



Developing interdisciplinary competences for Smart Logistics

Modules Design

April 2022

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Foreword

"INCO_SMRT: Developing interdisciplinary competences for Smart Logistics" is a project co-funded by the European Commission in the framework of the Erasmus+ Programme. Focusing on the T&L sector, its goal is to close the knowledge gap and skills mismatch between manufacturing industry requirements and academic curricula enabling ICT and Business students to become the graduates the job market will increasingly require.

The advent of the industrial Internet of Things (IoT) and what other research refers to as 'Industry 4.0' is allowing manufacturing companies, whatever they produce, to redefine everything from the way they interact with research institutions and introduce innovation to how they interact with customers and society at large. The introduction of AI into IoT infrastructure is hereby a critical element. The manufacturing industry is transforming, and the machinery installed in the production chains are prepared to incorporate IoT, AI and blockchain in their processes. This level of IoT connectivity enables the integration of increasingly efficient production processes with greater doses of predictive intelligence and provides more proactive and robust cybersecurity mechanisms because of the application of AI and blockchain. But they need qualified staff provided not only with technological abilities but with a suitable level of creativity in planning and applying innovative solutions that facilitate the strategic evolution and growth of industry and services for citizens. Unfortunately, the academic curricula have not been updated as quickly as the technology has evolved, with the serious consequence that there are not enough professionals able to lead and manage the vital transformation.

INCO_SMRT is performed by a strong consortium of 4 partners in 4 EU Member States: Belgium, Denmark, Italy and The Netherlands, representing a competent and skilled mix of excellent European HE institutions cooperating as a real "strategic partnership".

This document is the first project output concerning knowledge gaps and skills mismatch with specific focus on transversal skills. It is a continuation of the needs analysis carried out by the participating institutions when they decided to embrace this project.

This document reports:

- relevant transversal skills as identified in cooperation with companies
- learning outcomes in regard to knowledge, skills and competences
- course readings explaining headlines of course content

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Management Summary

In the EU, unemployment in general has been on the rise since 2008, due to the economic crisis which led to considerable job loss and fewer job offers. On the other hand, 40% of vacancies cannot be filled, because of skills mismatch and too few people have the preparation, mindset and competence to set up their own businesses or look for new opportunities. Higher education systems are key actors for improving graduates'

employability by strengthening their transversal skills. Focusing on T&L sector, the project contributes to close the highlighted knowledge gap and skills mismatch enabling ICT and Business students to become the graduates that the T&L job market will increasingly require.

The participating institutions perform research by means of literature study, brainstorm sessions and a survey involving companies, students, alumni and teachers in the four member states providing insight in: (1) relevant transversal skills as identified in cooperation with companies (included in IO1), (2) learning outcomes in regard of knowledge, skills and competences as well (3) course readings^[1] and module content for a total of 30 ECTS

Based on the output of IO1, giving insights: gained from the questionnaires, from the brainstorm session (high level topics), as well about the existing gaps the modules during the October workshop were defined as: (1) Dynamic Supply Chain, (2) Business Process Optimization, (3) Data Driven Supply Chain, (4) Technology Driven Supply Chain, (5) Sustainability Supply Chain and (6) Minor's thesis

The following set of transversal skills has been defined being required to incorporate in the teaching content and methods for the different course modules: (1) Cooperation & Collaboration, (2) Analytical, Methodical & Structured, (3) Entrepreneurial, (4) Communication, (5) Critical Thinking and (6) Reflecting.

Materials have been developed based on the social constructivism principles based on 'learning by doing'.

Abbreviations

EU	European Union
ICT	Information and Communication Technology
T&L	Transport & Logistics

1. The INCO_SMRT Project

1.1. Rationale

In the EU, unemployment in general has been on the rise since 2008, due to the economic crisis which led to considerable job loss and fewer job offers. Older workers are struggling to find new jobs despite their

experience, and young graduates are struggling to find new jobs, because they have none. The youth unemployment rate in EU in August 2019 was 14,2 % and in the countries represented in the proposal the rate goes from 27,1% in Italy to 14,1% in Belgium, 9,7% in Denmark and 6,9% in the Netherlands. These data do not give evidence to the unbearable fact that in EU, 30% of higher education graduates are working in jobs that do not match their talents or even do not need a university qualification. On the other hand, 40% of vacancies cannot be filled, because of skills mismatch and too few people have the preparation, mindset and competence to set up their own businesses or look for new opportunities.

Higher education systems are key actors for improving graduates' employability by strengthening those transversal skills, not specifically related to a particular job, task, academic discipline or area of knowledge but crucial in a wide variety of situations and work settings, such as the ability to work in a team, problem solving and creative thinking, highly required by employers. At the same time, the way we work, learn, take part in society and lead everyday life is quickly changing in line with the fast and disruptive technological developments. Thus, graduates of any field need to be equipped with the ability to learn and take initiative, as well as with cross-disciplinary knowledge and technical skills.

