Developing interdisciplinary competences for Smart Logistics

Needs Analysis Report

February 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 (Transport & Logistics) 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 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 (European Union) 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:

- the current education and training content and approach at involved and other educational institutes;
- the current knowledge and transversal skills of students who become available for the labor market;
- the expected developments for Transportation & Logistics in the coming 5 - 10 years;
- the required knowledge and transversal skills of students who become available for the labor market as of 2028;
- the existing GAP and how this can be closed including the subjects that are relevant to be included in the new curriculum.

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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 losses and fewer job offers. On the other side, 40% of vacancies cannot be filled, because of skills mismatch and too few people have the preparation, mind-sets, and competences 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) the current education and training content and approach at involved and other educational institutes, (2) the current and required knowledge and transversal skills of students who become available for the labor market as well (3) the expected developments for Transportation and Logistics in the coming 5 years.

Concluding that keeping the basic T&L and SCM attention in curricula, knowledge focus for the coming years should emphasize on facilitating digital transformation, software driven process changes, markets domestic commerce changes and machine-driven process changes considering sustainability and environmental interests.

Regarding transversal skills, students entering the labor market should operate more independently showing initiative and creativeness to deal with changing business environments that require flexibility and social behavior.

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Abbreviations

EU	European Union
IO1	Intellectual Output 1
T&L	Transport & Logistics
ICT	Information and Communication Technology
TMS	Transport Management System

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 losses 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 side, 40% of vacancies cannot be filled, because of skills mismatch and too few people have the preparation, mind-sets, and competences 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 come 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 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 chacteristics 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:

- to identify and define the new logistic skills;
- to develop and implement, together with companies, curricula that bridges both ICT and logistics skills;
- to develop and implement new models (toolbox) to assess transversal skills;
- to implement teacher training activities to enable them to adopt innovative teaching methods and design multidisciplinary; curricula providing transversal skills;
- to develop and implement teacher support systems;
- To 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 1

2.1. Methodology

This intellectual output provides an insight into knowledge gaps and skills mismatch with specific focus on transversal skills. This report is a continuation of the needs analysis carried out by the participating institutions when they decided to develop this project proposal. Representatives from industries, professionals, alumni, and curricula development experts did contribute providing the different points of view to the identified problems for a clear understanding of the current situation in relation to knowledge gaps and skills mismatch, industry needs and different teaching as well assessment approaches.

More concrete, IO1 will give insight into:

- The current education and training content and approach at involved and other educational institutes.
- The current and required knowledge and transversal skills of students who become available for the labor market as of 2028.
- The expected developments for Transportation and Logistics in the coming 5 years.

Concluding the existing gap and how this can be closed, including the subjects that are relevant to be included in the new curriculum.

The methodology used to develop IO1:

1. Develop interview guides: brainstorm in a brown paper session workshop with all partner institutes collecting high level topics considering specific local circumstances impacting Transport & Logistics. Get the outcome reviewed and validated by the partner institutions. In parallel literature study will be done to collect the latest developments and trends for the coming 5 years.
2. Develop and test questionnaires: set up a questionnaire that can be used to collect data from companies, teachers, students, and alumni and get this validated by the partner institutions. Test this questionnaire locally in a limited setting of the target groups. Improve where necessary and validate with partner institutions.
3. Collect and analyze data: distribute the questionnaires to the partner institutions so that they can be sent to the target groups. After receiving all questionnaires back, the outcomes will be analyzed, gaps will be concluded as well draft modules will be defined.
4. Report and distribute: draft the state-of-the-art report, get this validated by the partner institutions and distribute the definitive version.

2.2. Conducting the Research

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

After the project kick off on February 9th till 11th 2021 a workshop with all partner institutions involved took place on March 3rd,2021, via Teams to brainstorm about high level topics also considering specific local circumstances. The outcome of this workshop is the following brown paper sheet (Figure 1):

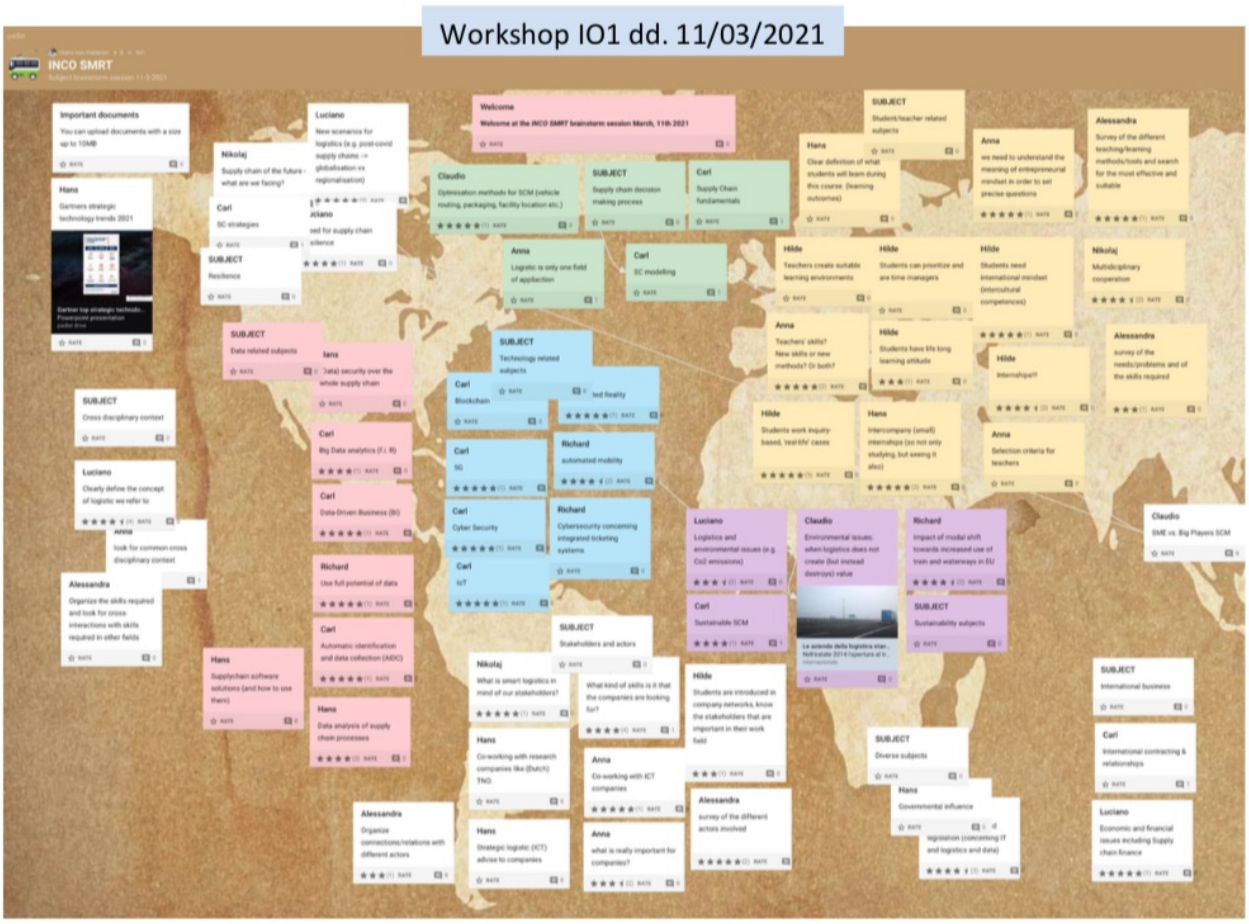


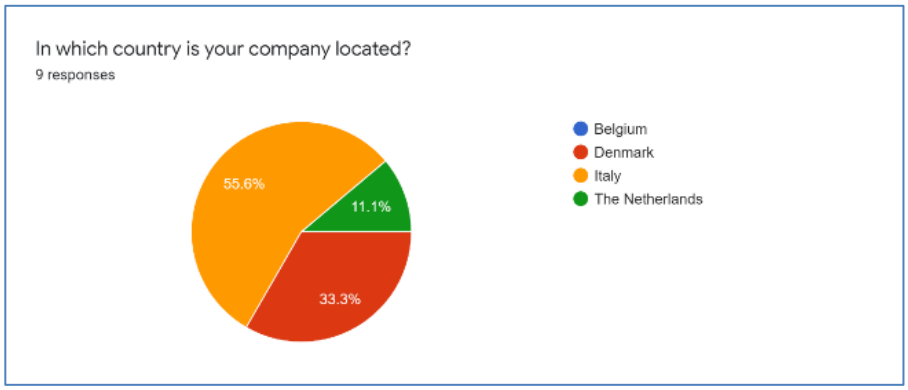
Figure 1: Brainstorm output

In this brown paper subjects have been grouped as follows:

