Interreg Italy - Croatia DIGSEA

EUROPEAN UNION

Cross-border training curriculum on ICT application in the freight transport sector

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1. Introduction

Information and communication technologies (ICT) are critical to effective management of intermodal transportation, and - technological, process, and policy-based innovations offer opportunities to improve the efficiency of transportation services and the management of congestion at nodes.

Over the past 30 years, the rapid rise of globalization has completely transformed the world economy, created an increasingly interconnected trade network and stimulated the production of new goods and services. Like many other sectors of the economy, the transportation and logistics sector has benefited tremendously from globalization, as the increase in international trade has provided lucrative opportunities for companies to capitalize on. As transportation and logistics companies benefit from a successful market integration, it is important to note that globalization to this extent has only been possible thanks to the innovation and investment of these companies, whose forward-thinking vision has shaped the world of international trade as we know it.

Considering the increasing use of new technologies - from automated trucks to electric vehicles - new technological breakthroughs are redefining the transportation and logistics industry - there is a growing need for training with well-defined learning outcomes that keep pace with the needs of the market.

Starting from the previous assumption, however, it should be underlined that although the direction that has to be taken is clear, i.e. the use of modern ICT technologies, it is not at the moment likewise precisely defined what type of skills and competences will be necessary for those who will have to manage the whole innovation process. Some studies have shown that it is reasonable to think that for the stakeholders who will have to implement the new ICT technologies within their organizations it will be relevant to have not only technical skills but also a "soft" knowledge background that will allow them to properly manage the change process. For this reason, since the target of the present curriculum is composed of policy makers and relevant freight transport stakeholders, the training path will also include some modules more focused on managerial issues.

2. Cross-border training curriculum

The curriculum is content of what is taught in a particular course or subject, including methodologies and tools used to achieve favorable teaching outcomes. Curriculum therefore refers to an interactive teaching and learning system with specific objectives, content, strategies, measurements, and resources. The desired outcome of a curriculum is the successful teaching and/or development of knowledge, skills, and attitudes.

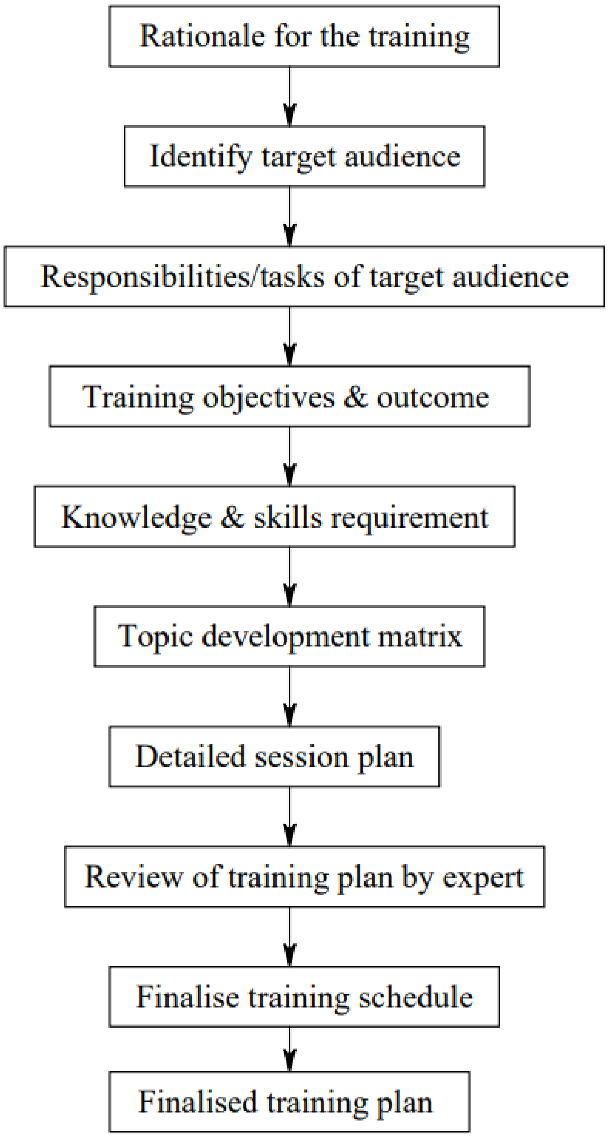
Training curriculum is, therefore, an overall set of learning activities designed to achieve the goals of the educational program. In a competency-based system, the goal or desired purpose for trainees is to acquire the specific knowledge and skills (competencies) they need to do their jobs. There are three main components that must be examined when evaluating a training curriculum. These are:

- the content or information to be taught,
- the organization of the curriculum: the structure, format and sequence,
- the training methods used

Training curriculum means an established set of course topics for instruction in an accredited training program for a particular discipline designed to provide specialized knowledge and skills.

In a participant-centered training program, the needs of the participants are in the focus of the entire training. The main goal is to develop participants' skills, with an emphasis on improving them along with the knowledge. Once there is clarity on the reason for offering the training program, the driving force in developing the curriculum is to identify the appropriate target audience and then address the details of their responsibilities and tasks. This forms the basis for the curriculum's development. Goals and outcomes provide greater direction to the educational program. Unlike educational institutions where specific subjects are taught, in this context, subjects are integrated, and the training content includes several topics related to their responsibilities and tasks. The subjects to be taught are identified using a two-page matrix table, with the responsibilities in the first column and the objectives of the course in the first row. Based on this, the detailed content is determined, so unlike a typical classroom, practical and theoretical content is integrated. The course duration must be determined, considering when participants may be absent from work and other obligations. Whatever is to be taught must fit within this period. Prioritizing the content will ensure that the focus is on the areas where participants require more in-depth input. The following flowchart (Diagram 1.) shows the various stages of curriculum development.

