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TU-E2021 - Advanced Operations Management (5ECTS)

Syllabus, version 1.1, January 6th, 2021

OVERVIEW

The course covers key operations topics from demand analysis to operations strategy. Moving from demand analytics and forecasting models, to planning processes and coordination of supply and demand through sales and operations planning. Based on the analysis of the demand side, we will design competitive operations with the use of process analysis and design, factory physics and supply chain design. We will evaluate solutions to operations problems using the fundamental models and relevant analytics and simulation tools, valuing operations flexibility, costs, network design, and optimizing capacity and decisions under uncertainty. We will also cover state-of-the art of planning and control of supply chains from practice and theory.

This is a case-based course, and we will use different methods for working on operations analytics and simulation. There are two types of assignments during the course. Weekly case assignments with questions requiring quantitative and qualitative analysis of the given case and its topic for the week. Simulation exercise assignments with two smaller and one larger, which are done in groups. The weekly case assignments are not extensive reports but more specific questions regarding the cases that need to be answered.

The cases have been chosen to correspond to what participants will experience in managing operations and supply chains in the workforce. The course analysis tool are spreadsheets (student can choose to use e.g., R, Python or Matlab as an alternative). Process simulation exercises and project will be done with a discrete-event simulation tool Simul8.

This course is for master students who already have background knowledge operations management, with prerequisites for the course basic course in operations management (e.g., TU-C2020).

LEARNING OBJECTIVES

After completing the course, you have developed following skills:

- Can evaluate, analyze and choose appropriate approaches for design, plan and control of advanced operations in global supply chain context
- Can model different supply chain designs and planning solutions to address various trade-offs in operations management
- Can apply analytical or simulation models with different OM models to solve challenging supply chain problems and use these to evaluate the suitability of solutions in different contexts: can identify the relevant drivers of performance and constraints in the environment and linked to the business strategy
- Identifies and can analyze the changes and benefits from digitalization and advancement of production technologies

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COURSE FORMAT

The course combines interactive lectures and case discussion sessions with individual study of technical materials and solving data-analysis problems linked to the cases. Each week consists of two sessions:

- **Monday sessions 10:00-12:00** (11.1-15.2) focus on the theoretical and technical concepts and different advanced operations management topics and how to apply the fundamental operations management concepts in analyzing operations. Teaching methods include lecturing, discussions and small in-class assignments. Some part of the theoretical and technical concepts can be provided asynchronously.
- **Thursday sessions 16:15-18:00** (14.1-18.2) focus on practical applications of the operations management frameworks and theories in cases. We will discuss the applications and solutions that students have developed for the weekly case. We will also focus on the general insights and value of the solutions for design and management of competitive operations in general. In the Thursday sessions, the students take an active role in case discussion and will be prepared to justify the logic and insight of their case solutions that were prepared before the session.
- **Simulation sessions Mondays 08:30-10:00 (**21.1, 28.1, 11.2, 18.2) Simulation exercises focus on *Factory Physics* from basic to more advanced concepts of how processes behave and how to analyze and design processes to deliver on the target performance. This is done with discrete event simulation analysis. The simulation session presents some theoretical knowledge and instructs using of the simulation software that you use in small groups to solve small simulation assignments.

This is an active learning course and some preparation is needed prior to both weekly sessions:

- **Monday sessions**: We will discuss the theoretical and technical concepts and their application within different areas of operations management. The focus of Monday sessions is on building a toolbox for analyzing operations from understanding demand to designing processes that deliver the performance. Students are expected to engage in group and class discussions and when there are some assigned readings, the students have familiarized with them prior to the session.
- **Thursday sessions**: Students will have prepared and returned their weekly case assignment, which will include both practical analysis of case data and also thinking and reflection of the operations strategy and the value of the solutions. The weekly returned assignment contains the student's answers to the case assignment questions and short reasoning behind the answers.
- **Simulation sessions**: Simulation exercise sessions present some technical and theoretical concepts and are aimed at walking through the simulation exercises.

TIMETABLE

LECTURES AND CASE SESSIONS

In 2021 the course will be taught online with all teaching and interaction sessions happening online with Zoom.

