Universitat Autònoma de Barcelona

2023/2024

System Thinking

Code: 44759
ECTS Credits: 6

Degree	Type	Year	Semester
4318306 Logistics and Supply Chain Management	OB	1	1

Contact

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Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject. Please note that this information is provisional until 30 November 2023.

Prerequisites

There are no requirements

Objectives and Contextualisation

Objectives and Contextualisation
It is well accepted that a supply chain (SC) is a complex system due to the difficulty to understand the underlying dynamics and its interdependencies, which can drastically affect its behaviour, and in consequence generates uncertainty to properly coordinate the different operations.
A comprehensive systems approach is a requirement for a better understanding of the different emergent dynamics which usually appears in systems characterized by a large amount of components with tight interdependencies. Quantitative models are frequently proposed for forecasting purposes, however, they lack of supporting tools for a better understanding of the system dynamics, which sometimes requires an interdisciplinary approach to consider also the human factor.
The main objective of this subject is to introduce a causal approach to develop efficient transparent models enhancing simulation tools with the capability to explore uncertainties, trend breaks, and discontinuities; and extend their potential to foster deliberation; and their relevance to decision makers. For this purpose, students will be trained with the use of Coloured Petri Net formalism to represent the cause-effect relationships that underlies in most SC systems, and the analysis of the state space for a better understanding of the so called emergent dynamics.
The set of sub-objectives of this subject are:
Introduce a holistic analysis approach, as opposed to reductionist, as a set of diverse interacting agents within an environment.
Recognize that the relationships or interactions between elements are more important than the elements themselves in determining the behaviour of the system.
Recognize a hierarchy of levels of systems and the consequent ideas of properties emerging at strategic, tactic and operational levels, and mutual causality both within and between levels.
Introduce influence variables for a better understanding of human behaviour in a supply chain system.

Learning Outcomes

1. CA02 (Competence) Interpret and develop LSCM systems as complex structures by understanding the part in relation to the whole.
2. CA03 (Competence) Develop arguments based on quantitative models and techniques.
3. KA04 (Knowledge) Select systems analysis methods and recognise the principles of systems engineering.
4. KA05 (Knowledge) Identify and model dependencies, influences and impact relationships among the components of a system.
5. KA06 (Knowledge) Identify and model emerging properties and key performance indicators.
6. SA05 (Skill) Analyse complex systems in relation to their performance and responsiveness.
7. SA06 (Skill) Use the methods and principles of LSCM systems analysis, evaluation and design.
8. SA06 (Skill) Use the methods and principles of LSCM systems analysis, evaluation and design.

Content

THEORY
ST.T.1: Introduction to Complexity
ST in Logistics
Flexibility as a source of Complex Problems
Key Parameter Indicators
Key Parameter Indicators
ST.T.2: Discrete Event System Modeling
Definition and concepts.
Petri Nets: Specification of logical relationships in the logistic field.
Coloured Petri Nets: Specification of the information flow
ST.T.3: State Space
The reachability tree
Cause-effect analysis
Mitigation mechanisms of undesirable dynamics
ST.T.4: Causal Simulation Models
Try and error approach
Verification of Simulation Models
Validation of Simulation Models
ST.T.5: Experimental approaches to remove non-added-value operations:
Bottleneck evaluation.
Policies based on the Little Law.
Algorithm to minimize the standard deviation in manufacturing
PROBLEMS
ST.P.1 Examples:
Simulation of a multimodal transport system
Simulation of warehouse
Simulation of an airport terminal
Simulation of a turnaround
ST.P.2 Petri Net Exercises
ST.P.3 Coloured Petri Net Exercises
ST.P.4 CPN-Tools Exercises
ST.P.5 State Space Exercises
PRACTISE
ST.L.1 Introduction to SIMIO
ST.L.2 Serial Manufacturing Line
ST.L.3 Animation Modules in SImio
ST.L.4 Routing Material Flows

ST.L.5 Flowchart Simio Processes
ST.L.6 Simulation Project

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 50% capacity."

The course is organized by means of lectures. The learning process will combine the following activities:
Theory lectures
Problem sessions
Practise sessions: computer lab, teamwork and oral presentation
Autonomous work
Practical case studies and simulation tools are used for promoting students hand on skills.
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.

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Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Personal Study	34	1.36	CA02, CA03, KA05
Problem Sessions	10	0.4	CA02, KA05
Theory Lectures	20	0.8	CA02, CA03, KA04, KA05, SA05
Type: Supervised			
Lab exercices	15	0.6	KA06, SA06
Type: Autonomous			
Modeling	70	2.8	CA02, KA04, KA05, KA06

Assessment

The proposed evaluation activities may undergo some changes according to the restrictions imposed by the health authorities on on-campus courses.
The final grade will be calculated from the assessment of different evaluation activities:
Petri Net exercises
State Space analysis of a case study and oral presentation.
Simulation models and report of 2 case studies.
In order to average all the evaluation activies, the mark of each of them must be above 5 points (out of 10). All the report-based activities must be submitted within the due dates specified by the professor. If a report-based activity is failed, the student will be asked to re-submit its report according to the corrections/indications

provided by the professor.
If the oral presentation is failed, the student will have the opportunity to work in a second case study for a short period of time, that will be communicated to the student well in advance.
The weights of each evaluation activity are given in the table below.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Petri Net Exercises	15%	0	0	CA02, KA04, KA05
Simulation Models	35%	0	0	CA03, KA06, SA05, SA06
State Space analysis and Presentation	50%	1	0.04	CA02, CA03, KA05, SA05, SA06

Bibliography

Flores, Guasch, Mujica, Piera, "Robust Modeling and Simulation", Springer. 2017.

N.Viswanadham,Y. Narahari. Performance Modeling of Automated Manufacturing Systems. Prentice Hall. 1992.
Merkuryev, Merkureva, Guasch, Piera: Simulation-Based Case Studies in Logistics: Education and Applied research. Springer London. 2009.
Jamshid Gharajedaghi. Systems Thinking: Managing Chaos and Complexity. Elsevier.

Further readings
Javier Campos, Carla Seatzu, Xiaolan Xi. Formal Methods in Manufacturing. CRC Press 2014.
Taylor. Agent Based Modeling and Simulation. Palgrave Macmillan. 2014
N. Gilbert . Simulation for the Social Scientist.. Open University Press.

Software

CPN-Tools (https://cpntools.org)
SIMIO