Diagram 1. Process flow for developing a training curriculum



2.1. Training content

Content includes the specific information, facts, attitudes, and skills to be taught through the training program. In a competency-based system, these are formalized in the competency statements. The following principles relate to the training content:

- the scope and depth of the content of any curriculum are determined by the competencies that the curriculum is designed to teach
- content should provide a theoretical framework and conceptual rationale for the training
- content should reflect the best standards of practice
- content should communicate a value orientation
- in a continuous training program, the content must be applicable in direct practice
- the content of a curriculum must be congruent and complementary both within and between sections

2.2. Structure and format

This refers to the structure of the individual sections and the organization of the parts of the curriculum into an integrated educational unit. This includes the design of the individual sections to achieve the objectives, the sequencing of sections and activities, the establishment of time frames, and the design of connections between various sections.

1. The sequencing of activities within each section and the curriculum should be consistent with the natural learning process.
2. Knowledge and skills conceptually related or performed together in the workplace should be taught together.
3. A broad overview of the content at the beginning of the sequence provides a conceptual framework into which the participants can place the individual parts.
4. The principles of sequencing are from the simple to the complex, from the general to the extraordinary, and from the basic to the refined.
5. Repetition of the key concepts in different contexts facilitates understanding. Linking sections within a curriculum helps to make logical connections between previous and current training content and to identify different situations in which similar knowledge and skills are applied, further promoting retention and generalization.

6. Allowing sufficient time to cover the content in the desired depth. Compressing the content into an unrealistic amount of time limits the effectiveness of the training. It cannot be done faster than the natural course of education process dictates.

2.3. Training methods

Training methods are the strategies used to deliver content and promote learning and knowledge retention. In the in-service training curriculum, training methods must be appropriate for use with adult learners in an applied setting. The method best suited to achieve the objective of the section should be selected. The usual course of action is the following:

1. Use a presentation to quickly convey information.
2. Use discussion to reinforce information and promote understanding.
3. Ask trainees questions or use exercises that feed information back to the trainer to determine how well trainees understand the content.
4. Use experiential (experience-based) exercises and examples to promote self-awareness.
5. If participants have prior knowledge or preconceived notions about the content, use the activity that challenges the mindset and motivates participants to rethink their own beliefs.
6. Use exercises and simulations to encourage application of the content to work tasks and develop trainees' skills.
7. Use activities that identify solutions to potential workplace or logistics process obstacles
8. Present the same concepts with a variety of learning strategies to ensure that trainees with different learning styles can absorb the knowledge. Listening, viewing, modeling, and then practicing the training content reinforces learning for individual trainees.

2.4. Framing the learning outcomes of each module

Learning outcomes are statements of the knowledge, skills, and abilities that individual participants should possess and can demonstrate upon completion of the learning experience or sequence of learning experiences.

They help the participants:

- understand why this new knowledge and these skills will be useful to them

- focus on the context and possible applications of knowledge and skills
- connect learning in different contexts
- guide assessment and evaluation

Good learning outcomes emphasize the application and integration of knowledge. Rather than focusing on covering the material, learning outcomes articulate how participants will be able to apply the material, both in the context of the class and more broadly.

Within the didactic concept, the teaching methods in this course program will include theoretical lectures, seminars and tutorials, individual practice work, extracurricular lectures by guest lecturers and key figures identified by the responsible project partners, active participation in debates and knowledge sharing. The course needs to provide participants with a favorable and diverse quality study environment to achieve specific knowledge and competences in areas of novel technologies and digitalization in the cargo and freight sector in order to have a successful knowledge transfer in the real market scenario or even further lateral advancement and transfer to other business and practical areas for implementation of innovative digital technologies. In order to identify satisfaction with the learning outcomes of the modules, a comprehensive collaborative environment with all the parties will be created and thus ensure that all members participate in their own evaluation and quality improvement processes, by means of open discussion with project partners where syllabi, learning outcomes, assessment forms, assessment results as well as overall performance of the courses are discussed. It is important to identify how much they have met their goals and objectives for the respective course in relation to the teaching process, how much they have done individual research and practical work, and how satisfied they are with the courses offered for their overall professional development and improvement of freight-related processes in their area of work.

The learning outcomes for the courses are formulated based on the approach adopted by the partners in charge, which includes transfer knowledge, skills as well as broader competencies. Learning outcomes reflect the indicators aligned with the application form, as they provide the provision of practical and theoretical knowledge, the development of participant skills for independent research work within the field of innovative digital technologies in the freight sector, collection and interpretation of relevant data to come up with judgments as well as apply their knowledge to problem solving within the field of transport, logistics and freight movement. In accordance with the identified requirements in addition to providing participants with the basis for progress in further areas, the courses are outlined so to provide them also with possibility to apply new knowledge in other business and academic areas.

2.5. Framing the objectives and outcomes of the course

The objectives would make it possible to determine the focus of the course. The objectives should be based on the knowledge and skills that the candidate is expected to acquire through participation in the training. The outcome decision would determine the exact impact of the training on the participants.

Every course needs to be adjusted with the general mission (objective) outlined in the DigSea application form. The course objective needs to be in compliance with the overall mission statement of the project. The design of the course was preceded by a comprehensive process of consultation and review with the involved project partners and builds upon professional experience of the responsible project partner in dealing with the stakeholders in the transport, logistics and freight sectors. This process was carried out in accordance with the goals set out in the application form.