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Monday sessions take place at 10:15-12:00 in Zoom (R037/TU7, TUAS, Maarintie 8). Thursday sessions take place at 16:15-18:00 in Zoom (R037/TU7, TUAS, Maarintie 8). The sessions last two lecture hours, Monday sessions can be shortened if all relevant concepts can be sufficiently covered asynchronously.

Technical readings are published on Monday (by midnight) of the week prior to the session where the readings are discussed. Cases will be published on Friday (by midnight) of the week before the case session.

Case assignment solutions are due on Thursday 12:00 (i.e., on the day of the respective session).

The preliminary schedule is below. Please note that changes are possible before the course.

Date	Topics
11/01/2021	Week 1: Demand uncertainty and Valuing supply chain responsiveness, Operations Strategy
14/01/2021	Case session: Sport Obermeyer
18/01/2021	Week 2: Forecasting and analysis of demand uncertainty for evaluation of optimal responsiveness
21/01/2021	Case session: Canyon - Judgmental forecasting
25/01/2021	Week 3: Pooling and design for postponement, managing sourcing and capacity for optimal flexibility
28/01/2021	Case session: Reebok
01/02/2021	Week 4: Managing inventory and MC simulation for operations, planning and scheduling
04/02/2021	Case session: Skiwear dual-sourcing game and Monte Carlo inventory simulation (Case assignment is to create a solution for dual-sourcing simulation case, we also have a competitive game round)
08/02/2021	Week 5: Managing process lead times - Process analysis, lead time reduction, queuing theory, designing processes, process mining and identification
11/02/2021	Case session: Manzana/Service process analysis
15/02/2021	Week 6: Planning systems, digitalization, and Advanced Manufacturing - Hierarchical planning systems, S&OP, Integrated business planning, Supply Chain Strategy, Digitalization and 3D printing
18/02/2021	Case session: Digitalization, additive manufacturing and operations strategy

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SIMULATION EXERCISES AND SESSIONS

There are three (3) simulation exercises as a part of the course. First two are smaller and the last one is a small project. Simulation exercises are done in groups of two or three persons. The simulation sessions are arranged for you to help you solve and walk through the solutions of the exercises. Simulation sessions:

Date	Topics
21/01/2021	Simulation 1: Bottleneck and process analysis fundamentals
28/01/2021	Simulation 2: Order penetration point and lead times
11/02/2021	Simulation 3: Lead time reduction through design: United Engines Case
18/02/2021	Simulation wrap-up session

The simulation exercises are carried out using the Simul8 software. Simul8 is a computer package for discrete event simulation. It enables to create a visual model of a given production process, analyzing the performance of the process and simulating alternative scenarios of improving the process. The Simul8 software requires a membership account which we will provide to all the registered students at this course. The software is compatible with Windows OS. For more information, see www.simul8.com.

All group members should enroll themselves before the fourth session of the course, on January 21st. To begin the simulation exercises, we provide you with a number of short videos regarding the features and capabilities of the Simul8 software. All the sessions take place remotely and through the Zoom platform. For the first two simulation exercises you have one week for the delivery of the solution report. In case of the third (final) simulation exercises we assigned two weeks for the development of a comprehensive solution and we expect a report that covers the solution reflecting the learnings from the case.

Each group delivers weekly a short 2 to 5 pages written report as a solution for the first two completed simulation exercises. The report for the third simulation exercise is expected to be at least 5 pages long. The questions to be answered in the reports are published in the simulation cases. The solution reports for the simulation exercises must be delivered before the next exercise session (Thursday at 8.00) to MyCourses.

