Universitat Autònoma de Barcelona

2022/2023

Material Handling System Design and Analysis

Code: 42635
ECTS Credits: 10

Degree	Type	Year	Semester
4313489 Logistics and Supply Chain Management	OT	2	1

Contact

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Use of Languages

Principal working language: english (eng)

External teachers

Prof. Dr. Gaby Neumann

Prof. Dr. Jens Wollenweber

Prerequisites

The student has to have successfully passed the following subjects:

- Decision making (42653)
- Material handling and transportation technologies (42651)
- Information Technology (42657)
- Supply Chain Network & Flow Management (42644)

Objectives and Contextualisation

This module has two course units: Simulation-based analysis and design of material handling systems (Prof. Dr. Gaby Neumann) and Analysis and design of transportation networks (Prof. Dr. Jens Wollenweber).

CU1: Simulation-based analysis and design of material handling systems (5 ECTS)

After the course the student will:

- Understand specific requirements of material handling systems and their design
- Be able to apply procedure, methods, tools for MHS analysis and design, esp. simulation methodology
- Understand subject, steps and constraints of tendering procedure, offer preparation and tender processing

CU2: Analysis and design of transportation networks (5 ECTS)

Students will gain an understanding of

- the decision making process in logistics and transportation
- the process of designing transportation networks
- modelling and solving related decision problems

Students will be able to solve strategic, tactical and operational decision problems

- for clustering/covering problems
- for assignment problems
- for finding optimal facility location

Competences

- Address problems of management and coordination of logistics operations in production, transport and services in a holistic approach, by means of the consistent application of the supply chain management concepts and strategies, taking into account the pertinent aspects of environment, human capital, quality, technology, and economics.
- Apply a rigorous and efficient approach to problem solving.
- Apply quantitative methods and techniques based on optimisation and/or simulation models in order to evaluate the different alternatives and select the most promising solution to be implemented
- Demonstrate abilities to document and reflect the problem-solving process in order to extract the lessons learned.
- Elaborate solid arguments based on quantitative models and analytical methods in order to convince and motivate decision makers, determine the adequate LCSM partners and then plan and coordinate the project to implement the solution.
- Face a new problem under a scientific perspective.
- Identify the main aspects to be planned in the resolution of a logistic project, specifying the project boundaries, and leading with a solution
- Select and apply the most relevant analytical methodologies, strategies and current technologies for designing solutions to the problams of management and coordination of material, information and financial flows.
- Student should possess an ability to learn that enables them to continue studying in a manner which is largely self-supervised or independent
- Students should be able to integrate knowledge and face the complexity of making judgements from information which, being incomplete or limited, include reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements
- Students should know how to communicate their conclusions, knowledge and final reasoning that they hold in front of specialist and non-specialist audiences clearly and unambiguously
- Work collaboratively in a group.

Learning Outcomes

1. Address MHS design problems from a holistic approach.
2. Apply a rigorous and efficient approach to problem solving.
3. Demonstrate abilities to document and reflect the problem-solving process in order to extract the lessons learned.
4. Elaborate solid arguments to convince/motivate decision makers.
5. Evaluate alternatives and select the MHS solution to implement.
6. Face a new problem under a scientific perspective.
7. Identify the main aspects to be planned in the resolution of a logistic project, specifying the project boundaries, and leading with a solution
8. Select and apply the right methodologies and strategies for the development of technical solutions in material handling problems.
9. Student should possess an ability to learn that enables them to continue studying in a manner which is largely self-supervised or independent
10. Students should be able to integrate knowledge and face the complexity of making judgements from information which, being incomplete or limited, include reflections on the social and ethical responsibilities linked to the application of their knowledge and judgements
11. Students should know how to communicate their conclusions, knowledge and final reasoning that they hold in front of specialist and non-specialist audiences clearly and unambiguously
12. Work collaboratively in a group.