Therefore, the knowledge transfer within course execution is done as an intra-team effort, where higher instances of the project partners already having adequate levels of knowledge, transfer it to lower instances, end-user participants and involved stakeholders.

2.6. Creation of the training plan

Similar content should be grouped together, and the logical flow or sequence determined, keeping in mind that some topics must be taught before others, in a logical order of sequence. The duration should be determined, considering the person's availability and individual focus capabilities. The content and training plan created so far must be fitted into the available time period. This is where weighing several topics helps in deciding how to allocate time.

2.7. Direct measures for evaluation

Direct measures of assessment of learning require participants to demonstrate their knowledge and skills. They provide tangible, visible, and self-explanatory evidence of what participants have and have not learned as a result of a course, program, or activity. Examples of direct measures include:

- objective tests (written, oral, or using LMS – Learning Management Systems)
- essays
- presentations
- in-class assignments
- portfolios

The organization of the cross-border training curriculum on ICT application in the freight transport sector will provide interesting results to enhance management efficiency and effectiveness in many areas of the supply chain.

It is a commonly accepted fact acknowledged by numerous research work conclusions that digitalization rests on the shoulder of people that used it. The issue of human capital is, consequently, crucial for successful adoption of digitalization in the freight market context. Two crucial questions to which the cross-border training curriculum need to shed light on is:

1) how to attract and retain talent; and

2) how to use software resources for better recruitment, development, and training processes.

3. Course description

This 3-week training program addresses multiple areas and subjects. The area of IoT is commonly understood to mean the networking of devices in the physical world by equipping them with sensors and devices connected to the network. In the first part of the course, we will give participants an introduction to the necessary technologies, skill components, and the requirements and constraints for deploying IoT in a logistics or transport enterprise. In the second phase of the course, the key trends will be explored, that are mainly characterized by the new waves in the crypto economy but can be applied to the transport sector. The evolving legal framework and regulations of blockchain will also be included. More will be elaborated about the future of blockchain technology and the opportunities that exist, from finance through transport/logistics to the Metaverse.

In today's world, properly leveraged data can provide organizations with different types of competitive advantages. Organizations process massive amounts of data daily, and the demand for professionals in this field has never been greater. That is why in the third phase of this course, extraction of useful information from data and its analysis will be taught. The Big Data Analytics module introduces to the audience the most important Big Data analysis tools, using demonstrations and case studies to introduce each of them.

In the AI in Transportation module, the participants will be able to create an intelligent environment for the transportation system to reduce or avoid accidents by developing AI capable of deep and continuous analysis and learning. For example, the participants will be able to understand how to transform transport vehicles into intelligent, self-learning and self-driving vehicles by developing an electronic brain of electronic neurons and an environment that analyses input data and interacts optimally with the environment.

The module in Simulation and Modelling, builds on the theoretical aspects of transportation planning and engineering to introduce a more applied approach that covers the state of the art in transportation modelling. The overall goal is to develop an understanding of the various approaches to modelling the consequences of transportation, planning, and policy decisions.

The final part of the training course aims at providing participants with a series of skills that are useful when innovating a certain organization (company or public body) mainly focusing on the implementation of new ICT technologies, and more in general within innovation or change processes. The three modules are aimed at providing managers with a series of skills and competences, mainly at a strategic level, that are fundamental in innovation processes as they contribute to creating the favourable “environment” that is at the base of the success of the process.

Table 1. Course summary

No of Modules:	8
Course Duration:	3 weeks (total of 60 hours)
Course Level:	Intermediate
Completion Certificate: **(if agreed by the consortium)**	University of Rijeka, Faculty of Maritime Studies (or another institution)
Course Language:	English/Italian/Croatian

3.1. Internet of things

The Internet of Things is a set of technologies that enable the integration of devices over the Internet and their mutual communication and interaction with various applications. This communication takes place between things (devices) and people, as well as between the devices themselves. Devices with embedded sensors generate information through the communication structure and provide insights into processes, secure a functional environment from attacks, increase the productivity of people and goods, and provide profitability by identifying new business opportunities. Among the challenges of IoT technologies is the way how this data is collected, transmitted, secured and stored.

The scale and scope of the Internet of Things requires the use of open, extensible and robust solutions in these areas, and the answers to the challenges posed will enable the extraordinary opportunities of the industrial IoT market to be realized. The use of Internet networked physical devices offers great opportunities in this regard. It facilitates and accelerates the flow of information and enables communication with other similar devices globally. It is a simplifying tool that can improve people's lives in many ways, but it can also threaten them in case of security breaches. Nowadays, people connected to the Internet are the leading users and producers of technology.

Internet culture is a culture of creation, and the creators are at the same time the first users, who form societies, the so-called virtual societies. Certainly, information technology is advancing and creating new opportunities for progress, but it must not be forgotten that the use of this technology carries several risks. A basic information system for supply chain management is the ERP (Enterprise Resource Planning) system. This system plays a key role in e-commerce business and enables the smooth functioning of the supply chain model. Successful implementation of IoT in logistics requires strong networking and participation of all supply chain players and competitive companies for joint investment in IoT infrastructure. Therefore, it is necessary to invest in M2M (machine to machine) and V2V (vehicle to vehicle) models. M2M refers to communication between several physical devices with built-in processors, smart sensors, drivers and mobile devices. The prerequisite for these two models to function is communication over the Internet in a single shared smart IoT network. The use of M2M communication is growing at an accelerating pace in recent years.