In a worldwide scenario the number of unemployed people is projected to rise, but this is not because of the economic crisis alone, but also of the industrial automation of processes previously performed by workers. The manufacturing industry is transforming thanks to the industrial IoT and what research refers to as "Industry 4.0". This is reflected in the machinery installed in the production chains, which is prepared to incorporate IoT, AI and blockchain in their processes. This transformation needs qualified staff provided not only with technological abilities but with a suitable level of creativity in planning and applying solutions that facilitate the strategic evolution and growth of industry and services for citizens. Unfortunately, the academic curricula have not been updated as quickly as technology has evolved.

The project will provide ICT and Business students with knowledge, competencies and skills enabling them to become graduates the job market will be more and more require. The project will focus on Transportation and Logistics that, like most other industries, is currently confronted with an immense change. Due to its multifaceted characteristics and problems, the solutions proposed will provide a useful toolkit for many other sectors.

1.2. Objectives

The General Objective to provide the right graduate profiles will be achieved through the specific objectives:

- identify and define the new logistic skills;

- develop and implement, together with companies, curricula that bridges both ICT and logistics skills;
- develop and implement new models (toolbox) to assess transversal skills;
- implement teacher training activities to enable them to adopt innovative teaching methods and design multidisciplinary curricula providing transversal skills;
- develop and implement teacher support systems;
- achieve these objectives, teachers need to update their teaching and assessing methods, students need to acquire and develop transversal skills and institutions need to allocate resources to professional development activities. Therefore, the project will address students, teachers, university governance and representatives from the labor market.

The INCO-SMRT project will develop six intellectual outputs:

- needs analysis
- multidisciplinary modules' development
- assessment toolbox
- teacher-training module
- teacher support systems and pilot
- one training activity (teacher-training week)
- and four multiplier events (three local training seminars and one international conference).

The problems tackled by the project are shared all over the world, thus exchange of good practices among institutions with different scope and organization and from north and south countries ensures a better approach and a wide spread of outcomes and results.

Focusing on T&L sector, the project contributes to close the highlighted knowledge gap and skills mismatch enabling ICT and Business students to become the graduates that job market will increasingly require. Strategies, teaching and learning methods, flexibility, innovative assessment procedures, curricula design with a strong cross-disciplinary content and transversal skills enhancement, can be reproduced in many other sectors allowing the higher education institutions and systems to renovate and provide the graduates of tomorrow.

2. Intellectual Output 2

2.1. Methodology

This intellectual output provides the design of new modules for curricula (corresponding to 30 ECTS) that

will provide students with cross-disciplinary knowledge and transversal skills in the field of T&L to reduce skills mismatch and foster employability as defined in the needs analysis.

More concrete, IO2 will give insight into:

- relevant transversal skills as identified in cooperation with companies (included in IO1)
- learning outcomes in regard of knowledge, skills and competences
- course readings^[1] and module content for a total of 30 ECTS

A collaborative working approach has been used as methodology in relation to this output. Collaborative learning is a method where two or more people work together towards a common goal. It is based on the general premise that groups can learn more from each other through sharing and social interaction than they would if they learned on their own. The cooperation takes place face-to-face (during consortium meetings) and online (through Teams). The work has been carried out in close cooperation with representatives from companies which ensures the modules/curricula are coherent with the job market's needs and expectations. The project also adopted experimental learning, which means that learning starts from experiences. That has been achieved by using the participants' previous experiences with curricula development, teacher-training, assessment and transversal skills when developing the modules.

2.2. Conducting the Research

Starting the research during the Covid-19 pandemic the research has been impacted. General meetings often took place online and responses from target groups ended up with lower quantities than expected.

October 5th and 6th a workshop took place in Eindhoven (The Netherlands) hosted by Fontys University for Applied Sciences, School for ICT. Except the University Degli Studi Dell'Aquila all partners were represented. The main activities were to define, discuss and decide about the gaps, the main modules, the learning outcomes and module descriptions in concept. Starting with each of the partners presenting their educational system including they're to this project related study content, this investigational part of the workshop finished with a presentation and discussion of the HILL-based educational model applied at Fontys lead by two educational specialists.

Based on the output of IO1, giving insights:

- gained from the questionnaires
- from the brainstorm session (high level topics), as well

- about the existing gaps

The modules were defined during the October workshop as:

1. Dynamic Supply Chain
2. Business Process Optimization
3. Data Driven Supply Chain
4. Technology Driven Supply Chain
5. Sustainability Supply Chain
6. Minor's thesis

Five modules plus the Minor's thesis will end up with a total of 30 ECTS.

3. Transversal Skills

It has been concluded in IO1 (Chapter 3) that companies prefer at least the following transversal skills well developed for graduates being vital as a requirement for good work performance in their jobs, as well for gaining success in their career development as of the moment they enter the labor market:

- Independent
- Initiative
- Creativeness
- Flexibility
- Social behavior

When analyzing these transversal skills (competence catalogue <https://www.10voor5.nl>) it becomes clear that companies highly appreciate an **entrepreneurial attitude** for graduates.

Employees with an entrepreneurial attitude are adventurous and willing to take initiatives. They have an internal motivation that drives them to act and get things done. They don't see problems as insurmountable but do act instead; internal motivation is of utmost importance. You mainly develop internal motivation by finding out what you are good at and what you like and find important. You do need some self-knowledge for that. That is why it is important to practice self-reflection.