Content

CU1: Simulation-based analysis and design of material handling systems (5 ECTS)

Introduction to material flow planning

- Terminology
- Principles and procedure in material flow planning
- The use of simulation in material flow planning
- Knowledge management in material flow planning

Analysis of materials handling systems

- Overview: How to investigate material flows
- Procedure and methods for material flow analysis
- Evaluating material flows
- Approaches for optimizing material flows
- Case 1: Analysing a materials handling system

Design of materials handling systems

- Overview: How to design material flows
- Specific planning problems: planning material flows in production, warehouse planning, planning order picking systems, designing logistics buildings
- Approaches for evaluating alternative solutions in material flow design
- Case 2: Designing a materials handling system

Tendering procedure

- Tendering procedure
- Requirement specification and tendering

CU2: Analysis and design of transportation networks (5 ECTS)

Part A: Selected theoretical basics for logistical decisions

1. Model building
2. Decision making and optimisation
3. Optimisation software

Part B: Modelling and solving of selected logistical decisions

1. Clustering Algorithms/Covering problems
    - C-means algorithms
    - Fuzzy C-Means algorithm
    - Set Covering problems
    - Maximum covering problems
2. Logistical Assignment Problems
    - The Standard Assignment Problem
    - Maximum Cardinality Problems
    - Generalised Assignment Problems
3. Location Problems
    - Facility Location Problems
    - Hub Location Problems

Methodology

Teaching will be offered on campus or in an on-campus and remote hybrid format depending on the number of students per group and the size of the rooms at maximum capacity allowed by local rules at any time of the semester.

CU1: Simulation-based analysis and design of material handling systems (5 ECTS)

The course is organized by means of traditional lectures combined with seminars and practical work. The learning process will combine the following activities:

- Classroom sessions: include theory lectures and guest lectures by Industry logistics management professionals and experts. Aims to understand specific requirements of material handling systems and their design; specify procedure for material handling system analysis and design; explain simulation application in material handling system analysis and design; understand subject, steps and constraints of tendering procedure, offer preparation and tender processing
- Lab sessions: include calculation exercises, guided exercises in software application, classroom discussions. Aims to calculate material handling system performance limit; build, validate, run simulation models using DOSIMIS-3 simulation package; evaluate and discuss alternative material handling system solutions.
- Case study: group work, project reporting, student presentation. Aims to apply procedures, methods, and tools for material handling system analysis and design, esp. simulation methodology; evaluate different alternatives and select the material handling system solution to be implemented; elaborate solid arguments to convince and motivate decision makers; run and manage a material handling system design project in a market setting.
- Autonomous work: reading, self-testing, reflecting. Retrieve and analyse information from different sources; reflect learning and problem solving processes in order to derive lessons learned.

CU2: Analysis and design of transportation networks (5 ECTS)

The course is organized by means of traditional lectures combined with seminars and practical work. The learning process will combine the following activities:

- Classroom sessions: include theory lectures and classroom discussions. Aims to understand theoretical issues of the decision making process in logistics environments and for modelling and solving selected logistics decision problems.
- Computer lab: includes supervised use of decision support software and classroom discussion. The students will be able to analyse selected logistics decision problems, to formulate the mathematical model, to allocate the required data and to solve it with Optimization Studio.
- Case study: group work, project reporting, student presentation. Aims to design, model and solve decision problems, esp. related to transportation networks; design and optimize a transportation network including the retrieval and evaluation of relevant market and cost data
- Autonomous work: reading, self-testing, reflecting. Retrieve and analyse information from different sources; reflect learning and problem solving processes in order to derive lessons learned.