The Internet of Things represents the digital or "smart" connection of objects using RFID sensors, Wi-Fi, Bluetooth and other "smart" protocols to accelerate business processes. Typical applications of IoT include logistics management using radio-frequency identification (RFID) technology, smart homes, e-health, smart power grids, maritime industry, etc.

The goal of IoT is to automate individual processes, systems and complex devices and increase their efficiency. The basis of this model is the collection of data, transmission of data through the communication network, data processing and response to appropriate information. This ensures that information is available in the right place for those users who need it most to make optimal decisions. This model is certain to impact the production process, communications and the exchange of goods, both locally and globally.

The Internet of Things (IoT) has the potential to transform the transportation industry by fundamentally changing the way transportation systems collect data and information, bringing together key technical and business trends in mobility, automation, and data analytics. The Internet of Things (IoT) refers to the networking of physical objects using embedded sensors, actuators, and other devices that can collect and transmit information
In this course, participants will also learn how effective fleet management can be achieved by using the IoT to monitor vehicles in real time using sensors and other devices, and how the Internet of Things can increase efficiency, reduce costs, and improve customer service by tracking vehicle location in real time.

Learning outcomes examples include:

1. Determining the basic concepts and features of the Internet of Things
2. Choosing the appropriate architecture for the Internet of Things
3. Differentiate approaches in the realization of IoT solutions
4. Differentiate between network and communication protocols
5. Identifying security threats and ways to compromise privacy
6. Suggesting appropriate IoT solutions for different application areas in transport

Evaluation of learning outcomes (examples) include:

1. Name the technologies that enabled the development of the Internet of Things?
2. What is I2C and for what purpose is it used?
3. What is the difference between cloud and edge IoT solutions?
4. What are the limitations of the IEEE 802.15.4 standard?
5. What security threats are recognized as the most significant in IoT solutions?
6. What classes of smart IoT objects are defined in the document RFC7228?

3.2. Blockchain

Blockchain is a shared, immutable ledger that facilitates the recording of transactions and tracking of assets across a business network. An asset can be tangible (a house, a car, cash, land) or intangible (intellectual property, patents, copyrights, trademarks). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and lowering costs for all involved parties.

Blockchain technology as a secure, transparent, public, and decentralized database leads to many divided opinions about the pros and cons of its use and its increasing use in all sectors of the economy. Blockchain technology is based on a method in which previously unknown parties can jointly create and maintain any database on a fully distributed basis, with the correctness and completeness of transactions confirmed by the consensus of independent auditors. Blockchain consists of two terms: the "block" and the "chain". The "block" represents transactions, while the "chain" links those transactions into a chain. The block is the basic unit of the blockchain. Each block contains a list of transactions and references the previous block in the chain. The principle of blockchain technology is realized through a decentralized peer-to-peer network. The peer-to-peer network is defined as a network for data exchange between many working entities.

Blockchain-based smart contracts represent a distributed operating system. A smart contract can be defined as a self-executing, pre-assessed contract. A smart contract aims to digitally facilitate, verify, or enforce the negotiation or performance of a contract. Blockchain technology incorporates several preventive mechanisms (e.g., distributed consensus and cryptography) to mitigate the risks of cyberattacks. Blockchain can be applied in various fields, from financial assets, payment systems, smart contracts, operational risks in the financial market, risk management, Internet of Things (IoT), to public and social services. IoT technology can be enhanced by using blockchain technologies to process collected data in a verifiable way.

The first blockchain was used as the basis for the cryptocurrency Bitcoin in the financial sector. Bitcoin uses peer-to-peer technology and works without a trusted third party, which can be a bank, accountant, notary or any other centralized entity. Bitcoin is open-source technology; its design is public, no one owns or controls it. In addition, it is a cryptographically secure electronic payment system that enables virtual currency transactions in the form of digital tokens called Bitcoins (BTC).

Transportation and logistics can learn a lot from blockchain; it seems almost like a technology developed specifically for this sector. However, more and more solutions are already being developed to support transportation companies, and it is expected that the share of blockchain in this industry will continue to grow.

In order to determine benefits of the blockchain use in the transportation sector, several use-case scenarios will be outlined. The first example is smart tracking of order deliveries. With the increasing demand for same-day and express (one/two hour) delivery services, traditional tracking technologies may no longer be sufficient. Blockchain technology provides a scalable, instant solution for tracking and authenticating orders, improving the quality of service provided by transportation and delivery companies. Thanks to innovative blockchain-based platforms, coordinating a company's documents and information in a shared distributed ledger minimizes paperwork and improves information flow and communication. In addition, smart contracts enable faster approval of transactions or inspections (e.g., customs clearance), reducing the time it takes to process goods. Blockchain is therefore a reliable tool for data verification in the transportation and logistics sector. The technology can also assist in tracking truck fleets, routes, traffic incidents and related operations. It contributes to greater visibility, security, and minimization of potential fraud or threats.

The goal of this course is to provide insight into the history, fundamentals, and philosophy of blockchain and to provide the understanding of the concepts and regulatory challenges of blockchain as a disruptive technology.

Learning outcomes examples:

1. Recognize and describe the basic terms and concepts of blockchain
2. Analyse the impact of blockchain (cryptocurrencies, electronic wallets, smart contracts, etc.) on the private and public sector and society
3. Apply the knowledge acquired to create your own ICO
4. Assess the potential of smart contracts (smart contracting)
5. Identify and clarify challenges and opportunities in blockchain implementation from a regulatory and business perspective
6. Identify and analyse key blockchain factors impacting society

Evaluation of learning outcomes (example):

1. What is the principle on which blockchain technology is based on?
2. Why is Blockchain a trusted approach?
3. Is it possible to modify the data once it is written in a block?
4. What exactly do you know about the security of a block?
5. What type of records can be kept in a Blockchain? Is there any restriction on same?
6. What are the benefits of Blockchain that you know?