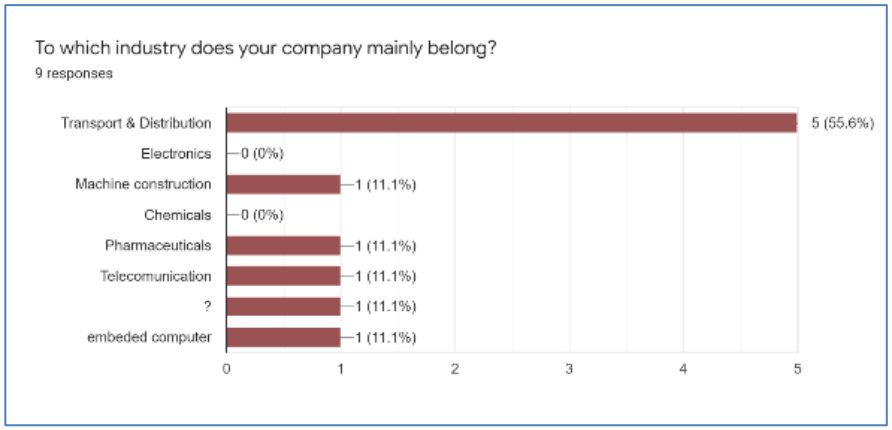
- Cross disciplinary context
- Data related subjects
- International business subjects
- Stakeholders and actors related subjects
- Student and teacher related subjects
- Supply chain subjects
- Sustainability subjects
- Technology related subjects
- Diverse subjects

Based on this outcome questionnaires per target group have been developed, discussed, improved, and eventually sent out by all partner institutions to companies, alumni, lecturers, and students in their countries. The final approved questionnaires can be found in the attachments (appendices A up till and inclusive D).

The surveys came back from three different countries. See below the pie-chart that gives the origin of the surveys. (Graphs 1 and 2)



Graph 9, what countries companies come from



Graph 10, what type of companies returned questionnaires

The students and alumni did come from the following fields of study (Table 1):

What studies	Logistics
	IT & Business
	Business
	Statistical planning
	Distribution / Warehousing

Table 2, what type of studies do the students study

2.2.1. Current education and training content and approach at involved and other educational institutes

In total 5 scientific universities and 4 universities for applied sciences have been compared in regard of their education and training content, see exibit-2. Material has been collected at 4 universities for applied sciences (Fontys ICT, Fontys Logistics Management, UCL and AP) while for the scientific universities their websites were used for input.

Universities for Applied Sciences:

- Fontys School for ICT (The Netherlands)
- Fontys School for Logistics Management (The Netherlands)
- Artesis Planteyn (Belgium)
- UCL Erhvervsakademi & Professionshojskole SI (Denmark)

Scientific Universities:

- Eindhoven University (The Netherlands)
- Erasmus University (The Netherlands)
- Maastricht University (The Netherlands)
- Tilburg University (The Netherlands)
- Twente University (The Netherlands)

The outcomes of the comparison are as follows, of the universities:

- 88% have included Transport & Distribution or Transport & Logistics in their curricula
- 66% have included Supply Chain Management or Integral Logistics comprising subjects as planning & scheduling, purchasing & supply, inventory management, order management, warehousing and production in their curricula
- 55% have included technologies s.a. Power-BI, R, Data Analysis, Machine Learning, Simulation
- 44% have included Organization & Economics
- 33% have included Quality
- 33% have included Sustainability
- 33% have included Research
- 33% have included Project Management
- 22% have included ERP systems (selection, implementation)

The way content is taught to students, of the universities:

- 66% works with projects, assignments, cases
- 33% use a combination of group learning, guided self-study, lectures and seminars where most others still prefer the classic way of predominantly lectures

The way testing and judgement is being organized, of the universities 22% used portfolio's with longitudinal feedback with assessments but most still prefer exams.

2.2.2. Current and required knowledge and transversal skills of students who become available for the labor market as of 2028

As technology moves to the forefront of logistics, businesses will need to rethink their hiring strategies as the nature of jobs transforms. Already, the shipping industry is beginning to see more of a hybrid workforce. For years now, the goal of many companies, especially the larger freight forwarders, has been to build systems to internally replace operational staff. The end game is for these systems to take charge and do what operational work they can and have staff perform the tasks that the systems cannot do.

Skills that are considered valuable will be redefined and new or fusion skill sets will be required for successful operations. Employees will move towards new roles in management and programming as basic logistics tasks get automated. There will also be innovative approaches to solution solving and problems.

Therefore universities will need to provide students with maximum opportunities and capabilities on the labor market. Transversal skills occupy a prominent place in that pursuit since they are crucial for building a career in general and in this case in the T&L professional world specific. T&L professionals are important enablers in today's organizations. While the processes in organizations are becoming increasingly complex (far-reaching integration of technical disciplines, new business models, real-time information management), the T&L professional must always try to tie the business, information and communication strings together. In addition this requires professionals who can look beyond walls, who are actively looking for improving themselves and who dare to take steps. High level transversal skills are therefore crucial for T&L professionals on the labor market.

UNESCO defines transversal skills as: “Skills that are typically considered as not specifically related to a particular job, task, academic discipline or area of knowledge and that can be used in a wide variety of situations and work settings (for example, organizational skills).”

These skills might also be called ‘soft’ or ‘transferrable’, because they are not specific to a particular sector or job role. The term ‘transversal’ refers to the way these skills ‘cut across’ different tasks and roles, just like a transversal line in geometry.

The following skills have been defined by the survey target groups:

- **Entrepreneurship**: being able to establish, administer and succeed in a venture along with taking risks with a view to making profit.
- **Communication**: being able to use words, sounds, signs, or behaviors to express or exchange information or to express ideas, thoughts, feelings etc. to someone else.
- **Team Player**: being able to work well as a member of a team helping the team to succeed more than his or her individual success.
- **Creative**: being able to have or come up with an original thought or imagination.
- **Independent**: being free from outside control not being subject to another's authority.
- **Social**: being able to interact and spend time talking or doing enjoyable things with each other.

- **Decisive**: being able to make decisions quickly and effectively settling an issue, producing a definite result.

- **Perseverance:** being able to do continue trying to do something even though it is difficult.

- **Initiative**: being able to assess and initiate things independently, the ability to decide what to do next and to do it, without needing other people to tell you what to do.

- **Flexible**: being able to bend easily without breaking, change easily and adapt to different conditions and circumstances as they occur.

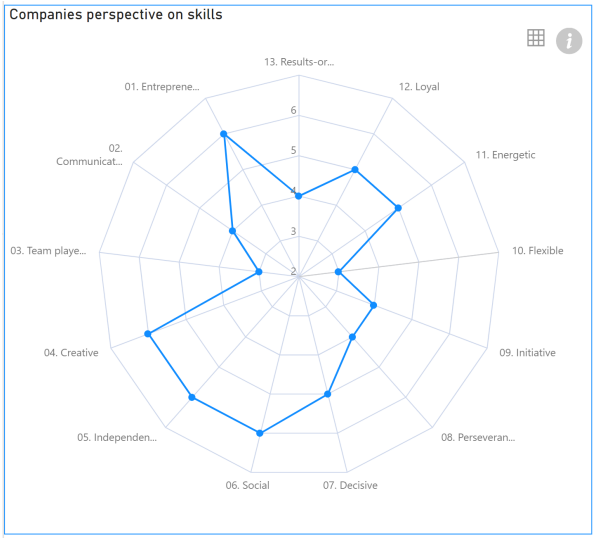
- **Energetic**: being able to show or involve great activity or vitality by physical and mental movement and/or power.

- **Loyal**: being able to give or show firm and constant support or allegiance, being faithful and devoted to a person or institution.