READINGS AND CASES

General readings and references: (final list will be added shortly)

Supply chain planning and hierarchical planning systems (two alternatives, relevant for week 6 and exam)

- Liberatore, Matthew J.; Miller, Tan C.: Supply chain planning: practical frameworks for superior performance
    - Available as e-book in Aalto library: https://aalto.finna.fi/Record/alli.807020
- F. Robert Jacobs, William L. Berry, D. Clay Whybark and Thomas E. Vollmann: Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill, 6th international edition, 2011.
    - Chapters: 1, 2, 3, 5, 7, 11

Week 1 – Valuing supply chain responsiveness, Operations Strategy

- Case: Sport Obermeyer (MyCourses)
- Readings:
    - de Treville, S., Bicer, I., Chavez-Demoulin, V., Hagspiel, V., Schürhoff, N., Tasserit, C., Wager, S., 2014. Valuing lead time. Journal of Operations Management 32, 337–346. https://doi.org/10.1016/j.jom.2014.06.002
- Optional readings:
    - Cattani, K.D., Dahan, E., Schmidt, G.M., 2008. Tailored capacity: Speculative and reactive fabrication of fashion goods. International Journal of Production Economics 114, 416–430. https://doi.org/10.1016/j.ijpe.2007.05.023

Week 2 – Demand uncertainty and forecasting

- Case: Canyon - Judgmental forecasting
    - https://pubsonline.informs.org/doi/10.1287/ited.2016.0165cs
- Readings:
    - Hyndman, R.J., & Athanasopoulos, G. (2018) Forecasting: principles and practice, 2nd edition, OTexts: Melbourne, Australia: **Chapters 3 and 4.**
- Optional readings:
    - **(Alternative to above Hyndman e-book)** Chapter 4: Forecasting: F. Robert Jacobs, William L. Berry, D. Clay Whybark and Thomas E. Vollmann: Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill, 6th international edition, 2011.
    - Chapter 3: Demand Management: F. Robert Jacobs, William L. Berry, D. Clay Whybark and Thomas E. Vollmann: Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill, 6th international edition, 2011.

Week 3 – Pooling and design for postponement

- Case: Reebok NFL Replica Jerseys
    - https://dspace.mit.edu/bitstream/handle/1721.1/71720/15-762j-spring-2005/contents/lecture-notes/reebok_draftscg.pdf
- Readings:

    - de Treville, S., Cattani, K., Saarinen, L., 2017. Technical note: Option-based costing and the volatility portfolio. Journal of Operations Management 49–51, 77–81. https://doi.org/10.1016/j.jom.2016.12.004
- Optional readings:
    - Tang, C., Tomlin, B., 2008. The power of flexibility for mitigating supply chain risks. Int. J. Prod. Econ. 116, 12–27. https://doi.org/10.1016/j.ijpe.2008.07.008

Week 4 – Managing inventory and MC simulation for operations

- Cases:
    - Monte Carlo Inventory simulation case (MyCourses)
    - Skiwear dual-sourcing game: https://forio.com/app/lausanne/sca/
- Optional readings:
    - Chapter 11 Order Point Inventory Control Methods: F. Robert Jacobs, William L. Berry, D. Clay Whybark and Thomas E. Vollmann: Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill, 6th international edition, 2011.

Week 5 – Managing process lead times

- Case: Manzana (MyCourses)
- Readings:
    - Fundaments of process analysis and queuing theory provided in MyCourses

Week 6 – Planning systems, digitalization, and Advanced Manufacturing

- Readings (preliminary):
    - Hedenstierna, C. P. T., Disney, S. M., Eyers, D. R., Holmström, J., Syntetos, A. A., & Wang, X. (2019). Economies of collaboration in build-to-model operations. Journal of Operations Management
    - Holmström et al. 2019, The digitalization of operations and supply chain management: Theoretical and methodological implications, Journal of Operations Management
    - Tuomikangas and Kaipia (2014: A coordination framework for sales and operations planning (S&OP): Synthesis from the literature

ASSESSMENT AND GRADING

The course points (max. 100) are allocated as follows:

- **Weekly case assignments 5 x 7 points: 35 points**
    - Individual assignments with case questions and case assignment to be submitted individually prior to Thursday lecture.
- **Simulation exercise & project reports: 30 points**
    - Group works * 3: two smaller exercises and one group project
    - 2 x 7.5pts + 1 x 15pts
- **Class participation and activity: 20 points**

  - 5 x 4 pts for weekly activity and class participation: Participation points can be collected in-class: discussion + written in-class assignment, or asynchronously: asking and answering questions regarding weekly case assignments on MyCourses Forum
- **Exam: 15 points**
  - Home exam with open book and assignment of manufacturing and planning control system evaluation provided for the exam week.