3.3. Big data analytics

Big data is a term that describes large, hard-to-manage volumes of data – both structured and unstructured – that inundate businesses on a day-to-day basis. It is not just the type or amount of data that's important, it is what organizations do with the data that matters. Big data can be analysed for insights that improve decisions and provide confidence for making strategic business moves.

Big data can be described in terms of data management challenges that – due to increasing volume, velocity and variety of data – cannot be solved with traditional databases. While there are plenty of definitions for big data, most of them include the concept of what is commonly known as "three V's" of big data:

- Volume: Ranges from terabytes to petabytes of data
- Variety: Includes data from a wide range of sources and formats (e.g., web logs, social media interactions, e-commerce and online transactions, financial transactions, etc)
- Velocity: Increasingly, businesses have stringent requirements from the time data is generated, to the time actionable insights are delivered to the users. Therefore, data needs to be collected, stored, processed, and analysed within relatively short time windows, ranging from daily to real-time.

Big Data analytics is a process used to extract meaningful insights, such as hidden patterns, unknown correlations, market trends, and customer preferences. Big Data analytics provides various advantages - it can be used for better decision making, preventing fraudulent activities, among other things. These massive amount of data sets that cannot be stored, processed, or analyzed using traditional tools. Today, there are millions of data sources that generate data at a very rapid rate. These data sources are present across the world.

Big Data analytics includes structured, semi-structured and unstructured data that are large and complex to process and analyse in terms of volume, complexity, generation speed and varying collection intervals. The module enables the acquisition of technical, organizational, communication and analytical skills through the entire process of collecting, analysing, processing and visualizing structured data to create new knowledge (process also known as data mining).
Basic big data processes include data acquisition, processing, aggregation and delivery. Data acquisition in transport relates to the collection of a high volume of data from specific data sources e.g., presence detection data, tolling and passenger transaction data. Data acquisition in a big data environment is characterised by a high volume of semi/unstructured raw data ready for processing (e.g., traffic speed). Data processing involves cleansing (e.g., anonymization), the application of unique IDs to records and identification of errors. Clean data from multiple data sources is then made available for aggregation. Big data aggregation is achieved by organising and processing data

from an unstructured to a structured state. For example, in transportation, vehicle presence detections are used to establish characteristics of traffic, such as flow or occupancy, which is used to establish congestion or delay data. Furthermore, train departure data can be used to predict future delays. Aggregated data may or may not be moved from its original location. Data sets may be aggregated into one big data set, which can be processed using intensive analytics to identify relations, trends and insight. These outcomes can be further used for analysis and dissemination.

Big data analytics is important because it helps companies leverage their data to identify opportunities for improvement and optimization. Across different business segments, increasing efficiency leads to overall more intelligent operations, higher profits, and satisfied customers. Big data analytics helps companies reduce costs and develop better, customer-centric products and services. The transportation sector is on the brink of a paradigm shift thanks to big data. Smarter transportation will result in operational efficiency, improved end-to-end customer experiences, reduced fuel consumption and increased flexibility.

Learning outcomes examples:

1. Distinguish types of problems and categories of big data.
2. Indicate the sources and methods of data collection.
3. Describe data processing and formatting.
4. Design of a system for finding similar entities, frequent sets and groups in big data.
5. Design of a referral system.
6. Distinguish and systematize systems for big data processing and analysis and software tools.

Evaluation of learning outcomes (example):

1. How does Big Data analytics help increase corporate revenue?
2. What are the five V's of Big Data?
3. Explain the steps to follow when implementing a Big Data solution.
4. How would you transform unstructured data into structured data?
5. Do you prefer good data or good models? And why?
6. What are the common input formats in Hadoop?

3.4. Artificial intelligence in transportation

Artificial intelligence (AI) is the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings. The term is often applied to the project of developing systems equipped with the intellectual processes characteristic of humans, such as the ability to think, recognize meaning, generalize, or learn from experience. Since the development of the digital computer in the 1940s, it has become apparent that computers can be programmed to perform overly complex tasks-such as discovering proofs of mathematical theorems or playing chess-with great power. However, despite continuing advances in computer processing speed and memory capacity, there are no programs that can rival human flexibility in larger domains or in tasks that require a great deal of everyday knowledge. On the other hand, some programs have reached the level of performance of human experts and professionals in performing certain tasks, so artificial intelligence in this limited sense can be found in applications as diverse as medical diagnosis, computer search engines, and speech or handwriting recognition.

The term can also be applied to any machine that exhibits characteristics associated with the human mind, such as learning and problem solving. Artificial intelligence is transforming the transportation sector. It is helping cars, trains, ships, and planes to function autonomously, making traffic flow more smoothly, and is already being used in many transportation sectors. It can not only make lives easier, but also help all modes of transport become safer, cleaner, smarter and more efficient. The ideal characteristic of artificial intelligence is its ability to make rational decisions and take actions that offer the best chance of achieving a given goal. One subset of artificial intelligence is machine learning (ML), which refers to the concept that computer programs can automatically learn from and adapt to new data without the assistance of humans. Deep learning techniques enable this automatic learning by ingesting enormous amounts of unstructured data such as text, images, or videos.