These employees typically possess the following underlying competencies (Wolff, A.C., 2016, *Visie op Ondernemend Gedrag, Ondernemerschap en Responsiviteit*, p. 3):

1. They are creative. They come up with original ideas, solutions and methods. They have empathy, are analytical and show perseverance. Take initiative and have courage.
2. Enterprising types are change-oriented. They see opportunities and don't like to keep things the way they used to be. They are eager to learn, enterprising and decisive. Can think critically, have courage and flexible since they can deal with uncertainty well.
3. Enterprising students are result-oriented. They are goal-oriented and act accordingly. They have perseverance, analytical insight, are accurate, decisive and have courage.
4. Being independent, enterprising types draw their own plan and act accordingly. They are independent, can think critically and are decisive. They have persuasiveness and courage.
5. Entrepreneurial types are relationship-oriented (sociability). They network, take initiative, listen and have good environmental awareness. Can communicate well, are collegial and have self-confidence.
6. They have perseverance. They are independent, have willpower and take initiative. Are result-oriented, stress resistant, decisive and have courage.

The developability of a competency differs per individual. Within a person it is related to knowledge, skills, motivation and personality. The easiest to develop are knowledge and skills that also play a role in a large part of the competences. It is more difficult if there is a development question in the field of motivation or personality. To improve yourself, Self-reflection and Self-knowledge are of great importance. Reflection is therefore also important for an entrepreneurial attitude. Reflection has to do with becoming aware of yourself to be able to look ahead from there. This competence is therefore

indispensable. When it comes to entrepreneurial behavior, it is a condition for growth, necessary to acquire a position as a valued professional.

There are many different definitions of reflection. For most it is all about looking back on one's own experiences to learn from them. Reflecting means holding up a mirror to yourself to reflect on how you work, for example, what choices you make within that, what skills you use and how that feels.

There are three forms of reflection (<https://www.carrieretijger.nl/functioneren/ontwikkelen/jezelf-ontwikkelen/reflectie>):

- Reflecting on personal performance. You mainly focus on who you are, what your motivation and your goals are. This form of reflection can help you in your personality development where all defined competencies for entrepreneurial behavior are addressed.
- Reflecting on professional actions. This form of reflection focuses mainly on methodical action. This way you can investigate the effect of the methods you use. As a professional you will have to continue to develop yourself. With 'lifelong learning' growth and improvement do not come naturally. This requires entrepreneurial behavior to make this possible. Reflection is an important first step for this.
[../..../Applications/Microsoft%20Teams.app/Contents/Resources/app.asar/assets/icons/icn_close.svg](https://www.carrieretijger.nl/functioneren/ontwikkelen/jezelf-ontwikkelen/reflectie)
- Reflecting on personal professional actions in the social context. With this form of reflection, you also look at the context of your functioning and actions. Here you ask yourself what the effect is on the environment, society and to what extent you are responsible for this.

Reflecting is about constantly looking back and asking yourself questions about how your learning process is progressing and what the backgrounds are. Having self-knowledge is a great asset; who knows him/herself, knows where his/her strengths and weaknesses are. Self-knowledge makes it easier to learn from your own mistakes, but also, for example, to collaborate with others. Moreover, self-knowledge is indispensable for a healthy and successful career. The three forms of reflection mentioned are complementary to each other and not always so clearly distinguishable from each other; one is closely related to the other. All three are important for a balanced development of the graduate, as a person but also as a professional.

Analysis of the questionnaires in IO1 (Par. 2.2.2.) comprising all four target groups (companies, teachers, alumni and students) additionally shows the following transversal skills:

- Entrepreneurial
- Communication

- Team player
- Decisive
- Perseverance
- Energetic
- Loyal

Except for team players, energetic and loyal, the others are already covered in the definition of an entrepreneurial attitude.

Next to this, teachers have in the Learning Outputs defined, the in their view required transversal skills to successfully complete education for the set of 7 course modules:

- Communication
- Cooperation & Collaboration
- Studious
- Leadership
- Critical thinking
- Entrepreneurial
- Taking initiative
- Methodical and structured
- Reflecting
- Analytical
- Problem solving
- Helicopter view

Those not mentioned yet or not being considered within the definition of an entrepreneurial attitude, direct or indirect are: cooperation & collaboration, methodical & structured.

To conclude, leaving out those transversal skills which have a support base of less than 50% of all respondents (which itself is arbitrary but necessary to keep judgement practically feasible), the following set of transversal skills, brought in line with the 21st century skills terminology, has been defined being required to incorporate in the teaching content and methods for the different course modules:

- **Cooperation & Social skills.** Where cooperation is to work together with somebody to achieve a single shared goal, collaboration means to work with other people by achieving one's own goals as part of a common goal.
- **Analysis mindset.** Gather and consider information at length before deciding by breaking down a problem or task into smaller elements to solve the problem or complete the task. Do this systematically in an organized and careful way.
- **Flexibility, Initiative & Reflection.** Showing an entrepreneurial attitude, it is about being flexible, taking initiative and applying knowledge and insight. Being able to apply knowledge and understanding in such a way as to demonstrate a professional approach to work or profession, and furthermore possesses competences for drafting and deepening arguments and for solving problems in the field. Reflection mainly concerns the learning aspect of the attitude to work, aimed at personal development. Also includes the ability to translate reflection into action which prepares for lifelong learning. Looking back, analyzing, seeing events in a wider context and considering how what has been realized can be applied in the future.
- **Communication.** Being able to send messages, ideas and solutions effectively being understood by the target audience. Communication can be categorized into three basic types: (1) verbal communication, in which you listen to a person to understand their meaning; (2) written communication, in which you read their meaning; and (3) nonverbal communication, in which you observe a person and infer meaning.
- **Critical Thinking & Creativity.** Being able to collect and interpret relevant data in the field with the aim of forming an opinion that is partly based on weighing up relevant social, scientific, or ethical aspects. Questioning or reflecting on their own knowledge as well as information presented to them in a clear and rational way, understanding the logical connection between ideas.