Grades will be given as follows:

- 0-49 points = 0
- 50-59 points = 1
- 60-69 points = 2
- 70-79 points = 3
- 80-89 points = 4
- 90-100 points = 5

Individual weekly assignments

For the Thursday sessions of the first five weeks, there is a case assignment that will involve both quantitative questions based on analysis of case data and qualitative questions that will test the students' reflection on the analysis and solution to OM problems more generally.

The weekly assignments will be short word write-ups, spreadsheet analysis reports and potentially MyCourses quiz type questionnaires.

During class, we will discuss the answers given to questions, and individual participants will be asked to explain and defend their answers. The answers and participation in the discussion will be assessed as the individual class participation part of the grade (total of 20pts). Higher grades will be given for "wrong" answers that show in-depth thought than for those that are "technically correct" but that person is not able to explain.

Please refer to each week's detailed instructions on MyCourses.

Individual class participation

Individual class participation will be based on your answers and participation during the case discussion as described in the previous section. In online environment we will also use small assignments and quizzes during class time to enable interaction and activity and enable asynchronously participating through being active with questions and answers in the course MyCourses-forum.

The evaluation of individual in-class participation is based on assessment by course staff. The primary purpose of assessing your participation is to encourage everyone to be active and ensure engagement in the learning throughout the course. The targeted learning outcomes of this course are applied and aim at bridging the gap between technical analytics knowledge and business context. This requires active engaging in both solving the cases and reflecting the choices made in the process of creating the solution and the impact of the analytics in the business contexts.

Update Online teaching Spring 2021:

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To facilitate interactions in online environment, we will add options to class participation:

- Option 1: In-class activity:
  - Participation in class discussion during class in Zoom session
  - Written questions and assignments during class in Zoom session
- Option 2: Asynchronous activity: Forum discussion
  - Discussing cases and their solutions on MyCourses forum:
    - Asking questions that are helpful and answering other students questions in an insightful and reflective manner.

Student can participate in the course through both options during the same week, but the maximum points per week is 4pts. **Example:**

- Student A: Prepares the weekly case assignment, participates in class on Thursday and presents very insightful viewpoints and arguments to advance the class discussion and can clearly explain the logic of her case solutions, also answers to a small in-class assignment during class time → **4 points for participation grade for the week**
- Student B: Prepares the weekly case assignment, does not participate and is not present during the case session. But is active in answering and asking questions during the week regarding the case and how to solve it. Student B's participation on forum clearly advances other people's learning and facilitates a better learning experience with outstanding contributions → **4 points for participation for the week**

Simulation exercises:

Simulation exercises will be graded based on your groups report and the quality of the solution and its presentation. All of the group members will receive the same grade.

Exam

During the last week of the course, we will have a home exam in the form of an evaluation assignment of a selected case for the analysis and design of a company's operational planning and control system. The cases and exam questions will be made available *on to be specified date* during the exam week.

Instructions for the exam will be provided 18.2.2021.

Exam readings:

These books are alternatives, for a more detailed and full representation of the topic the *Jacobs et al.* book is recommended (any edition of the book).

- Liberatore, Matthew J.; Miller, Tan C.: Supply chain planning: practical frameworks for superior performance
  - All chapters of the book are necessary readings
- F. Robert Jacobs, William L. Berry, D. Clay Whybark and Thomas E. Vollmann: Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill, 6th international edition, 2011.
  - Chapter 1: Manufacturing Planning and Control
  - Chapter 2: Enterprise Resource Planning

- Chapter 3: Demand Management
- Chapter 5: Sales and Operations Planning
- Chapter 7: Master Production Scheduling
- Chapter 11: Strategy and MPC System Design

Absences

Since much of the learning occurs in the classroom, attendance is expected. The penalty for each missed session is that the student loses the opportunity to earn individual classroom participation points from that session. Missing class does not excuse students from assignments or change assignment due dates.