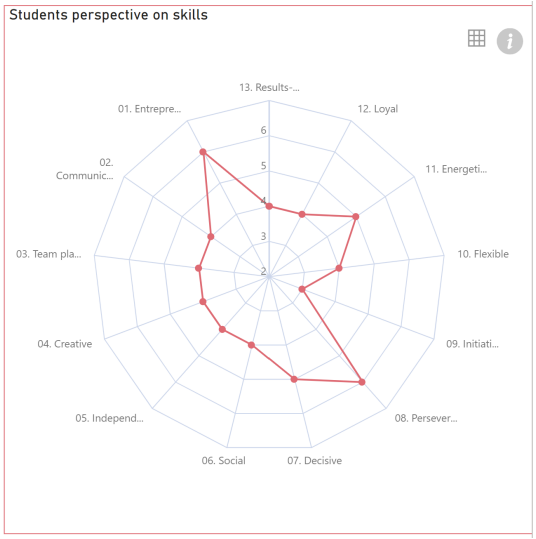
- **Result oriented**: being able to focus on outcome rather than processes making things happen.

https://www.skillsandeducationgroup.co.uk/transversal-skills-what-are-they-and-why-are-they-so-important/

The survey shows in the following two radar-graphs a difference between the way companies versus students look at skills young graduates should have. (Graphs 3 and 4) There are skills that companies grade higher than students do: creativity, independence, social skills, and loyalty. On the other hand, students grade perseverance higher as a skill than companies do in general.



Graph 11, Companies look at skills they need



Graph 12, Students look at skills they need

Companies have implemented relevant planning solutions already that have the higher interest of students. For the continuation of the processes this is interesting to know. The students can use the material they are taught inside the companies.

The students are interested more in digitization of the T&L processes than companies. This could mean that many of the digitization projects are already implemented or are in the process of implementing.

In the area of supporting technologies students and companies think the same about relevance. Some of the subjects are not implemented yet. This could give the students a possibility to contribute to the implementation of specific topics.

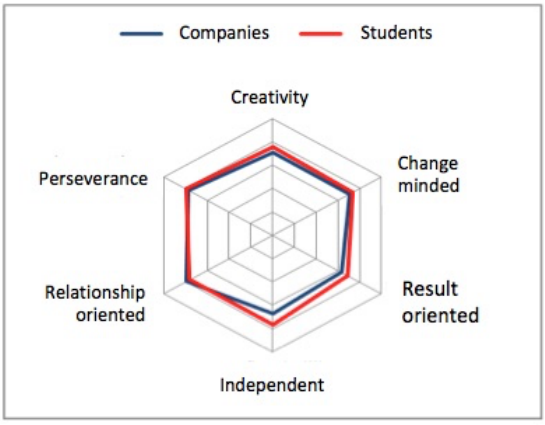
The largest difference between companies and students is in the area of digitization. For companies, several subjects are less relevant than students would rate them.

Separate from this survey earlier research (Fontys ICT 2016) had been conducted in regard of entrepreneurial behavior, focusing on the following target groups: Students (142), Alumni (117), Teachers (185) and Companies (28), being a mix from different European and Asian countries, working internationally.

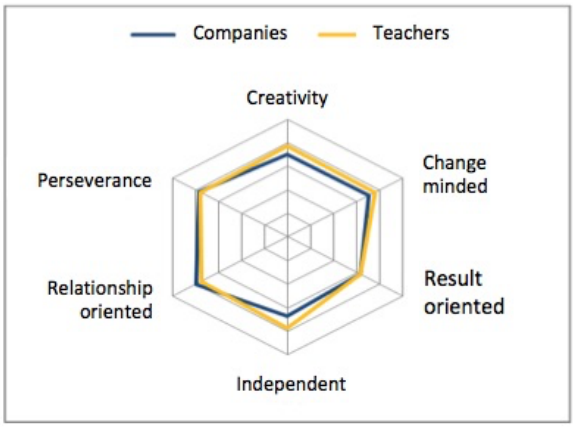
- Middle and higher management in 20 Companies in different branches received a questionnaire to ask about their requirements in regard to transversal skills and where they think improvement is important. These companies are: M2X, Bspyre, Sligro Food Group, Van den Broek Logistics, KSE Process Technology, Vanderlande Industries, CGI, Priple A, Sioux Embedded Systems, Ranj Serious Games, Mirabeau, Simac ICT, Brunel, Atos, Isah, Gemoro, MAD, Euroscrips, DSP Valley and AMIS. For them the most important transversal skills are: Creativity, Adaptability, Goal / result oriented, Independence, Relationship oriented, Perseverance and Self-reflection.

- Additionally for 9 companies' Top Management have been interviewed by phone. These companies were: Capgemini, SNS Reaal, Sligro Food Group, Hobéon Groep, ICT automatisering, Estate MM Guide, DAF Trucks and Paccar. They indicated that the following transversal skills are important for those who graduated and want to start working: Craftsmanship, Flexibility, Curiosity, Ownership, Guts (no yes-person), Independence, Adaptability (quickly adjusting), Ambassadorship with regard to the company, Added value (the alumnus makes the difference), Innovative capacity, Taking initiative, Mentality (not a nine to five attitude), Coachability (can take feedback), Critical ability (gives feedback), Future proof (adaptive, responsive, international).

The survey shows in the following two radar-graphs a difference between the way companies versus students look at skills young graduates should have as well as how companies versus teachers do. (Graphs 5 and 6)



Graph 13, Companies and students look at skills they need



Graph 14, Companies and teachers look at skills students need

The research shows that:

- Teachers and students have more or less the same opinion, except for a gradual difference with regard to the result orientation point, where students score lower in the opinion of teachers than where they see themselves.

- Businesses are increasingly deviating from both in terms of creativity, result orientation and independence. The business community believes that students score lower on this than students see themselves.

- Lessons do not fully match business expectations. This is also reflected in the difference between business and teachers, where teachers most likely have a different view of what they think the business needs and design their lessons accordingly.

- Alumni and the business community agree on their views on transversal skills. transversal skills, but this is done implicitly and is not named as such or is not done consciously. It depends on the respective teacher. Transversal skills is a limited area of attention within the curricula and as a result, there is no programme-wide coordination about this.

2.2.3. Expected developments for Transportation and Logistics in the coming 5 years

Defining a window with challenges for the coming 5 years, a literature study was conducted.

Freight transportation market
In the age of globalization and international trade, transportation and logistics have become hot topics, impacting business-to-business and consumer behavior worldwide. The necessity to cover wider markets and ship safely and quickly has pushed the freight industry to undergo some changes. Companies have started to empower their operations with smart technologies to be able to satisfy extraordinary demands and preserve customer loyalty.

ReportLinker (https://www.reportlinker.com/p05960735/Global-Transportation-Services-Industry.htm) mentions the global freight transportation market will reach $7.8 trillion by 2027. This market research (https://explodingtopics.com/blog/transportation-industry-trends) stresses that in the coming years, there will be a global shift in the vision of freight technologies as demand for transportation agility increases, as does the creation of integrated logistics services accessible on demand.

The market has become more challenging:
- Web-based retail channels are changing the nature of demand.
- Personalization and customization of services is rising.
- Growing investments in road infrastructure is pushing the efficient use of transit.

These developments encourage logistics providers to innovate, accelerate digital transformation, and stay aligned with the latest freight tech market trends. In an overview of Grand View Research (https://www.grandviewresearch.com/industry-analysis/freight-transport-market), “urbanization” and “communication innovations” are shown to be the key global factors amplifying the freight market by 2025.

Substantial market growth is pushed by:
- Innovations in freight delivery processes.
- New networks with secure contacts and speedy transaction times.
- Demand for more reliable shipments that comply with international regulations.
- Freight transportation revenue covers one-third of logistics costs, yet barely influences the logistical software system’s performance.
- Local and small players are hoping to compete in the global arena by using efficient high-tech freight transportation management systems.
- Clients trying to deliver freight on time at a lower price.

DataBridge (https://www.databridgemarketresearch.com/reports/global-freight-forwarding-market), an e-science collaboration environment tool for big data analyses, performed research where they forecast freight market growth at a rate of 6.6% in the period of 2021 up to 2028. In this every transportation sector, air, truck, rail, ocean, and other grows – and this proves the growth of the entire freight industry.