The potential applications for artificial intelligence in transport and logistics are endless. Technology can be used in many different sectors and industries. For example, artificial intelligence in transportation uses important advanced technologies such as Big Data in transportation to improve safety and machine learning to increase efficiency so that cities - and smart cities - can reduce traffic accidents, improve traffic flow, and even bring criminals to justice.

Traffic problems become a challenge when it is too difficult to model the system and user behaviour and predict traffic patterns. Therefore, AI is considered suitable for transportation systems to address the challenges of increasing traffic demand, CO_2 emissions, safety concerns, and environmental degradation. These challenges arise from the steady increase of traffic in rural and urban areas due to the growing population, especially in developing countries. Many researchers in the 21st century is trying to create a more reliable transportation systems with less impact on people and the environment using less expensive and more reliable AI techniques. AI has potential applications for road infrastructure, drivers, road users, and vehicles. AI applications in transportation have so far been developed and implemented in a variety of ways.

AI in transportation and infrastructure can collect traffic data to reduce congestion and improve public transportation planning. Traffic is affected by the vehicle flow, and the AI will enable streamlined traffic patterns, smarter traffic light algorithms and real-time tracking that can effectively manage higher and lower traffic patterns. This technology can be applied to public transport for optimal planning and routing.

This course highlights the fundamentals of artificial intelligence in transportation systems (AITS) and safety and addresses the technologies involved in its implementation. It also covers the main problems in transportation and safety and the corresponding solutions related to the AI.

Learning outcomes examples:

1. Analyse problem solving methodology and uncertainty modelling.
2. Describe the current landscape of AI and other disruptive technology in the transportation sector
3. Define and analyse nature-inspired optimization algorithms.
4. Define and analyse machine learning.
5. Define and analyse game theory.
6. Apply artificial intelligence to the optimization problem.

Evaluation of learning outcomes (example):

1. What are the three sources of uncertainty?
2. Name an example of a disruptive technology in transportation nowadays and explain it.
3. Name some examples of optimization algorithms inspired by nature.
4. What are the 7 steps of machine learning?
5. Explain the impact of game theory on business and the economy.
6. What are the five steps in solving optimization problems?

3.5. Simulation and modelling in transportation

Modelling is the process of making a model; a model is a representation of the structure and operation of the system of interest. A model is alike, but simpler than the system it represents. One purpose of a model is to let the analyst predict effects of the system changes. On one hand, a model should be a good approximation of the real system and contain most of its key features. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A crucial issue in modelling is model validation. Model validation techniques include simulating the model under known input conditions and comparing the model output with the system output.

A simulation of the system is operational use of the model of the system. The model can be reconfigured and tried; usually this is not possible, too expensive, or impractical in the real system it represents. The operation of the model can be studied, and properties can be inferred that affect the behaviour of the actual system or its subsystem. In the broadest sense, simulation is a tool for evaluating the performance of an existing or planned system under various configurations of interest and over extended periods of time.

Modelling and simulation are the use of a physical or logical representation of a particular system to generate data and make decisions or predictions about the system. They are used in the social and natural sciences, engineering, manufacturing, product development, and many other fields.

Modelling and simulation are also used to study complex systems. A system is defined as the set of entities that make up the facility or process in question. To facilitate the testing and evaluation of a system, a representation - called a model - is created. Physical models represent systems as actual hardware, while mathematical models represent systems as a set of computational or logical links. Models can also be static, representing a system at a particular point in time, or dynamic, showing how a system changes over time.

Modelling and simulation methods also enable experiments that would otherwise be cumbersome or impossible. For example, computer simulations have led to numerous advances in fields such as biology, meteorology, cosmology, population dynamics, and military efficiency. Without simulation, the study of these topics would be hampered by the lack of accessibility to the real system, the need to study the system over long periods of time, the difficulty of recruiting human subjects for experiments, or all of these factors. As technology provides solutions to these problems, it has become an extremely powerful tool for studying the intricacies of today's increasingly complex world.

Transportation planning and fleet management are highly complex, from planning and maintenance to risk management and human resources. Moreover, the transportation system is a dynamic system with many uncertain factors. By using simulation methods to represent the state of movement and calculating the different timing parameters of vehicles, it is possible to determine the different influences and flow of different vehicles, derive possible delays and blockages in advance, improve and plan road conditions, etc. The simulation applied to transportation or traffic systems goes through the following phases: Model creation, program opening, debugging and computer operation, analysis and verification of results Simulation modelling allows for effective management of transportation resource planning, maximization of the traffic utilization, minimizing costs, and calculating the probability and impact of transportation cost overruns. As a safe environment for experimentation, it allows to identify potential difficulties in advance.

This module is designed to introduce participants to simulation modelling and its application to business process analysis and transportation model design. Simulation modelling enables the creation of dynamic business process models, the execution of simulation experiments with the model, and the evaluation of business process performance. Discrete event simulation enables the development of detailed models of queuing systems.

Learning outcomes examples:

1. Analyse and interpret solutions after simulation experiments
2. Identify problems in the field of business systems that can be solved by different methods of simulation modelling
3. Apply appropriate methods to perform simulation experiments
4. Develop a business decision-making process based on the results of simulation experiments
5. Create simulation models using software tools that support methods and techniques of simulation modelling and their verification
6. Analyse the output data of the simulation experiment.

Evaluation of learning outcomes (example):

1 What are the possible reasons for the difference between theoretical results and experimental results?
2. What are various uses of simulations in solving a business problem?
3. Name and explain three methods that are used in simulation.
4. Explain agent-based modelling and simulation.
5. Create a model of a simple manufacturing plant using the Flexsim software tool.
6. Based on the obtained model, show the workload of the processor and the work status of the operator using a diagram?