4. Learning Outcomes

4.1. Dynamic Supply Chains

Purpose	The purpose of Dynamic Supply Chains is to gain insight into what supply chains look like and how they can be optimized and managed in changing business environments.
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Study Load	5 ECTS
Learning Outcomes	<ol style="list-style-type: none"> 1. You understand the supply chain and analyze problems, processes and/or challenges of an (existing) Supply Chain System or network or part thereof. 2. You identify improvements, possible solutions and extensions based on information from analyzed data from said system.
Judgment scales	<ol style="list-style-type: none"> 1. Associate student level: chain scope 2. Bachelor student level: network scope 3. Master student level: global impact scope
Professional Products	<ul style="list-style-type: none"> • An advisory report for the client containing substantiated proposals for improving a problem in the Supply Chain domain. • Comprising a process improvement based on requirements, KPIs of the client and a data analysis based on data arising from supply chain processes.
Learning Activity	<ul style="list-style-type: none"> • Draw up a process model or control concept of a chosen process and provide it with input and output data using a self-selected tool. • Perform an (data) analysis by means of a self-chosen tool with conclusions on the analysis. • Design a process improvement by means of a self-chosen tool based on predefined requirements that have been discussed and determined with a client. • Write, present and discuss an advisory report in which the above has been substantiated.
Skills	The student is able to analyze data, present, prioritize, solve a problem, report, do research, schedule.
Knowledge and Methods	The student has knowledge about process improvement, data analysis, transformation of data into information, LEAN, KPIs, requirements, SCM, MRP.
Tools and Models	<ul style="list-style-type: none"> • The student can use a process design tool, data analysis tool • The student can apply LEAN, BPM, KPI, PDCA, ERP, MRP

4.2. Business Process Optimization

Purpose	The purpose of Business Process Optimization is to gain insight into business (supply chain) processes and to improve according to actual business (supply chain) requirements including related digital solutions.
Study Load	5 ECTS
Learning Outcomes	<ol style="list-style-type: none"> 1. You have an understanding of the regulatory and organizational context of business and/or logistical processes 2. You apply methodologies and a common language to describe, visualize and analyse business and/or logistical processes 3. You identify potential process optimizations and points of failure 4. You are aware of the logic underlying business process optimization models 5. You propose and implement process improvements, define as-is and to-be situations and the transition 6. You translate business processes towards digital solutions
Judgement scales	<ol style="list-style-type: none"> a. Associate student level: chain scope b. Bachelor student level: network scope c. Master student level: global impact scope
Professional Products	A consulting report based on an analysis using sector specific raw data around a problem and bring arguments on how a conceptual data analysis and/or AI solution can help optimize a business process
Learning Activity	<ul style="list-style-type: none"> • Identify and understand the added value of (specific parts of) Business and/or logistical Processes • Learn about models, methods or tools that can be used to analyse Business and/or logistical Processes from a present to a future situation • Understands methods and tools to analyse data to improve Business and/or logistical Process • Learn how to structure and argument a conceptual solution that improves a process • Present the outcomes of own analysis
Skills	<p>The student is able to:</p> <ul style="list-style-type: none"> • apply innovative methods with a focus on project work in practice-oriented analysis

	<ul style="list-style-type: none"> • apply key methods for internal and external communication • evaluate the quality of suggested logistic/business solutions • evaluate the legal and ethical compliance of a suggested improvement • is capable of handling data and the results on an objective and unbiased way • has curiosity for the development of their study on technological and non-technical domains
Knowledge and Methods	The student has knowledge about basic BP optimization models, DOT framework, Lean, Six Sigma
Tools and Models	The student can use Engage, Business Model Canvas, Balanced Score Card, Python, R, Power-BI, Tableau

4.3. Data Driven Supply Chain

Prerequisite Knowledge	Before beginning this module, it is required that the student have prior knowledge of a basic Supply Chain management and theories.
Module Overview	From within the scope of supply chain, the module aims to provide you with a sound understanding of the data-driven organization, the basics of Big Data, and the fundamentals of artificial intelligence (AI). On completion of this module, you should have developed a comprehensive and informed opinion about the potential of data-driven supply chain and be able to reflect on its implications and limitations. Through exposure to empirical research, tactile experience, and real-life case studies, you will begin to consider the potential presented by data science and AI and will be able to make an informed decision around its application within your own organization or context. You will be challenged throughout the module to critically appraise the use of data science and AI, both within your own organization and in society at large, while considering the ethical, legal, and societal implications that the use and implementation of data science and AI entails.
Purpose	Introduction to Data Driven Supply Chain aims to provide you with a sound understanding of artificial intelligence (AI) in terms of its history, functionality, and potential, as well as the limitations that are inherent in its methods. On completion of this module, you should have developed a comprehensive and informed opinion about AI's potential and be able to reflect on its implications and limitations.