It is expected each of the following transformation forces to impact the market successively, due to trends driving them (https://www.pwc.com/m1/en/industries/documents/transport-logistics-trendbook-2019-en.pdf). (Figure 2)

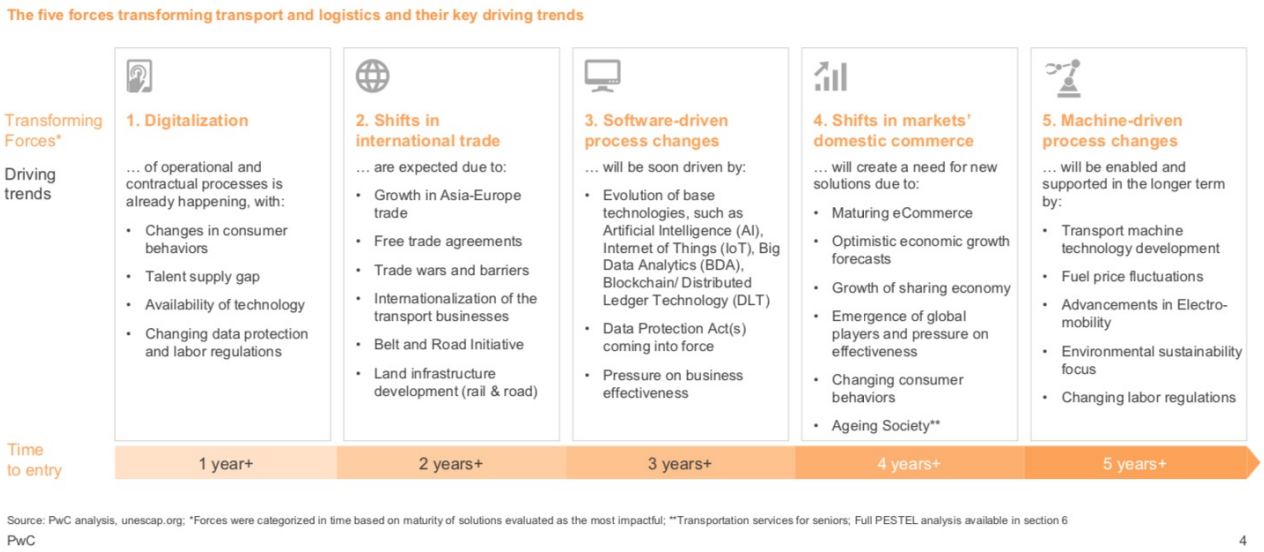


Figure 2: 5 Forces transforming transport and logistics and their key driving trends

All five forces transforming T&L – digitalization, shifts in international trade, software-driven process changes, changes in markets' domestic commerce and machine-driven process changes – will be accompanied by innovative solutions. (Figure 3)

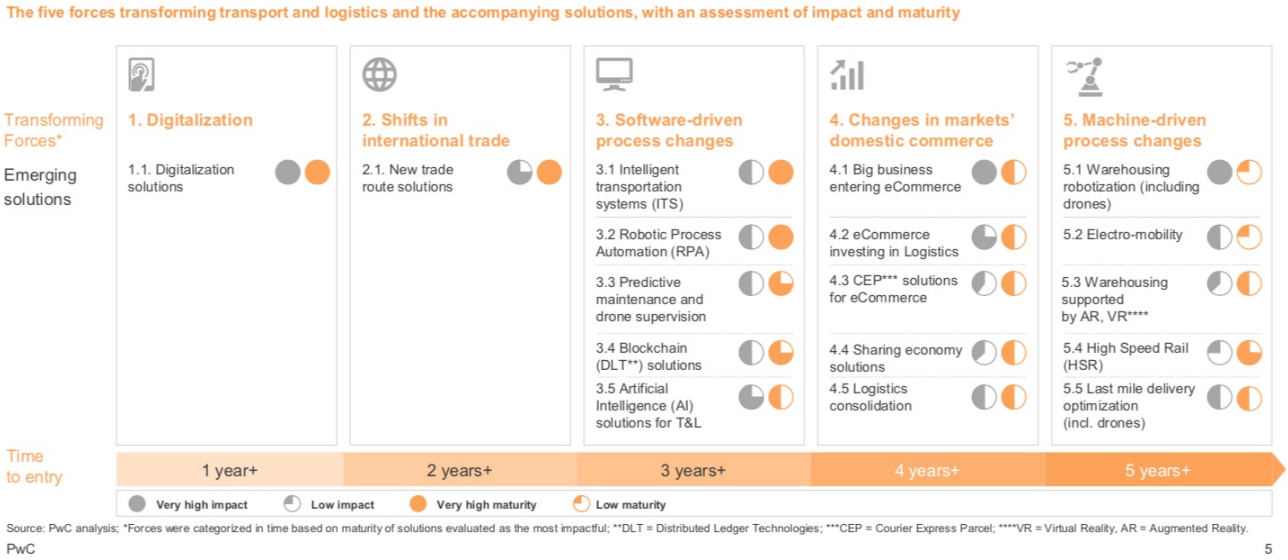


Figure 3: 5 Forces transforming transport and logistics and their key driving trends, with an assessment of impact and maturity

Pandemic impact: Online Commerce and last-mile services

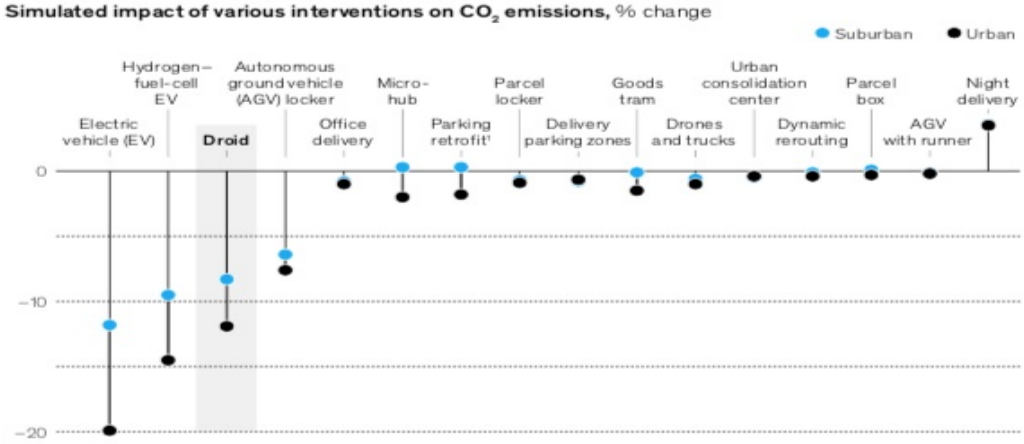
According to JDSupra (https://www.jdsupra.com/legalnews/transportation-and-logistics-trends-to-6755848/) the COVID-19 pandemic brought a redefined realization to our integrated world in early 2020 and has changed the industry for good. The pandemic has created a sizeable shift in the logistics sector. Consumers have leaned into online shopping, and pandemic-related lockdowns have created a need for businesses to improve their last-mile services. The surge in e-commerce volumes has put huge pressure on the last-mile delivery system, the process by which products are transported from distribution centers

to final consumers. In a time where consumers expect swift, often same-day deliveries with real-time tracking, many of companies in T&L say last-mile delivery is the most inefficient process of their supply chain becoming a bottleneck.

Logistics providers are struggling to deal with increasing volumes of goods, resulting in slower delivery times, less flexibility in delivery time slots, and higher delivery costs for customers. Furthermore, as delivery traffic steadily rises, the negative effects on the environment will grow unless actions are taken to mitigate them. The World Economic Forum and McKinsey have been researching ways to reform last-mile delivery for efficiency and sustainability. By studying the effectiveness of various interventions currently employed to mitigate the negative consequences of rising costs and carbon dioxide emissions, the study finds that delivery robots—small, personal delivery devices that can transport packages weighing 100 kilograms or less at a maximum speed of five kilometers per hour or less (*The future of the last-mile ecosystem,* World Economic Forum, October 1, 2020, weforum.org.) - may be the best bet to reduce carbon emissions and costs, while coping with issues like labor shortages. Other interventions, such as electric vehicles (EV's), H2FCEVs, and parcel lockers, will continue to generate cost savings and reduce carbon dioxide emissions. Despite good intentions, unfortunately maturity levels remain low. Therefore, last mile delivery optimizations are expected to have moderate impact on T&L industry over the next five years, with the focus on such solutions from the postal and CEP (courier, express, parcel) segment. (Figure 4)

The potential for droids to reduce delivery costs and carbon dioxide emissions remains largely untapped because of low maturity levels.

Simulated impact of various interventions on CO_2 emissions, % change



Change in delivery costs, %

	Electric vehicle (EV)	Hydrogen–fuel-cell EV	Droid	Autonomous ground vehicle (AGV) locker	Office delivery	Micro-hub	Parking retrofit[1]	Parcel locker	Delivery parking zones	Goods tram	Drones and trucks	Urban consolidation center	Dynamic rerouting	Parcel box	AGV with runner	Night delivery
Suburban	0	0	0	0	0	–1	–1	–1	0	0	0	0	0	0	3	4
Urban	0	0	–1	0	0	0	0	–1	1	0	0	0	0	0	2	3

Maturity rate,[2] %

	Electric vehicle (EV)	Hydrogen–fuel-cell EV	Droid	Autonomous ground vehicle (AGV) locker	Office delivery	Micro-hub	Parking retrofit[1]	Parcel locker	Delivery parking zones	Goods tram	Drones and trucks	Urban consolidation center	Dynamic rerouting	Parcel box	AGV with runner	Night delivery
Overall	100	50	25	25	100	100	100	100	50	50	50	50	100	100	25	75

Note: Adoption scenarios for the initiatives are estimated based on the best possible knowledge in 2021.
[1]Retrofitting of parking-based infrastructure.
[2]The higher the maturity rate, the more widespread the implementation of the respective interventions.

