MS.C in Operations and Supply Chain Analytics

(A supplement of programme introduction)

The Operations and Supply Chain Analytics (O&SCA) replaces our current master programme in Logistics and Supply Chain Management from 2020. Since the relevant course descriptions are not available in the AU course catalogue, we provide a brief description regarding the learning objectives of each course in the program here.

First, the new program will still have its focus on Operations and SCM, and logistics is still included and considered as an indispensable part of the Supply Chain.

However, according to the practical development and trends in operations and supply chain management fields, data-driven analytical approaches become more and more important. We have modified current courses and developed a new course structure shown in Table 1. You can see the differences between the new program and the old program (LOG) in Table 1 and Table 2.

<table>
<tr><th colspan="2">1st semester
Prerequisite courses</th><th colspan="2">2nd semester
Specialisation courses</th><th>3rd semester
Electives</th><th>4th semester</th></tr>
<tr><td>1st Quarter</td><td>2nd Quarter</td><td>1st Quarter</td><td>2nd Quarter</td><td></td><td></td></tr>
<tr><td colspan="2">Supply Chain Design and Management
(10 ECTS)</td><td colspan="2">Demand and Production Management
(10 ECTS)</td><td rowspan="4">Internship,
Study abroad,
AU Summer University,
Electives at AU:
Revenue Management
(5 ECTS)
Logistics and Business Processes in SAP
(10 ECTS)
Sequencing and Scheduling (5ECTS)
Cases in Transportation
(5ECTS)</td><td rowspan="4">Thesis
(30 ECTS)</td></tr>
<tr><td colspan="2">Optimisation for Prescriptive Analytics
(10 ECTS)</td><td colspan="2">Applied Modelling in Operations and Supply Chains
(10 ECTS)</td></tr>
<tr><td colspan="2">Business Process Modelling
and Simulation
(5 ECTS)</td><td colspan="2">Distribution and Transportation
(5 ECTS)</td></tr>
<tr><td colspan="2">Tools for Analytics
(5 ECTS)</td><td colspan="2">Inventory Control
(5 ECTS)</td></tr>
</table>

Table 1: The course structure in Operations and Supply Chain Analytics

<table>
<tr><th colspan="2">1st semester
Prerequisite courses</th><th colspan="2">2nd semester
Specialisation courses</th><th>3rd semester
Electives</th><th>4th semester</th></tr>
<tr><td>1st quarter</td><td>2nd quarter</td><td>1st quarter</td><td>2nd quarter</td><td></td><td></td></tr>
<tr><td colspan="2">Supply Chain Design and Management
(10 ECTS)</td><td colspan="2">Production Planning and Inventory Control (10 ECTS)</td><td rowspan="5">Internship (15 ECTS),
Study abroad,
AU Summer University
Electives at AU:

Revenue Management (5 ECTS)
Logistics and Business Processes in SAP (10 ECTS)</td><td rowspan="5">Thesis (30 ECTS)</td></tr>
<tr><td>Project Management: Dynamic Scheduling and Control (5 ECTS)</td><td>Simulation: Modelling and Analysis (5 ECTS)</td><td colspan="2">Applied Modelling in Logistics
(10 ECTS)</td></tr>
<tr><td colspan="2">Optimisation Methods (5 ECTS)</td><td colspan="2">Distribution and Transportation (5 ECTS)</td></tr>
<tr><td colspan="2">Advanced Excel (5 ECTS)</td><td colspan="2">Demand Management (5 ECTS)</td></tr>
</table>

Table 2: The course structure in Logistics and Supply Chain Management

Furthermore, for the following courses in the program of Operations and SC Analytics, the course descriptions in the AU course catalogue (titles in brackets) are still applicable:

- **Supply Chain Design and Management** ("Supply Chain Design and Management")
- **Applied Modelling in Operations and Supply Chains** ("Applied Modelling in Logistics")
- **Distribution and Transportation** ("Distribution and Transportation")

In addition, the following courses are modified or expanded from previous courses. We briefly clarify the contents and learning objectives of each course below.

Optimisation for Prescriptive Analytics

The content: Prescriptive analytics is generally concerned with the use of normative models for providing suggested solutions to decision problems. Given available data obtained by descriptive and predictive analytics, this course focuses on the methodologies used in the search for optimal solutions to problems arising in operations and supply chains. The primary focus will be on the different approaches that can be used to prescribe solutions to such problems. In the course, we will study the underlying theory of the presented solution methods.