	Through exposure to empirical research, tactile experience, and real-life case studies, you will begin to consider the potential presented by AI and will be able to make an informed decision around its application within your own organization or context. You will be challenged throughout the module to critically appraise the use of AI, both within your own organization and in society at large, while considering the ethical, legal, and societal implications that the use and implementation of AI entails.
Study Load	5 ECTS
Learning Outcomes (Exit-level outcomes (ELOs))	<ul style="list-style-type: none"> • Understanding on an introductory level to how to apply data to drive the organization supply chain. • Being able to deduce the potential trajectory transforming an organization to a data-driven organization. • Being able to justify which areas in the sector or profession of choice have the greatest potential to be impacted to your supply chain by AI applications. • Develop a business case for the supply chain application for AI in your organization or an organization of your choice. • Selecting an appropriate machine learning type for a specific project (fx. Classification, Estimation, Recommendation, Prediction ect.) • Pointing in the direction of appropriate machine learning technology for a specific supply chain project (fx. Shallow learning, Deep learning, Re-enforced learning.) • Learning how to develop a supply chain case for the analysis and application of AI in your organization or an organization of your choice • Being able to deduce the potential trajectory of AI in your organization or an organization of your choice from the analysis of the history and case examples of artificial intelligence. • Being able to judge the machine learning workflows for supervised, unsupervised, and reinforcement learning. • Being able to assess the mechanics of machine learning algorithms, such as neural networks. • Being able to draft the ethical principles or considerations that your organization or an organization of your choice should instill for its AI applications.
Judgement Scales and Assessment	In order to pass the module, the student should demonstrate competencies corresponding to the Solotaxonomy level 4: Relational. The student should be able to analyse a particular situation presented in a case, and apply the various tools, theories and models to argue a solution as well as consider various risks and weaknesses associated with the proposed solution, both related to theory as well as praxis. Exam

	In groups of 4-5 students, they are to hand in a 8-10 page business case in data-driven logistics. At the exam, the groups are assigned to make a 20min presentation of the Business case and its main results. This is followed by a 20 min individual examination. The students are to be examined with special attention to evaluating the level of competence (solo-taxonomy) relating to the Learning outcomes, knowledge, skills and competencies here stated.
Professional Products	<ul style="list-style-type: none"> • An empirical research, tactile experience and real-life case studies • An informed decision in regard of an application in a company
Learning Activity	<ul style="list-style-type: none"> • Understand artificial intelligence (AI) in terms of its history, functionality, and potential, as well as the limitations that are inherent in its methods. • Develop a comprehensive and informed opinion about AI's potential and be able to reflect on its implications and limitations. • Appraise the use of AI, both within your own organization and in society at large, while considering the ethical, legal, and societal implications that the use and implementation of AI entails.
Skills	<p>The student is able to:</p> <ul style="list-style-type: none"> • Working independent with problem solving involving selecting and applying theory and models for the task. • Apply innovative methods with a focus on project work in practice-oriented data science and AI projects • Apply key methods for internal and external communication • Evaluate the quality of a suggested data science / AI solutions • Evaluate the legal and ethical compliance of a suggested data science / AI system • Transversal skills <ul style="list-style-type: none"> ○ Independent problem solving ○ Creative solution making ○ Flexibility ○ Social behavior
Tools, Knowledge and Methods	<p>The student has:</p> <ul style="list-style-type: none"> • knowledge about how data science and Machine Learning can improve the quality of decision making within the business. • knowledge about ethical principles for businesses working with AI • Knowledge about the network structure of a supply chain and different optimization tools • development-based knowledge about data science, AI analysis and development methods

	<ul style="list-style-type: none"> • development-based knowledge about the importance of methods to ensure the quality of products and processes • Development-based knowledge about AI in supply chain • knowledge about discover and preparing data for machine learning
Competencies	<p>The student is able to:</p> <ul style="list-style-type: none"> • handle the connection between design of business processes and the design of data science / AI systems • participate in project work and collaborate with stakeholders in data science projects / AI as the business representative, using a professional approach • acquire new knowledge, skills and competencies about new technology in a structured context from a professional perspective
Literature	<p>Geron, Aurelien, 2019, <i>Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd New Ed.</i>, O'Reilly Media, Chapter 1, 2 + Appendix A (Machine Learning Project Checklist)</p> <p>Min, H., 2010, Artificial intelligence in supply chain management: theory and applications, <i>International Journal of Logistics Research and Applications</i> 13 (1), pp. 13-39.</p> <p>Van De Poel, Ibo and Royakkers, Lambèr, 2011, <i>Ethics, Technology and Engineering</i>, Wiley-Blackwell.</p> <p>https://www.linkedin.com/learning/data-ethics-making-data-driven-decisions-2022/ethical-decisionmaking</p> <p>https://www.linkedin.com/learning/data-analytics-for-business-professionals/welcome</p> <p>https://www.linkedin.com/learning/data-driven-decision-making-for-business-professionals/</p> <p>https://www.europarl.europa.eu/meetdocs/2014_2019/plmrep/COMMITTEES/JURI/DV/2019/11-06/Ethics-guidelines-AI_DA.pdf</p> <p>https://machinelearningmastery.com/</p>