Figure 4: McKinsey Global Publishing , Efficient and sustainable last-mile logistics: Lessons from Japan, May 2021, this article was a collaborative effort by Takakazu Doi, Eric Hannon, Bernd Heid, Anja Huber, Robert Mathis, Yuta Murakami, and Hiroshi Odawara, representing views from McKinsey's Travel, Logistics & Infrastructure Practice

These findings confirm an earlier study performed by PwC in 2018 that come to the following outcome (Figure 5):

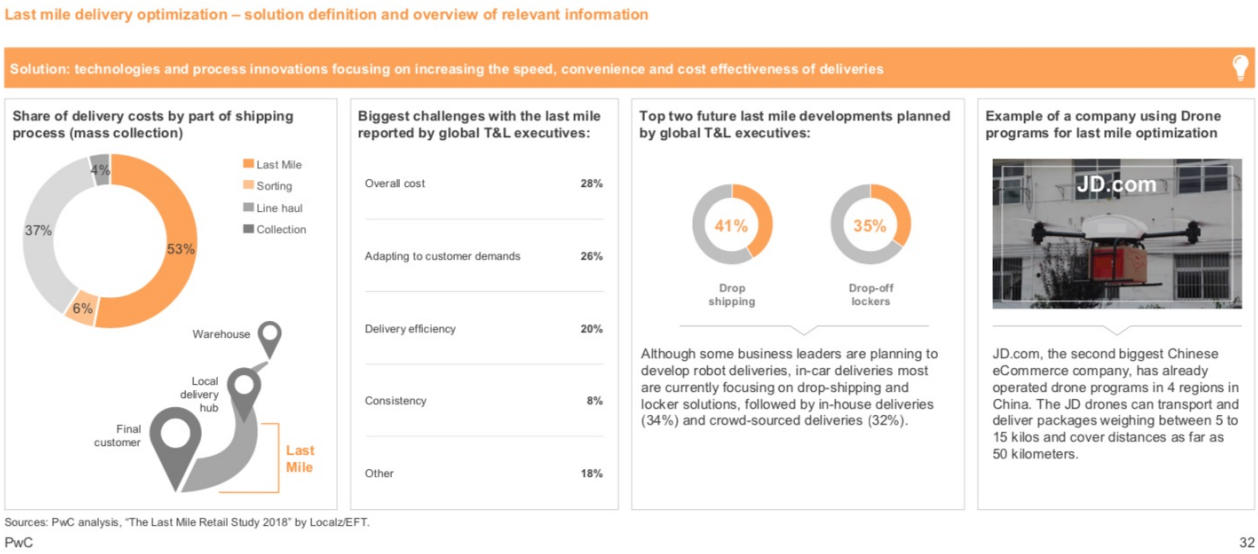


Figure 5: Last mile delivery optimization – solution definition and overview of relevant information

Technology

All tech trends in the freight transportation industry are focused on mobility, ownership cost reduction, and sustainability (https://www.jdsupra.com/legalnews/transportation-and-logistics-trends-to-6755848/). Under the growing freight market, it is crucial to stay competitive by applying RPA for operations efficiency, edge computing for safer and easily accessible delivery fleets, AIoT for establishing interconnected united delivery networks, prescriptive shipping for better freight management, and autonomous vehicles to speed up freight dispatching as well as human risks reduction. Market leaders in the freight industry utilize technologies for generating profits alongside staying socially responsible and sustainable.

Technology continues to modernize industry, as shippers and carriers realize that there are several promising technologies that can deliver significant returns on investments. The drive towards digital transactions, e-commerce, data analytics and other technologies can provide businesses with the tools to address fast-changing needs. Key technology trends that will play a significant role in accelerating this shift include:

- **Artificial Intelligence (AI):** AI allows T&L companies to process historical trends to forecast and manage inventory, and address variable demands across supply chain operations. Historical data from past operations can help AI algorithms conduct primary operations automatically, reducing human error in the supply chain.

- **Automation:** As expectations for fast and accurate delivery are expanding among consumers, automation in the T&L sector is on the rise. With automated warehouses and the introduction of autonomous vehicles, companies can be better situated to plan, purchase and predict the

behavior of cargo in transit.

- **Blockchain:** The use of blockchain solutions in the T&L realm has been pitched for several years, and this is likely to continue. Blockchain can be used as a solution for traceability, execution of smart contracts and to provide payment to linked T&L partners. The primary purpose of blockchain in the industry has been to improve transparency, allowing data to be shared seamlessly throughout the supply chain to all concerned parties, while also ensuring information is unmodifiable. Blockchain technology could also be used to help smooth last-mile deliveries by reducing inefficiencies at this stage.

- **5G:** The 5G mobile broadband standard promises to innovate the T&L sector by accommodating faster transfer speeds for more data and, in turn, increasing visibility throughout the supply chain. With the development of 5G technology, thought to be more secure and 100 times faster than current technology, logistics processes can be faster, safer, and more reliable.

- **Crowd-sourced fleets:** Crowdsourced deliveries, functioning like the likes of Uber and DoorDash, allow corporations to employ contractors to assist with the delivery process. The flexibility of crowd-sourced fleets will appeal to companies pushing to better their last-mile deliveries, while remaining adaptable to seasonal demand and evolving consumer demands.

- **Cloud computing:** This has become a game-changer for the transportation industry, bringing opportunities such as on-demand service scalability, solid data protection, and significant cost reduction.

Sustainability

One of the challenges for the T&L sector for the coming years will be grappling with national and international regulations concerning shipping emissions and other potential environmental risks associated with distribution (https://www.jdsupra.com/legalnews/transportation-and-logistics-trends-to-6755848/). Consumers are becoming increasingly climate conscious and are more likely to purchase from companies with sustainable, eco-friendly reputations. Companies that have integrated robust sustainability practices throughout their supply chains are well-placed to confront these trends.

To achieve the targets of the Paris Agreement, companies such as Amazon, JetBlue and some consumer ride-sharing platforms are currently implementing initiatives such as Climate Pledge 4 seeking to support the development of sustainable technologies and minimize carbon emissions with respect to ships and vehicles. As the sector experiences mounting pressure from its stakeholders, companies will be looking for innovative technologies to reduce resource consumption and enhance the efficiency of operations.

In recent years vehicle emissions have been a significant part of climate change conversation since it began to catch speed in the early part of the millennium (https://www.sdcexec.com/sustainability/article/21135481/how-logistics-takes-on-sustainability). Both auto- as well truck makers increasingly push more environmentally friendly models. Major players in the last-mile delivery sector, including Amazon, USPS, UPS, and DHL have introduced innovative programs and goals as part of an overall strategy to integrate sustainable practices into delivery.

For instance, Amazon has pledged to be carbon neutral by 2030, investing in renewable energy and battery-powered fleets to do so. USPS is introducing propane gas trucks to reduce emissions, alongside plans to deploy 6,000 natural-gas powered trucks in an agreement with Agility Fuel Solutions over the

next three years. And, DHL has integrated sustainability into its overall strategy, going as far as releasing reports on sustainability efforts, launching a podcast on the subject in addition to making sure its fleet and operations reduce emissions.

Sustainable logistics aims to lower the ecological footprint of its tasks, such as CO2 emissions, noise pollution, and accidents. Logistics suppliers must look for a balance between financial growth, environmental care, and the health of society. For the trucking industry specifically, every part of the tractor & trailer, from the front bumper to the rear of the trailer doors have had some form of improvements, modifications, and/or innovative products designed to help with these issues. For example, lower resistance tires, streaming airflow, reduction of drags, major improvements to engines, are all focused on improvements of fuel mileage, and reducing the carbon footprint.

While reducing the impact on the environment, if correctly planned, companies can also assist their bottom line. Reducing fuel emissions can also cut fuel costs in addition to consolidating shipping costs and streamlining efficiency. Companies look for efficiency and sustainability daily. By increasing the productivity of carriers and minimizing deadhead miles and other wasted resources, the environmental impact of critical transportation activities as well as its impact on existing infrastructure will increase.