In addition, focus will be on the modelling aspects of optimisation and the question of what constitutes a good model. In order to develop skills applicable

to real-world problems, the students will model and solve cases using state-of-the-art software.

For large scale problems, we will concentrate on heuristic solution methods. This includes conventional construction heuristics and improvement heuristics, as well as metaheuristics.

In terms of mathematical models and methods, this course lies a foundation for several other courses in the Operations and Supply Chain Analytics specialisation.

The course relies on the use of several software tools, including the programming languages R and Excel/VBA, the mixed integer programming solver CPLEX, and its modelling language OPL.

L**earning objectives:** The course is intended to provide the student with knowledge, skills and competences as follows.

Knowledge of

- the interrelations between different elements in optimisation such as branch-and-bound, cutting planes, pre-processing, and heuristics,
- methods to **solve** integer linear programming problems, including cutting planes, branch-and-bound,
- characteristics of heuristic methods in general.

Skills to

- **apply** state-of-the-art software tools to solve optimisation problems,
- **solve** linear programming problems by the Simplex method,
- **apply** duality theory in linear programming, for example to test for optimality,
- **interpret** sensitivity analyses for linear programming problems,
- **apply** specific heuristics to optimisation problems.

Competences to

- **formulate** a mathematical model based on a given problem description,
- **compare** different formulations of the same problem and **discuss** their advantages and disadvantages,
- **compare** different heuristics for the same problem and **discuss** their advantages and disadvantages.

Tools for Analytics

The content: Business Analytics (BA) refers to the scientific process of transforming data into insight for making better decisions in business. BA can

both be seen as the complete decision making process for solving a business problem and the creation of business value by integration of concepts, methods and data. As a process, it can be characterized by descriptive, predictive, and prescriptive model building using 'big' data sources.

Since the amount of available data has increased extensively in many companies, there is a need for analysts with the ability to do tasks within Analytics. For instance, extract relevant data and perform valid quantitative analysis. Clearly, it is also important that the analyst can communicate the results of the analysis to their surroundings. This requires for the analyst to be particularly qualified in handling IT based tools beyond e.g. basic Excel. The use of programming is the basis for performing a variety of analytical tasks including impact studies, risk analysis, and design of reports.

The student is given an introduction to the compiled programming language VBA (Visual Basic for Applications) in Excel. This includes declaration of variables, the use of logic constraints and loops, and debugging. In addition, the student will acquire skills to structure a computer program using modules and subroutines.

Furthermore, the student is given an introduction to the interpreted programming language R. This includes among other things the use of data structures, import and export of data, and tools for cleaning, transforming and analysing datasets. The student will also learn to present data and results graphically.

The learning objectives: The purpose of this course is to give students a knowledge about IT tools for Analytics that require the analyst to be qualified in handling tools beyond e.g. basic Excel. After having participated in the course, the student must, in addition to achieving general academic skills, demonstrate:

Knowledge of

- how a computer works at a basic level,
- basic programming such as variables, arrays, loops, functions and procedures,
- what an algorithm is,
- how to implement an algorithm based on a description,
- different programming languages,
- how to manage a code in a collaborative working environment.

Skills to

- handle data such as import, tidy, transform, visualize and export,
- develop well-structured code,
- perform testing and debugging,
- implement/code selected algorithms,

- apply analytical techniques on data,
- apply relevant methods, algorithms and techniques from this course in order to solve a specific problem.

Competences to

- independently handle data given a problem,
- independently analyse data given a relevant research question,
- compare different programming languages,
- compare different algorithms solving a problem and discuss their advantages and disadvantages,
- interpret and discuss results based on a data analysis in relation to the relevant academic literature,
- communicate results from applied research in a scientific way, e.g. using literate programming.

Business Process Modeling and Simulation

Contents: The course will start by setting the stage and defining a business process. Thereafter, we define performance metrics and methods for performance evaluations, among others using concepts from queueing theory.

Thereafter, the course will enter the field of simulation, which is about developing a computer model of a real "system", so the computer model can imitate the real "system". The computer model can be used to explore the impact it will have to make some changes in the design of the "system" as well as making changes in the policies employed to control the "system".

As developing a simulation model can be quite challenging, we may need to work with special software programs, in this course the simulation program Arena. However, a standard tool like Excel might turn out to be an adequate standard tool.