4.4. Technology Driven Supply Chain

Purpose	The purpose of Technology Driven Supply Chain is to gain insight into the supply chain networks as complex systems of firms and suppliers and to acquire the methodologies for detecting bottlenecks and the technologies for providing solutions.
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Study Load	5 ECTS
Learning Outcomes	<ol style="list-style-type: none"> 1. You analyse and map the business process of a logistics division of a company/supply chain 2. You identify bottlenecks in the process and make an estimation of their impact and define a set of criteria/KPIs (e.g., economic, environmental, social etc.) to rank the performance of the process 3. You carry a market analysis with regard to technologies, products or services that can be applied to solve the identified bottlenecks and identify the data necessary for the set of criteria/KPI 4. You present in a structured way: the issues identified, the potential solutions and the data related to the set of criteria/KPI 5. You take initiative to develop a specification sheet of a conceptual technological solution that solves the identified supply chain bottleneck 6. You will take more informed and transparent decisions to design an optimal supply chain network.
Judgement scales	<ol style="list-style-type: none"> a. Associate student level: chain scope b. Bachelor student level: network scope c. Master student level: global impact scope
Professional Products	The students define a specification sheet of a technology (trend), concept or solution that can be used to address a logistics challenge
Learning Activity	<ul style="list-style-type: none"> • Map the business process of a logistics division of a company/supply chain • Learn about technologies, products or services that can be applied to solve supply chain issues • Learn about the content of a specification sheet • Present outcomes of an own analysis in a way that both supply chain and tech minded actors can understand
Skills	<p>The student is able to:</p> <ul style="list-style-type: none"> • analyze, organize, manage, solve a problem • prioritize, communicate solutions • work independently, systematically, flexibly and accurately • act in a solution-focused and innovative way in order to deliver (intermediary) results on time.

Knowledge and Methods	<ul style="list-style-type: none"> • The student makes a selection/ranking of technologies that solve a specific logistics challenge by defining on own set of criteria/methodology (e.g., economics, environmental or operational KPIs, EOQ, lot sizing, transportation, etc. or a combination of the above). • The student based on this methodology will be able to define a conceptual design and a specification sheet for a solution. This specification sheet serves as the basis to create a commercial offer or defining implementation steps for a solution in logistics. <p><u>Prerequisites</u> to basic optimization models and methods such as EOQ, lot sizing, transportation: mathematical functions of one or more variables, linear and convex functions, elements of linear algebra, basic use of spreadsheets.</p>
Tools and Models	<ul style="list-style-type: none"> • The student can apply BPM, LEAN, a Cost-effectiveness, or cost-benefit analysis based on xls or other calculation environment • The student can set up and maintain a data base to keep track of own market research • The student can work with a template for a specification sheet

4.5. Sustainability Supply Chain

Purpose	The purpose of Sustainable SCM is insight into how sustainability will lead to constant changes in the supply chain management and lead to different factors of optimization of flow through the supply chain.
Study Load	5 ECTS
Learning Outcomes	<ol style="list-style-type: none"> 1. You have a profound knowledge of basic supply chain principles 2. You understand the environmental, social and economic impact of supply chain management, 3. You analyze and map the business process of a logistics division of a company/supply chain from a sustainability perspective in its three dimensions: economic, social and environmental 4. You become aware of the change that can be produced by a wise, competent and globally interconnected

	<p>management strategy</p> <ol style="list-style-type: none"> 5. You are able to identify their sustainability goals and objectives, and then create a plan for how to achieve them 6. You identify critical points in the process and make an estimation of their impact and define a set of criteria/KPI's to rank the sustainability of the process along the whole life-cycle 7. You identify and collect data relevant to the problem 8. You identify models and methods to cope with the issues observed and carry on a market analysis with regard to technologies, products or services that can be applied to tackle the problem 9. You present in a structured way: the issues identified, the potential solutions and the results potentially obtainable 10. You have the capacity to create a sustainability policy for the suppliers and customers (precise requirements for waste disposal, energy use, transportation and more)
Judgement scales	<ul style="list-style-type: none"> • Continuous formative assessment (posing questions to the class, homework evaluation, • Summative assessment through: <ul style="list-style-type: none"> ○ team group work ○ concrete problem solution ○ short report ○ written and oral exam.
Professional Products	<ul style="list-style-type: none"> • The students will be provided with an insight into how sustainability will lead to constant changes in the supply chain management and lead to different factors of optimization of flow through the supply chain. • The students will be able to work independently, systematically, flexibly and accurately and act in a solution-focused and innovative way in order to deliver your (intermediary) results on time.
Learning Activity	<ul style="list-style-type: none"> • Essentials of supply chain management: Revisit basic supply chain principles, looking to expanding the perspective on the impact and influence of global supply chains. • Practical implications for supply chain management: Expand the conception of value and rethink dependencies with a global perspective on supply chains. • Designing efficient, resilient supply chains: Discover how a life cycle approach and innovative business models can