Data availability is one of the biggest challenges in tackling sustainable logistics. Accurately measuring freight emissions, for instance, depends on several variables, including the type of load, equipment type, distance and more. For many companies, the necessary data is only partially recorded, and much of it remains siloed in systems throughout the organization. Beyond data, technology has allowed sustainable practices to flourish, as seen with the modernization of trucking. Many times, investment in these eco-friendly technological solutions can have up-front costs but will eventually offer significant return on investment eventually by reducing continuous expenses that can add up like fuel. The pandemic has caused an increased investment in digital technologies around sustainability and transparency while also raising costs. Ensuring the health safety of the available drivers and the infrastructure to support them is a major concern from the pandemic. Road transport is the primary mode of transportation for essential goods and is relied upon heavily for the continued supply of food, medicine, and other essential products.

Digital challenge

As global trade expands, and supply chains become more complex, T&L professionals are finding it difficult to consolidate and centralize their supply chain data and compliance efforts (https://www.porttechnology.org/news/pti_blog_5_big_challenges_for_digital_logistics/). Finding solutions to breaking down data silos and increasing flexibility along the chain is necessary for success. On the one hand, there is a growing call for more connectivity. But as more systems get connected and more remote controlling capabilities emerge, the risk of data being compromised increases. With the rise of digitalization and technology, data integrity and privacy challenges and risks have soared.

With digital tools creating a more connected business world, leaders in the T&L industry are finding it challenging to manage customers' expectations for access to information and transparency at all points in the supply chain process. Clients now have unprecedented access to information and data and expect businesses to adhere to these new standards. Also internally, within their own organizations they face challenges. Research by PwC shows a lack of digital culture and training resulting in digital literacy. (Figure 6)

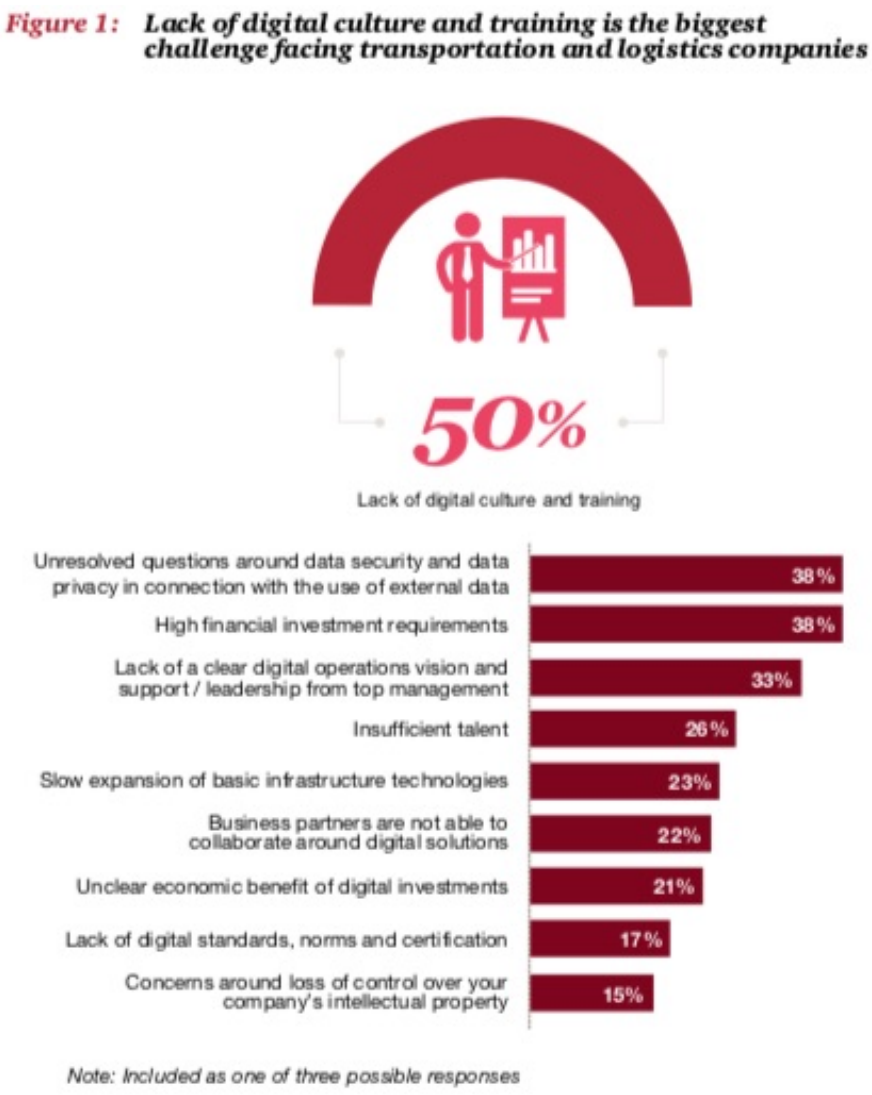
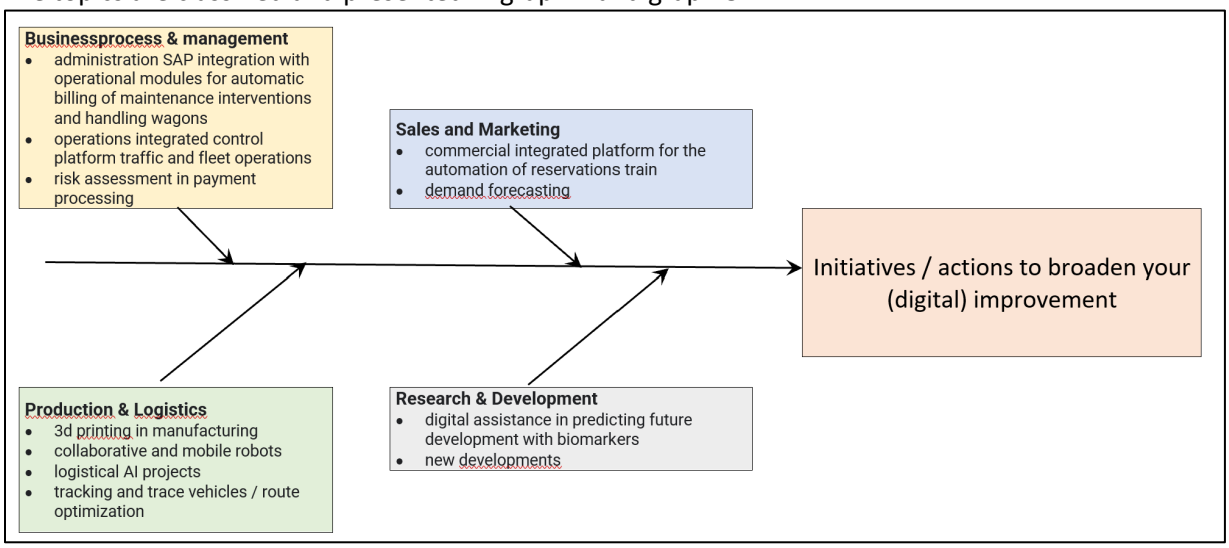


Figure 6: Lack of digital culture and training is the biggest challenge facing transportation and logistics companies. From: Shifting patterns: the future of the logistics industry, www.pwc.com/futureinsight, 2016