3.6. Global trends in transport and logistics

Global trade is foreseen to grow in the near future. The OECD estimates that, by 2050, a third of trade will pass through countries currently outside the OECD. Industry will probably concentrate around airports and ports, making them strategic logistics clusters and the development of transport around these hubs will play an essential role in their development. The companies present in these areas will consequently become economically stronger and will help to further expand the infrastructure. Due to the economic difficulties of governments, these hubs will increasingly be controlled by private individuals. Examples of this trend can be identified in the four largest global operators – APM Terminals, SP World, HPH and PSA International – which already currently control over half of the world's ports and airports.

Maritime transport will instead benefit from the increase in trade with Asia, thanks to the fact that many Asian ports have been equipped with new infrastructures able to host large ships.

Moving now to economic development, it can be easily understood that it largely depends on the efficiency of logistics for the supply of materials to the industry manufacturing and distribution sectors and for the mobility of goods along supply chains until they reach the final consumer. Although logistics includes different types of activities, the most evident and, at the same time, harmful element for the environment is the widespread use of the transport of goods. Whether in the future there will be the development of new more efficient, effective and sustainable transport systems, it will be necessary to understand to what extent sustainability can be a key element for freight transport and to develop policies that will facilitate it.

It is known that greenhouse gas emissions and congestion are the most serious problems regarding the environmental impact and the sustainability of logistics and transport, problems whose importance will tend to worsen with the progressive increase of population, incomes and consumption.

It is foreseen that between at the end of the 21st century the average temperature will increase by 1-1.5° C. This change will lead to increased winter rainfall and flooding in Northern Europe, as well as water shortages and prolonged drought in the Mediterranean area. Changes in weather conditions will create problems for road and river transport, creating inconvenience and delays. Meanwhile, the oil-dependent transport sector will be called upon to reduce CO_2 emissions by 60% by 2050. To achieve this goal, efforts to replace traditional transport, by road, rail, sea or air, are enormous and the significant necessary investments.

Sustainability in freight transport may be much more difficult to achieve than in passenger transport; this is due to many factors, including the long-term possibilities to achieve significant technological innovations applied to vehicles, issues related to the type/nature of the goods that are transferred, the need for price changes able to stimulate the modal shift and the lack of innovation applied to the more sustainable transport modes.

In recent years, the increase in volumes of goods moved across Europe has been in line with economic growth (Source: European Parliament). From this starting point it can be underlined that the achievement of objectives such as the reduction of carbon dioxide emissions could generate considerable difficulties. In the future, it can be possible that sustainability will be separated from economic growth, even remaining a major challenge. The current EU approach to sustainability in freight transport and logistics has significant strengths including, in particular, the focus on intermodal transport and a wider and more efficient use of ICT applications.

There are many options offering important opportunities to improve freight transport and logistics' sustainability. The more conventional ones include the adoption of alternative fuels, the promotion of modal shift, the improvement of the environmental performance and the efficiency of existing transport modes, the support and promotion of intermodal transport chains, the exploitation opportunities offered by ICT and ITS applications. For example, digitization offers the opportunity to use mobility data to manage traffic, improving services. The use of sensors capable of indicating wear out levels, aging or highlighting problems on trains, trucks or ships also helps to improve their maintenance, in turn reducing the role of man. All these innovations however need people able to implement and then handle them.

In order to exploit the full potential of these options, it will be necessary to invest in technological research and development and to encourage behavioural change in organization, both firms and public bodies.

Another significant emerging trend is the one related to population growth. By 2050, more than half of the world's population growth will be concentrated in a limited number of countries such as India, Nigeria, Pakistan, Indonesia, etc. In the same period in Europe about a third of the population will be over 65 years old. In a long-term perspective, the European population will increase mainly due to waves of migration linked to climate change and natural disasters. Eastern European countries as well, such as Germany, will see a decrease in population. At the same time, European citizens will increasingly move from the countryside to big cities. For companies, low population growth will pose a problem in finding workers with low added value; on the other hand, the aging of the population in Europe will have a substantial impact on the transport sector, since the workforce in the sector already has a very high average age today.

Looking at the long term, probably radically different ways of transporting goods could be available, albeit with huge costs for research, development and implementation. There could also be a shift towards alternative and more sustainable economic and business models, leading to, for example, a setback from globalisation, although right now this seems not so easy to happen.

Learning outcomes examples:

1. Analyse and evaluate data and information concerning trade patterns;
2. Analyse and evaluate information concerning economic and social future patterns;
3. Evaluate trade patterns and related drivers and link them to the organization of origin;
4. Identify strengths, weaknesses, opportunities, and threats linked to the evolving scenarios.

Evaluation of learning outcomes (example):

1. What are the main challenges that transport and logistics sector is thought to face in the near future?
2. Which are the drivers that will allow the sector to face future challenges?

3.7. Innovation management in transport and logistics

Management and manager are terms that have become commonly used, words that express broad concepts, valid in any kind of professional/operational context. Management can be considered as a set of actions that have to be implemented so that an organization can pursue the objectives set in its business planning and take choices concerning the relationships between its constituent elements; on the other hand, mainly referring to the management of a private company, the term manager can instead be that for which the activity of the manager of a commercial or industrial enterprise, is aimed at achieving the maximum profit; this meaning is of course completely different from the one concerning, on the other hand, the management of public companies and services, to which it is mostly preferred to assign the name of administration. Both definitions focus on business management, i.e., the concept applied to the business world, however management does not only refer to actions carried out to generate profit but can also refer to organizations that operate on a non-profit basis.