GRADING PRINCIPLES FOR WEEKLY ASSIGNMENTS

This course is about applying advanced analysis in operations management cases and reasoning the value of the improved solutions in the given contexts, often there can be multiple "correct" answers. Your answers will be graded based on their logic, relevance and quality of reasoning and analysis. **Each assignment is graded out of 7 points (for the first 5 weeks) along the below dimensions and the same applies for the simulation exercises.** The bullet points below the dimensions provide more details on what to focus on while working on the assignments. Note that not all the dimensions apply in all cases (particularly 3 and 4, if no recommendations or figures of your analysis results are asked for).

1. Technical quality: use of relevant methods, applied correctly and results are interpreted in a coherent manner
    a. The analysis and chosen models, frameworks, theories are applied correctly and make sense in the case
    b. The results are relevant for answering the questions
    c. Strengths and weaknesses of the analysis or modeling are discussed (where applicable and focusing on the substantial issues)
2. Reasoning and analysis
    a. The analysis includes necessary quantitative analysis to answer the questions of interest
    b. All analysis and calculations are well explained and correct
    c. The quantitative analysis is based on solid reasoning and the results are qualitatively interpreted.
    d. Qualitative interpretation of results is sound and demonstrates the usefulness of the analysis in the practical context. The reasoning is logically sound.
    e. All of the presented questions are addressed in the analysis and discussion
3. Quality of recommendations/conclusions (when applicable)
    a. In cases where the questions it is necessary to give a recommendation, the recommended action should be grounded in the analysis and alternative solutions should be discussed
    b. Actionable: good analysis leads to action

   c. Considers limitations: good analysis discusses the limitations, boundary conditions and main assumptions that are necessary for the presented conclusions and recommendations.
4. Presentation and clarity
   a. Clear and insightful graphs and figures used for presentation of the results
   b. Informative presentation of results (use of plots, graphs or tables where necessary)
   c. Pleasant and easy to read, easy to understand, no or few errors
   d. Simple is beautiful

GRADING PRINCIPLES FOR INDIVIDUAL CLASS PARTICIPATION

Total of 20 points are available for the class participation. The class participation will be evaluated by the course staff on-weekly basis with **weekly maximum of four points**. In the final participation points we will take **best five out of the six weeks.** Additionally, the course discussion forum for any student questions will be on MyCourses, based on **activity in the forum for answering and helping your fellow students can be counted as an alternative (or in addition) to your class room (Zoom) activity**. Your participation and presence in the class room / forum will be evaluated as follows:

- **Outstanding contributions (4/4):** Contributions in class reflect exceptional preparation. Ideas offered are always substantive, yield one or more major insights and the logic for the case assignment analysis is clear. Arguments are well substantiated and persuasively presented. If this person were not a class member, the quality of discussion would diminish significantly.
- **Good contributions (3/4):** Contributions reflect good preparation. Ideas are usually substantive, provide good insights into the topic under discussion. Arguments reflect clear thinking. If this person were not a member of the class, the quality of discussion would be diminished.
- **Present and contributed (2/4):** Student is present in the classroom and contributed to the discussions. Contributions in class reflect satisfactory preparation. Ideas are sometimes substantive, provide generally useful insights, but seldom offer a major new direction for the discussion.
- **Non-participation and unsatisfactory contributions (0-1/4):** Student was not present or was present partially. The person has said little or nothing in the class If they have, contributions reflect clear inadequate preparation.

PLANNED WORKLOAD

THE COURSE WORKLOAD	H
CLASSROOM HOURS	24
READINGS	6
CASE ASSIGNMENTS	60
SIMULATION EXERCISES AND PROJECT	18
HOME EXAM AND STUDYING	24

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TOTAL	132h (5 ECTS)

INSTRUCTOR AND CONTACT INFORMATION

The course staff consists of assistant professor Lauri Saarinen (lauri.3.saarinen@aalto.fi) and post-doctoral researcher Siavash Khajavi Haghighat (siavash.khajavi@aalto.fi), doctoral candidate Lauri Loikkanen (lauri.loikkanen@aalto.fi).

In general course and content related matters, preferably the MyCourses forum for your questions. In student specific practical matters: Lauri Saarinen. Simulation exercises student specific: Siavash Khajavi Haghighat. Grading related questions: Lauri Loikkanen.