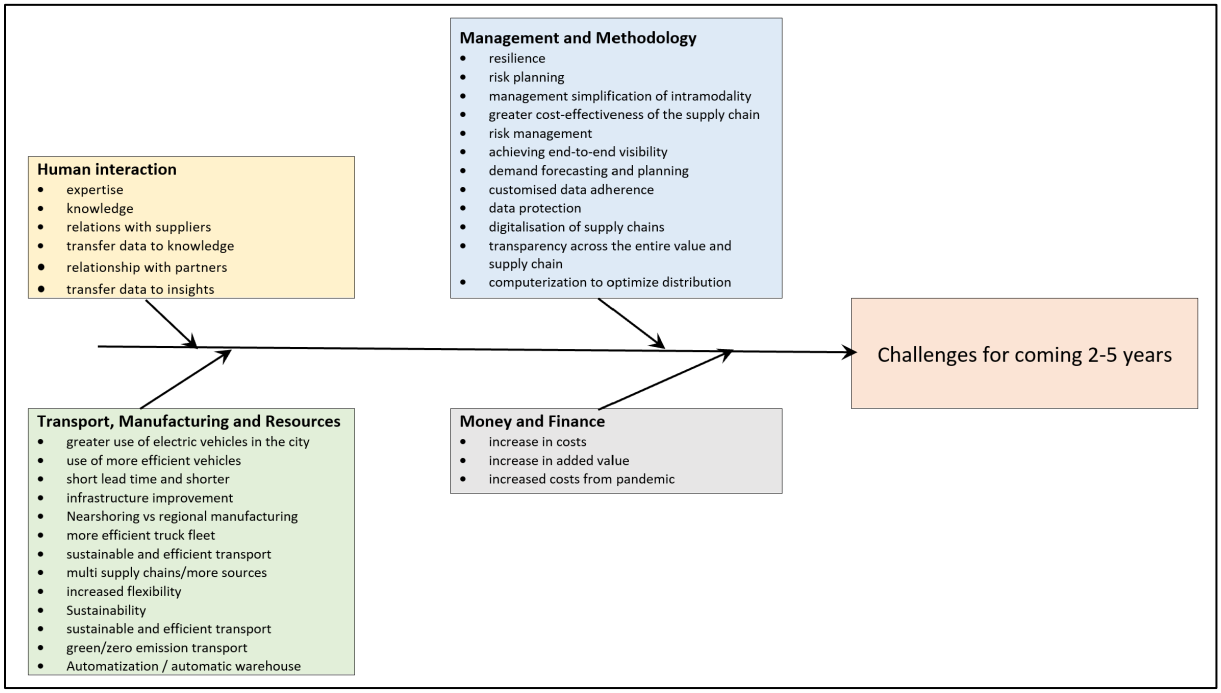
The outcome of the survey as far as companies and students are concerned.

As far as companies are concerned, there is a specific interest in the near future regarding digitization.

The topics are classified and presented in graph 7 and graph 8.



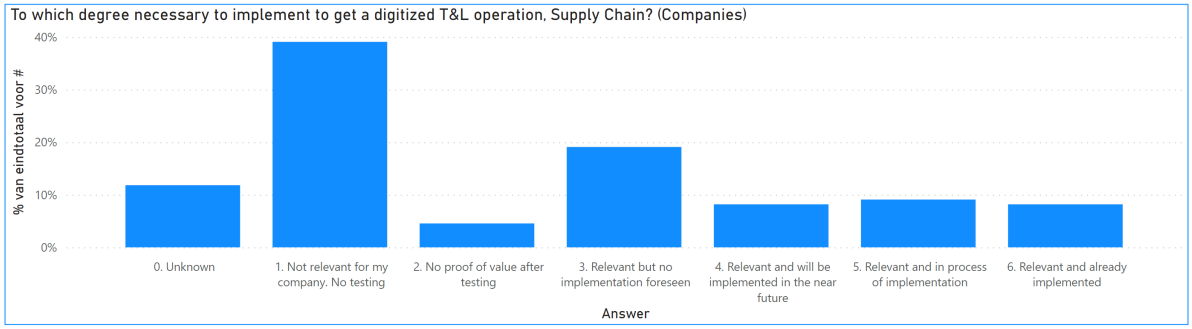
Graph 15, classification of the initiatives/actions to broaden (digital) improvements expected coming 2-5 years



Graph 16, classification of the challenges companies expects coming 2-5 years

Digitized T&L operation

Digitization of T&L operations is mainly NOT RELEVANT for companies. There is a higher relevance for AI and automated mobility or truck loading or case picking. (Table 2)

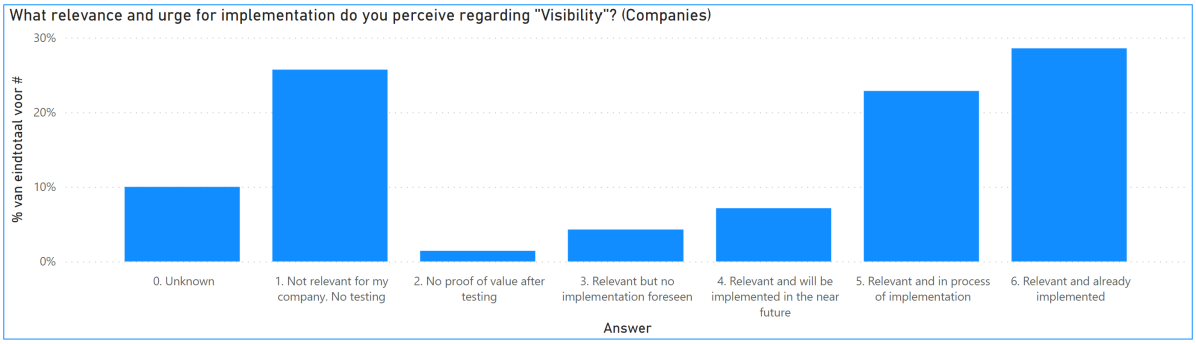


To which degree necessary to implement to get a digitized T&L operation, Supply Chain? (Companies)	0. Unknown	1. Not relevant for my company. No testing	2. No proof of value after testing	3. Relevant but no implementation foreseen	4. Relevant and will be implemented in the near future	5. Relevant and in process of implementation	6. Relevant and already implemented
01. Artificial intelligence	10%	20%	10%	40%		10%	10%
02. Manufacturing Execution Systems (MES)	10%	60%	10%		20%		
03. Video recognition	10%	30%	10%	10%	20%		20%
04. Virtual & Augmented reality	10%	30%	10%	10%	10%	10%	20%
05. Drones for inventory	10%	60%	10%	10%	10%		
06. Collaborative robots	10%	70%				10%	10%
07. 3D printing	10%	60%			20%	10%	
08. Picking robot arm	10%	50%		20%		10%	10%
09. Automated mobility	20%	10%		40%		20%	10%
10. Automated truck loading	10%	20%		40%		20%	10%
11. Automated case picking	20%	20%		40%	10%	10%	
Totaal	**12%**	**39%**	**5%**	**19%**	**8%**	**9%**	**8%**

Table 2, Companies find necessary digitization implementation

Visibility

Regarding this subject, companies find many relevant and have already or are in the process of implementing. Like Track & Trace, Internet of Things and Electronic Delivery Notes. (Table 3)

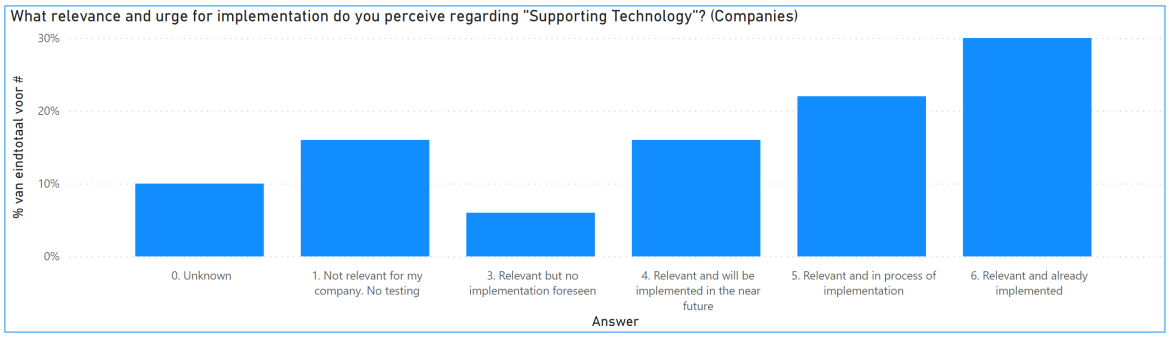


What relevance and urge for implementation do you perceive regarding "Visibility"? (Companies)	0. Unknown	1. Not relevant for my company. No testing	2. No proof of value after testing	3. Relevant but no implementation foreseen	4. Relevant and will be implemented in the near future	5. Relevant and in process of implementation	6. Relevant and already implemented
07. Track & Trace	10%	20%				20%	50%
06. RFID	10%	20%	10%	10%	10%	10%	30%
05. Electronic delivery note (e-Pod) 5	10%	20%		10%		40%	20%
04. Control Tower	10%	50%				30%	10%
03. Automatic Identification & Data Collection	10%	30%			20%	20%	20%
02. Big Data Analysis	10%	20%		10%	10%	20%	30%
01. Internet of Things	10%	20%			10%	20%	40%
Totaal	**10%**	**26%**	**1%**	**4%**	**7%**	**23%**	**29%**

Table 3, Companies find relevant to implement regarding "Visibility"

Supporting Technologies

With the exception of Block Chaining all these subjects are relevant and many are already or in the process of implementing. This is for the subjects Data Security, Cyber Security and 5G. (Table 4)