	<p>revitalize supply chain design.</p> <ul style="list-style-type: none"> • Supply chain analytics: Reflect on the importance of analytics and KPIs for optimizing supply chain management. • Innovation and supply chain technology: Discover the role of technology in facilitating integrated supply chains, the new frontiers of digital supply chains and the opportunities for increased traceability. • Supply chain collaboration and partnerships: Consider the range of relationships that exist within contemporary supply chains, and how to extend and strengthen these relationships to optimize the design and impact of supply chains. • Rewiring a supply chain: Identify the goals and develop a strategy to realize them within a continuous DPCA approach to revision.
Skills	<p>The student is able to:</p> <ul style="list-style-type: none"> • analyze future challenges in SCM <ul style="list-style-type: none"> ○ Quantify the impact of the SCM on the three domains of sustainability. ○ Identify which solutions can be a quick win and which challenges might occur in the (near) future. • identify KPI's for monitoring and measuring • identify digital solutions that could support the new business models (data analytics, sharing platforms, AI,...) • create an action plan to implement the new solutions • implement sustainable digital solutions • apply sustainable business models • monitor and manage the implementation including testing and training • critically reflecting on the topic
Knowledge and Methods	<ul style="list-style-type: none"> • Broad overview of the three domains of sustainability: economic, social and ecological. • Awareness of the full supply chain and the impact of every part on sustainability (Design, Procurement, Production, Packaging, Transportation) • Knowledge of the existing and upcoming solutions in Energy Management, Waste Management, Product Design, Materials, Transport Management, Warehouse Management. • Knowledge of new economic models such as Value Creation, Embedded economy, Social entrepreneurship.

Tools and Models	<ul style="list-style-type: none"> • The student can work with the sustainable BMC. • The student can apply integrated value creation in the strategy of a company. • The student can apply circular economy principles and business models in the value chain.
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4.6. Minor's Thesis

Purpose	The purpose of the Minor's Thesis is to integrate all gained knowledge and skills in a final project to conclude the minor.
Study Load	5 ECTS
Learning Outcomes	<ol style="list-style-type: none"> 1. You are able to make an analysis having the right mindset distinguishing essence and details asking the right questions. 2. You are able to communicate and argue with colleagues individually as well in groups using professional language, making use of tools, and being able to train and guide. 3. You are able to collaborate and perform tasks in a team, establishing positive relationships with respect to each other using your social skills, adhering to agreements made where team interests are above self-interest. 4. You can think critically, not only focusing on the problem but actively and creatively seeking the best solution, being able to evaluate alternatives and reflect on them. 5. You are flexible to the needs and proactive in taking the initiative to collect and obtain relevant information and knowledge necessary to carry out the project properly, being able to estimate impacts of decisions and choices while showing perseverance and commitment learning from self-reflection.
Judgement scales	<ul style="list-style-type: none"> • Continuous formative assessment (posing questions to the team, project evaluation, evaluation of intermediate deliverables,) • Summative assessment through: <ul style="list-style-type: none"> ○ team group work ○ concrete problem solution and implementation ○ short report

	<ul style="list-style-type: none"> ○ final and intermediate presentations
Professional Products	<p>The students will deliver a report describing the delivered solution, the steps and the process to reach this solution and the possible next steps that would make the solution futureproof.</p> <p>The students will be able to work independently, systematically, flexibly and accurately and act in a solution-focused and innovative way in order to deliver your (intermediary) results on time.</p>
Learning Activity	<ul style="list-style-type: none"> • The students will be provided with a realistic case in collaboration with a company or organization in which they have to apply all knowledge and skills gained in the other modules of the minor. • The students will collaborate in an international team, working together in virtual or life sessions and will report to the coaches weekly. The documents and progress reports will be made available in a collaboration tool. • The students will be asked to present their (intermediate) results in different presentations.
Skills	<p>The student is able to:</p> <ul style="list-style-type: none"> • Communicate • Collaborate and use social skills • Analyze • Think critically, being creative • Show flexibility, initiative and reflect
Knowledge and Methods	<p>The student applies the knowledge and methods obtained in the other modules of the minor.</p>
Tools and Models	<p>The student applies the tools and models obtained in the other modules of the minor.</p>

5. Learning Materials

The development of learning materials needs to fit within a vision about learning based on which derived development principles will be the starting point.

The vision for learning will be based on the consensus in actual scientific research that the social constructivist learning approach equally scores on the traditional learning objectives, but better in planning, thinking critically and solving problems <https://www.stibco.nl/sociaal-constructivisme/>.

Transversal skills are highly valued by companies for graduates who want to start their working career as has been discussed before.

Social constructivism is a modern learning theory that assumes that students themselves assign meaning to their environment and that social processes play a prominent role in this. Knowledge is constructed by each person in his own way, whereby one is strongly influenced by the reactions and views in the social environment. In the translation of social constructivism into daily teaching or educational practice, 'learning as a social process' forms the starting point.

The central assumption of the constructivist theory is that the acquisition of knowledge and skills is not so much the result of a direct transfer of knowledge by the teacher, but rather the result of (constructive) thinking activities by the students themselves: they learn by doing, using new information. Connect to what they already know (prior knowledge). In the constructivist view, students must organize the information in such a way that it is relevant and useful to them. The role of the teacher should consist of creating optimal conditions for the learning process. The teacher stimulates, offers a clear structure and checks longitudinally whether the students have absorbed the information offered. Being part of the transversal skills (professional attitude) the students in the first instance should take initiative in this process themselves.