Simulation is certainly not just about building a simulation model. Rather, it is about appreciating simulation as a methodology. We must acquire knowledge about techniques for developing a good model. We should know how to collect and prepare input data for our model. We should also have some insights into how to validate the model against the true "system". Certainly, we must also know how to make a proper analysis of the output that our model produces. This will typically be accomplished by applying some statistical methods.

Learning objectives: The course is intended to provide the student with knowledge, skills and competences as follows.

Knowledge of

- how to **define** business process design performance metrics,
- how to **apply** queuing theory to evaluate system performance.

Skills in

- how to **describe** all the elements of a simulation analysis,
- how to **choose** the appropriate simulation tool (Excel vs. a special designed simulation tool),
- how to **conduct** statistical analysis for providing inputs to a simulation model,
- how to **build** a simulation model,
- how to **verify and validate** a simulation model against the "true" system,
- how to **conduct** statistical analysis of the output of a simulation model.

Competences in

- how to **present** the results of simulation analysis,
- how to **put** a simulation analysis into a business process perspective.

Demand and Production Management

Contents: An effective demand and production management process will help companies to be able to supply goods to customers in an on-time, responsive manner, without creating excessive inventories. As such, the demand and production management process is very important to companies.

Main topics are:

- Production planning: levels and time-horizon.
- Sales and Operations Planning (SOP)
- Matureness of SOP
- Master Production Scheduling/Material Requirements Planning
- Capacity planning
- Just in Time
- Scheduling
- Industry 4.0
- The fundamentals of developing useful forecasts
- Collaborative forecasting and scheduling
- Specific forecasting methods
- Case examples to illustrate the concepts, principles and best practices of demand management.

Learning objectives: The course is intended to provide the student with knowledge, skills and competences as follows.

Knowledge of

- the strategic impact of demand and production management,

- how demand and production management affects system-wide supply chain performance,
- commonly used techniques and methods of forecasting and demand management,
- the planning hierarchy of production management and the individual problems and concepts on each level.

Skills to

- **describe** and **analyse** the generic conditions for production which prevail in modern production companies,
- **describe** and **analyse** distinct methods for performance evaluation of production systems,
- **develop** and **apply** mathematical optimisation models for solving basic decision problems within production,
- **describe** and **analyse** distinct concepts within production management and **explain** how these can be used to plan and control the physical flow of products in production companies.

Competences to

- **characterise** different types of demand and make a qualified choice among various types of forecasting methods,
- **judge** if a given problem within supply chain management would benefit mostly from improving the forecasting setup or should be handled by improvements of control of internal factors such as agility or decoupling in the supply chain structure.

Inventory Control

Contents: In many industries and supply chains inventory is one of the dominant costs, and inventory related decisions can have a huge impact on customer service levels as well as on supply chain system-wide costs. However, managing inventories in a supply chain is typically a difficult task.

The course will start out by developing a proper classification of various types of inventories, control policies, cost components and service level measurements. We will also focus on how to collect and analyse sales data necessary for doing any inventory analysis.

With regard to how to make optimal decisions, we will start out by exploring single-stage system. Thereafter, we will explore multi-item inventory systems, and finally consider multi-stage inventory systems, resembling a real supply chain.

Finally, we will widen the perspective by comparing basic inventory control policies with KANBAN and MRP systems.

Learning objectives: The course is intended to provide the student with knowledge, skills and competences as follows:

Knowledge of

- how to **classify** different types of inventories,
- how to **perform** basic classification analyses, like an ABC classification,
- how to **classify** relevant demand models for inventory management,
- how to **classify** cost parameters and service measures for relevant performance measure assessment of an inventory system,
- how different inventory control policies operate.

Skills in

- how to **conduct** statistical analyses for a preparation of inputs for doing an inventory analysis,
- how to **compute** the optimal control parameter in single-stage inventory systems,
- how to **develop** an interface between a forecast model and an inventory control model,
- how to **analyse** a multi-item inventory system with focus on coordination and aggregation,
- how to **develop** computational and simulation models of multi stage inventory systems.

Competences in

- **know how** to investigate MTO (make-to-order) and MTS (make to stock) boundaries in a multi-stage inventory system,
- **know** to what extent KANBAN and MRP systems resembles a classical inventory control system,
- **knowledge** of the strategic impact of good inventory control and how it affects system-wide supply chain performance.