Modelling Requirements for Direct Effect Forecasting. *Procedia - Social and Behavioral Sciences*, Volume 125, 20 March 2014, pp. 239 – 250. 4. Nuzzolo, A., Comi, A., (2015). Modelling challenges to forecast urban goods demand for rail. *Transport Problems*, 10 (4). pp.75 – 90. 5. Guidebook for Understanding Urban Goods Movement (2012) 6. Diego Cattaruzza, Nabil Absi, Dominique Feillet, and Jesús González-Feliu (2017) Vehicle Routing Problems for City Logistics
Support tools	*PTV Visum* *AnyLogic* *Statgraphics* *MS Office*

3.3.3 Employment opportunities

Graduates who hold a Master degree in the field of Smart transport and logistics for cities (Transport Technology (in motor transport)) may have the following professional titles (according to Ukrainian encoding):

- 2149.1 - scientific staff;
- 2149.2 - engineers;
- 2149 - professionals in other fields of engineering;

- 2310 - teachers at universities and higher educational establishments;
- 2359 - other professionals in the field of education;
- 2359.1 - other academic staff in the field of training under the Classification of Occupations are valid from November 1, 2017.

Graduates will be able to hold the following positions:

- Engineer in management and organization of transportation (II category);
- Transport engineer at transport enterprises, in the management of public and passenger transport, transport and communications management of the region, district and city administration, in research laboratories of design institutes and institutes of forensic examinations, in transport and forwarding enterprises;
- Engineer in employee training and retraining departments;
- Teacher at higher education institutions, assistant in higher educational establishments;
- Junior researcher at research and development institutions of transport, design organizations.

Graduates have the right to engage in such activities in accordance with the classifier of economic activities (КВЕД ДК 009: 2010 (2017)):

- Section "M" - Professional, scientific and technical activities, section 72 - Research and development, class 72.19 - Research and experimental development in the field of other natural and technical sciences;
- Section "H" - Transport, Warehousing, Post and Courier Activities, Section 52 Warehousing and auxiliary transport activities, group 52.2 - Support activities in the field of transport, class 52.21 - Support services for land transport.
- Section "H" - Transport, warehousing, postal and courier activities, section 49 - Land and pipeline transport, group 49.4 - Freight transport by road, provision of transportation services, class 49.41 - Freight transport by road.

3.3.4 Prerequisites (Admission procedure):

Possession of a first (Bachelor's) degree or qualification level of a specialist. The procedure for admission to the Master degree is based on the students' rating and examination. The dates of the admission procedure run from July to August.

3.3.5 Cycle / Level

National Qualifications Framework of Ukraine - 7th level, FQ-EHEA - second cycle, EQF-LLL - 7 level.

3.3.6 Teaching and learning

Lectures, laboratory work, practical training, individual work based on textbooks, tutorials and lecture notes, consultations with teachers, scientific seminars, demonstration classes, elements of distance (on-line, electronic) training of passing practice to profile enterprises and in research institutions, performance of scientific research, traineeship, preparation for Master qualification work.

The Department of Transport Technologies owns the "Traffic flow simulation" Laboratory, which students use during their studies.

The scientific component of the educational-scientific programme involves conducting one's own Master's scientific research under the guidance of a scientific supervisor. The results are issued in the form of a master's qualification.

An integral part of this programme`s scientific component is the preparation and publication of scientific articles, talks at scientific conferences, scientific workshops, round tables, symposiums.

3.3.7 Evaluation

Cumulative points-rating system which provides evaluation of students for all types of classroom and extracurricular study and research activities, aimed at acquiring academic workload from the educational-research programme: continuous assessment, laboratory reports, oral presentations, course project presentations, written and oral exams and final tests, exams from special courses of scientific research in speciality, final tests from scientific research and practicum, educational-research practice and practice on the subject of the Masters qualification work, presentation of Masters qualification work.

3.3.8 Personnel support

Masters training in the speciality SmaLog (275 Transport technologies (on motor transport)) - is provided by the Transport Technologies Department of the Institute of Engineering Mechanics and Transport of the Lviv Polytechnic National University.

In all, 26 lecturers hold lectures, practical and laboratory classes in the Department of Transport Technologies.

The structure of the personnel, the system of selection, use, advanced training, the dynamics of the composition of scientific and educational staff is sufficient to ensure the high-quality training of specialists at Masters level.

3.3.9 Internship

Internship for students consists of two types:

1. Scientific practice;
2. Practice on the topic of the Masters.

A student can practice, for example:

- in research institutions;
- at university departments;
- in transport companies;
- in public or private institutions;
- in colleges and vocational schools.

The student's design plan and experimental work is approved by the head.

After completing the practice, the student must pass the assessment stage and take a test, which is conducted at the department.

3.4 Equipment and material

the following categories of equipment and material support students and teachers in providing studying and teaching process (Table 3):

- computers, software packages and peripheral equipment;
- multimedia equipment to be used for visualization and direct presentation during auditorium classes;
- special technical equipment which will be used during practical training and laboratory work;
- teaching materials which are up-to-date and support Master/PhD student training;
- special software which has been revised to improve the quality of SmaLog training.

Table 3 – Equipment available for SmaLog students

Computers	**Quantity**
Workstation	1
Monitor 27"	15
Patriot Optim Mini N3150/60	15
Peripherals	
LAPTOP HP ProBook 430 G5 (1LR32AV_V7) Silver	2
Printer Epson L1455 with WI-FI (C11CF49403) + USB cable	1
Mouse	15
Keyboard	15
Software	
WinMultiPointSvrPrem 2012 RUS OLP NL Acdmc	1
WinMultiPointSvrCAL 2012 RUS OLP NL Acdmc wWinSvrCAL DvcCAL (11 unit)	15
STATGRAPHICS Centurion XVI (32-bit/64-bit) Multilingual (5 unit (1525 per/unit)	5
PTV Vision Traffic Suite (Visum, Vissim, Vistro) academic licence	1
AnyLogic University Researcher	1
One Year of Maintenance and Technical Support Services for AnyLogic University Researcher (2 years)	1
AutoCAD Civil 3D 2018	1
Copert street level	
Multimedia equipment	
BenQ MS527 (9H.JFA77.13E) (Мультимедийный проектор)	1
VGA ATcom M/M 15м (9152) (кабель)	1
Walfix PB-14B (Кронштейн для проектора)	1
Intech RD80A (Интерактивная доска)	1
Walfix SNM-4 120" (Проекционный экран)	1
Technical training	
traffic counting radar tms-sa	1
Pupil world camera	1
Books	
Urban Transportation and Logistics: Health, Safety, and Security Concerns	
Public Transit Planning and Operation: Modeling, Practice and Behavior, Second Edition	
Modelling Intelligent Multi-Modal Transit Systems	
Transportation Systems Analysis	

4 Conclusions

Provision of training of highly qualified specialists in speciality 275 “Transport technologies”, specialization “Smart transport and logistics for cities” able to implement smart transport in city transport systems, make decisions on development of transport systems and logistics in cities, impact of persons on safety and stability of city logistics and estimate the effectiveness of city transport systems and also prepare students for further employment in their chosen speciality.

The educational-research programme is based on the results of state-of-the-art knowledge in smart transport and logistics in cities, urban passenger transport, traffic flow simulation, road traffic management, freight transportation, management of traffic flows in city centres, impact of persons and environment on safety and stability of city logistics and also the effectiveness of city transport systems. This raft of knowledge is designed to enhance the Master students’ professional skills and provide a sound framework for a professional and scientific career.