The learning process can be guided by tasks that enable the student to acquire and process knowledge and skills in a constructivist way (Fontys, development document 2021). There are five pillars when designing tasks and lessons:

1. The student must be active: he must do something to process the subject matter.
2. The student must be constructive: he must construct the new knowledge himself, i.e., deepen it and connect it with the existing prior knowledge. In this way new knowledge is created.
3. The student must deal with the knowledge in a goal-oriented manner: learning produces successful experiences if students have an (achievable) goal in mind.
4. The student must be (cooperatively) engaged in acquiring and processing knowledge and developing skills. Learning is a social process. Explaining each other and having peer reviews appears to improve the results.

5. The student must be able to regulate his own learning process. Being able to direct one's own learning process motivates.

Social constructivism also pays attention to social-emotional problems because it focuses on the acquisition of knowledge and the acquisition of skills. Attitude changes are facilitated by being collaborative, constructing, active, goal-oriented, self-regulating.

Powerful features of social constructivism are that:

- The student influences their own learning process.
- There is a link with previously acquired knowledge (prior knowledge).
- New knowledge is meaningful.
- Motivation is increased because students are actively involved because the process is aligned with the development level and pace of the student.
- Knowledge becomes a tool that can also be used in other contexts the student develops meaningful competences.
- A higher learning efficiency is achieved also because the student develops self-reflection.
- The supervisor is a meaningful facilitator, not a driver.

Social constructivism assumes that much of what learners learn is actively constructed by themselves. A student links new knowledge to existing prior knowledge. Knowledge and skills are linked to experiences in a specific context. This knowledge is then applied in other contexts. Social constructivism assumes that students continue to refine the level of understanding in this way.

Learning environment

Therefore, in regard of developing learning materials students must be offered a stimulating and challenging learning environment. Module content should not be fixed but the student should have room to get started with stimuli from the environment. In every educational activity, the stimulation of mutual transfer between theory and practice must be demonstrable.

Personal development

In the supervision of the student's professional development, attention to the broad personal development (personal profile) is at the service of his or her professional development. Courses and transversal skills must be integrated with each other providing full attention to agile knowledge, professional attitude and professional skills.

Testing

Tests direct learning and are therefore educational activities that must be designed as such based on the pyramid of Miller. Testing behavior will be done multidimensionally, at several moments,

with several assessors and using different instruments. The educational themes will be tested integrally but it should also be possible to examine knowledge, skills and attitude separately.

Within these boundaries the learning materials per module have been set up according to the following content mapping structure, each module fitting a study load of 5 ECTS:

1. General Introduction giving background on the course, explaining goals and learning content as well the learning and testing principles and approach s.a. working in sprints and/or using portfolios.
2. Presentations which are merely short subject introductions with good reference to sufficient educational materials such as literature, videos etc. are preferably supported with company visits and presentations.
3. Challenges in the form of preferably real-life industry assignments or management games where students individually but also in groups can work on writing a content document including personal reflection on what they have learned and what they can improve, f.i. supplemented with peer reviews.
4. Other materials that might be useful for the students' learning process.
5. Project assignment to work on using a professional approach in a project group preferably in a company setting based on a real problem to be solved and presented for and in collaboration with the customer.

The students who will attend may have different backgrounds (Supply Chain, ICT or else) and different educational entrance levels ranging from Associate Degree via Bachelor to Master. The educational materials will have flexibility to facilitate these differences. The study load and difficulty level are particularly expressed in the level of content explanation as well as the output quality of the challenges. So, using the same presentation materials the complexity and depth of the introductory explanations related can be adjusted to the level and experience of the audience. This same principle is valid for the challenges where the answers and outputs can have different quality with different judgement according to the level of the students.

Materials can be found in the INCO_SMRT Teams environment.

For each of the modules, the learning materials have been archived with the following folder structure:

1. General: learning outcomes as well as introductory material about content, planning, way of working and judgement to make the student at ease and confident.
2. Presentations: short and to the point content presentations about the different subjects that challenge and help students on their way to further dig and find out for themselves.
3. Challenges: assignments comprising problems, questions and/or games to be worked on individually or in groups.

4. Other materials: in depth background materials s.a. literature (books, articles) that students can use to study themselves, but they also have the freedom to consult the internet or other sources.
5. Project: description of a small integral project to be worked on individually or in groups that helps students to 'tie all knots together'.

6. Conclusion

Based on the mutual defined transversal skills Cooperation & Collaboration, Analytical, Methodical & Structured, Entrepreneurial, Communication, Critical Thinking and Reflecting learning materials have been developed for six content modules including an overarching thesis. These six modules are Dynamic Supply Chain, Business Process Optimization, Data Driven Supply Chain, Technology Driven Supply Chain and Sustainability Supply Chain.

This all within the vision of social constructivism where acquisition of knowledge and skills is not so much the result of a direct transfer of knowledge by the supervisor, but rather the result of (constructive) thinking activities by the students themselves: they learn by using new information.

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