The proposed teaching methodology may undergo some modifications according to the restrictions imposed by the health authorities on on-campus courses.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
CU1. Practical sessions	30	1.2	1, 5, 3, 4, 8, 2, 12

CU1. Theory lectures	30	1.2	1, 5, 4, 8
CU2. Practical sessions	30	1.2	1, 5, 3, 6, 2, 12
CU2. Theory lectures	30	1.2	1, 5, 4, 8
Type: Supervised			
CU1. Case Study	50	2	3, 7, 10, 11, 8, 6, 2, 12
CU2. Case Study	50	2	3, 10, 11, 8, 6, 2, 12
Type: Autonomous			
CU1. self-learning	15	0.6	1, 5, 4, 9, 8
CU2. self-learning	15	0.6	1, 5, 4, 9, 8

Assessment

CU1: Simulation-based analysis and design of material handling systems (5 ECTS)

The final mark of this course will be calculated from the assessment of following evaluation activities:

- Case study MHS. For a given scenario current system design and performance is to be described in a formalized way, represented by a simulation model and analysed by use of simulation technology. Needs for improvement are to be specified as well as future system requirements. For matching them, appropriate (alternative) technical solutions are to be developed, investigated, evaluated and selected. The favourite solution is to be presented in respective tender documents and as 3D VR scene. Procedure and outcomes of the case study are described, discussed and presented to decision makers in an attractive way.

CU2: Analysis and design of transportation networks (5 ECTS)

The final mark of this course will be calculated from the assessment of following evaluation activities:

- Case study TN. For a certain geographical region an entire network planning and optimisation process has to be developed and executed, applying proper decision models. Procedure and outcomes of the case study are described and discussed in a project report and presented to decision makers in an appropriate way.

CU1 and CU2

The student passes the module if each of the case studies is evaluated "sufficient" (grade 4.0 corresponding to a minimum of 50% of the maximum performance per evaluation activity) at least. The student fails if performance in at least one of the evaluation activities does not reach the 50% threshold or if any evaluation documents (reports, presentations, models) on case studiesare not submitted within the due dates specified by the respective professor.

In case of fail the student needs to retake just that part of module exam s/he failed. The decision about this is in hands of the respective examiner. If any of the case studies is failed, the student will either be provided with a new case study or asked to re-submit its report according to the corrections/indications provided by the professor.

Students who fail an exam may be permitted the opportunity to retake this examination twice at a maximum. After that, his/her right for examination terminates. Retaking an exam is allowed only in case the student previously failed, but not to improve grades achieved so far.

Submission deadlines for case studies and any presentation activities related to them are announced when giving case studies to students. Specific examination dates are published on the university's website.

The weights of all evaluation activities are given in the table below.

The proposed evaluation activities may undergo some changes according to the restrictions imposed by the health authorities on on-campus courses.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
CU1. Case Study	50%	0	0	1, 5, 3, 4, 7, 10, 11, 9, 8, 6, 2, 12
CU2. Case Study	50%	0	0	1, 5, 3, 4, 7, 10, 11, 9, 6, 2, 12

Bibliography

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Gudehus, T.; Kotzab, H.: Comprehensive Logistics; 2nd ed., Springer: Berlin and Heidelberg, 2012.

Hillier F., Lieberman G.: Introduction to Operations Research, 10th ed., Irwin Industrial Engineering, 2014

Law, A. M.: Simulation Modeling and Analysis, 5th ed., McGraw-Hill: New York, 2015.

Rodrigue, J.-P.: The Geography of Transport Systems, 5th ed., Routledge, New York, 2020.

Rushton, A.; Croucher, P.; Baker, P.: The Handbook of Logistics and Distribution Management; 6th ed., Kogan Page: London and Philadelphia, 2017

ten Hompel, M.; Schmidt, T.: Warehouse Management. Automation and Organisation of Warehouse and Order Picking Systems; Springer: Berlin and Heidelberg, 2014.

Tompkins, J.; White, J.; Bozer, Y.; Frazelle, E.; Tanchoco, J.; Trevino, J.: Facilities Planning; 4th ed.; John Wiley&Sons: New York, 2010.

The Transportation Planning Process: Key Issues, U.S. Department of Transportation: Washington DC, 2015.

VDI standards: several standards available on the topics of this course; search the database on www.vdi.eu (in English) or www.vdi.de (in German)

Software

DOSIMIS-3 (simulation package)

taraVRbuilder (software tool for dynamic 3D visualisation of logistics systems)

ILOG Optimization Studio by IBM.