The person who deals with management is the manager, who commonly and in the broadest sense of the term is identified as someone who holds a managerial role. It is a figure that finds application in every professional area, both in the public and private sectors. Depending on the type of context in which a manager operates and the functions it carries out, a specification is generally added so we can have health managers, public managers, tourism sector managers, marketing managers and so on. In other words, whatever the sector, the manager is a professional, who carries out responsibility functions and who concretely deals with managing and coordinating the resources of a company efficiently to achieve the objectives.

Innovation management is, literally, the management of innovation, that is, the definition and development of new ideas and strategies for an organization, useful for improving processes, products and/or services.

Recently, the term is very frequently linked to digitization or, in a broader sense, to the implementation of new ICT tools, since it is considered as the most important one and innovation that is at the base of all other innovations. Innovation management is therefore seen as the management of digital innovation processes in organizations.

Innovation management includes a series of theoretical-practical approaches: the distinction between the different types of innovation (product, process, system); the distinction between the different degrees of intensity of innovation (incremental, disruptive, radical, architectural); the distinction between the different models of business innovation, i.e. internal business innovation and open innovation, a model that "opens up" to startups, universities, external bodies to commercialize their own ideas and/or commercialize those of others. Last but not least, the distinction between the different drivers of innovation: the user (user-driven innovation), the market (market-driven innovation), the technology (technology-driven innovation), the design (design-driven innovation).

Innovation management provides various tools based on the business areas to be analysed and improved: from knowledge management to market intelligence, from cooperation with human resources, from product design and development to process improvement, up to the development of creativity and networking.

DA QUA Innovation management, considered as the definition, development and implementation of new products/services or process strategies, is a fundamental key for organizations' competitiveness. It is not aimed at the innovation considered itself as the end, the goal, of the process, but it applies methodologies and tools by putting them at the service of specific organization objectives, which can be achieved more easily and with less waste of resources through targeted changes.

Innovation management allows the organization not to be unprepared when facing context changes, technological innovations, therefore not to lose sight of the market, keeping in touch with the needs of its users. Innovation management is a mix that requires rational analysis, lateral thinking, emotional intelligence to "calibrate" the change on the basis of actual organization's possibilities, to overcome internal and external resistance, to obtain tangible and concrete results.

Starting from this introduction and now moving on to the skills and abilities that a manager is supposed to possess, it is easy to see that such a professional profile must possess and develop general skills, the ones that are suitable and usable in any sector of the market. Being a versatile figure, which deals with the management of a series of different and complementary activities, to become such a professional a manager needs to acquire an updated and complete multidisciplinary know-how, as well as, of course, personal characteristics and attitudes.

Learning outcomes examples:

1. Define the innovation path towards the goal of the innovative challenge;
2. Analyse the "as is" state of the organization;
3. Design the proper structure, roles and tasks to implement the innovation ("to be" state).

Evaluation of learning outcomes (example):

1. How can an innovation path be structured?
2. How can be in an innovation process properly designed the involved organization?

3.8. Soft skills for innovation processes

Organizations, both private and public, are experiencing the need to continuously adapt to changes in markets and customers. In this context, managers are called to develop the need for organisational, relational and instrumental changes which are facilitated and sometimes resolved through the introduction of the dynamics associated with soft skills in all levels of company processes.

Very often in organizations there is not the lack of technical skills, since are the relational aspects that do not sufficiently facilitate the achievement of positive results. There is the need to develop collaboration in different ways, to take critical decisions effectively, to plan innovative needs, so as not to react without direction, but to manage changing scenarios.

Soft Skills can be considered as personal skills. In particular, the concept of soft skills refers to those skills related to emotional intelligence and natural abilities that each person possesses. Soft skills are not technical skills, they are rather related to how a person interacts with colleagues, solves problems and manages work. In other words, soft skills are all those transversal skills that are essential in professional life.

On the other hand, hard skills refer to the person's technical skills. Every position in a company requires a certain kind and level of technical and hard skills to effectively carry out the job. For example, among the hard skills we can find the ability to use software, graphics programs or other technical tools required by the specific role. Soft skills are, as we have understood, more transversal and characteristics that are very close to specific personality attributes.

Soft skills are essential to effectively relate/interact with people who are part of the same working place or context: colleagues, managers, customers, suppliers, etc. They essentially depend on the socio-cultural background of each of us, being the result of experience (working and not).

Being able to effectively communicate or having an aptitude for teamwork are examples among the most common and relevant soft skills; considering managerial profiles there are also others such as:

- stress resistance: being able to cope with work pressure and maintain control over one's work priorities;
- planning and organizing: being able to better manage one's working time;
- precision and attention to detail;
- study and updates: being always up to date on industry trends helps to keep up with the times and news;
- set goals: a good dowry of determination helps the employee to achieve their goals (and exceed them);

- be a good communicator: knowing how to express one's ideas clearly, allows to reach the audience directly and constructively;
- problem solving: in the presence of a problem, an analytical and rational approach allows the employee to resolve it quickly;
- decision making
- leadership;
- team working and team building;
- know how to negotiate: being able to negotiate a solution is always important;
- know how to listen: increases the probability of understanding the tasks and projects to be carried out, creates strong relationships with colleagues, allows to resolve problems and conflicts.

Learning outcomes examples:

1. Start and develop the innovation culture;
2. Create company engagement and behaviour;
3. Turn business problems into challenges and opportunities;

Evaluation of learning outcomes (example):

1. How can employees be engaged when introducing an innovation in the organization?
2. How can a challenge be seen as an opportunity?