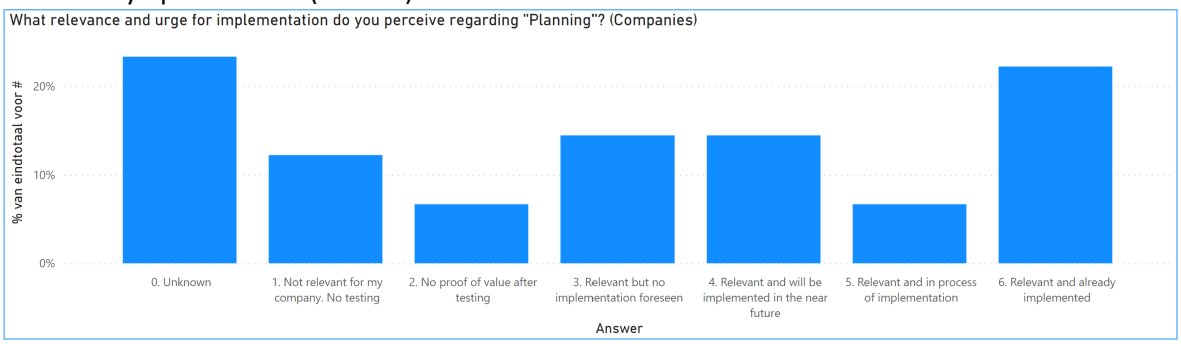


What relevance for implementation do you perceive regarding "Supporting Technology"? (Companies)	0. Unknown	1. Not relevant for my company. No testing	3. Relevant but no implementation foreseen	4. Relevant and will be implemented in the near future	5. Relevant and in process of implementation	6. Relevant and already implemented
01. Blockchain Technology	10%	60%	20%			10%
02. 5G	10%	10%	10%	20%	40%	10%
03. Data security	10%			10%	30%	50%
04. Cyber security	10%			20%	30%	40%
05. Cloud	10%	10%		30%	10%	40%
Totaal	**10%**	**16%**	**6%**	**16%**	**22%**	**30%**

Table 4, Companies find relevant to implement regarding "Supporting Tech."

Planning

This is an area that some parts relevant and already implemented: Master data management, Sales and Operations planning and Integrated Business planning. While other subjects are less relevant. Interesting is inventory optimization. (Table 5)



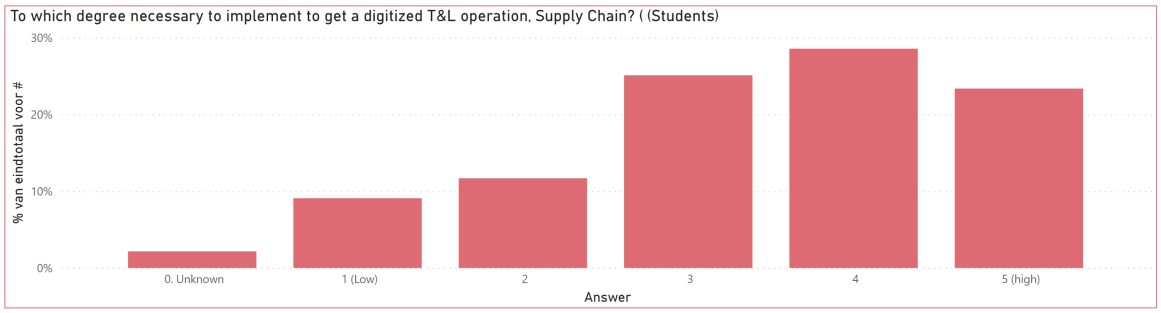
What relevance and urge for implementation do you perceive regarding "Planning"? (Companies)	0. Unknown	1. Not relevant for my company. No testing	2. No proof of value after testing	3. Relevant but no implementation foreseen	4. Relevant and will be implemented in the near future	5. Relevant and in process of implementation	6. Relevant and already implemented
01. Master data management	20%	10%	20%	20%			30%
02. Integrated business planning	20%			20%	10%	20%	30%
03. Sales and Operations Planning (SOP)	20%	20%			20%	10%	30%
04. Collaborative forecast	20%	10%	10%	20%	20%		20%
05. Dynamic Network design	30%	20%	10%	10%	10%		20%
06. Cost-to-serve analysis	20%	10%	10%	30%	10%		20%
07. Inventory optimization	20%	30%			30%		20%
08. Process optimization	30%		10%	10%	20%	10%	20%
09. Predictive maintenance	30%	10%		20%	10%	20%	10%
Totaal	**23%**	**12%**	**7%**	**14%**	**14%**	**7%**	**22%**

Table 5, Companies find relevant to implement regarding "Planning"

As far as students are concerned:

Digitized T&L operation

Digitization of T&L operations are mainly regarded RELEVANT for students. Especially automated picking, robot arms and drones are high on the list. (Table 6)

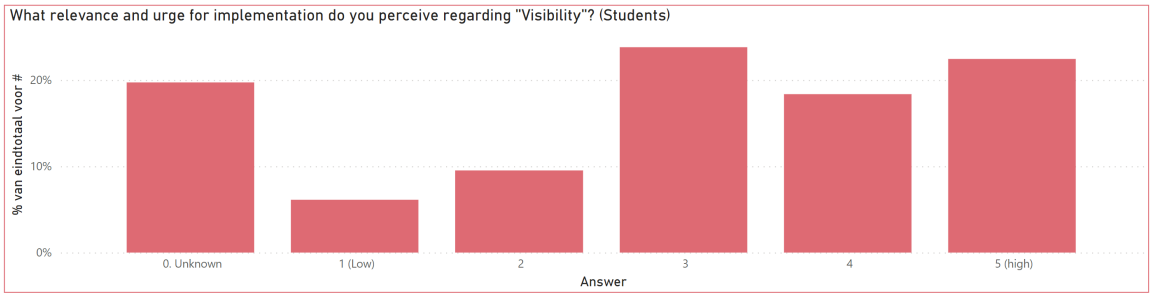


To which degree necessary to implement to get a digitized T&L operation, Supply Chain? (Students)	0. Unknown	1 (Low)	2	3	4	5 (high)
01. Artificial intelligence		5%	14%	24%	29%	29%
02. Manufacturing Execution Systems (MES)	5%	5%		29%	33%	29%
03. Video recognition	5%	19%	14%	33%	19%	10%
04. Virtual & Augmented reality	5%	14%	33%	29%	14%	5%
05. Drones for inventory	5%		14%	24%	24%	33%
06. Collaborative robots	5%	5%	5%	33%	29%	24%
07. 3D printing		24%	24%	10%	24%	19%
08. Picking robot arm		10%	10%	24%	38%	19%
09. Automated mobility		10%	5%	38%	33%	14%
10. Automated truck loading		5%	5%	19%	33%	38%
11. Automated case picking		5%	5%	14%	38%	38%
Totaal	**2%**	**9%**	**12%**	**25%**	**29%**	**23%**

Table 6, Students find necessary digitization implementation

Visibility

Regarding this subject the students find Automatic Identification & Data collection relevant and next to that mostly that Control Towering important but not as relevant. (Table 7)

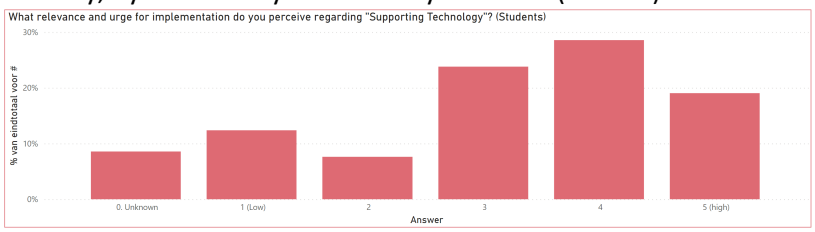


What relevance and urge for implementation do you perceive regarding "Visibility"? (Students)	0. Unknown	1 (Low)	2	3	4	5 (high)
01. Internet of Things	10%	19%	19%	24%	10%	19%
02. Big Data Analysis	10%	10%		19%	33%	29%
03. Automatic Identification & Data Collection	5%		14%	24%	19%	38%
04. Control Tower	5%	5%		52%	14%	24%
05. Electronic delivery note (e-Pod) 5	100%					
06. RFID	5%	5%	14%	29%	19%	29%
07. Track & Trace	5%	5%	19%	19%	33%	19%
Totaal	**20%**	**6%**	**10%**	**24%**	**18%**	**22%**

Table 7, Students find relevant to implement regarding "Visibility"

Supporting Technologies

Students think that many subjects in this area are relevant. Besides Block Chaining are subjects also Data Security, Cyber Security and 5G truly relevant. (Table 8)

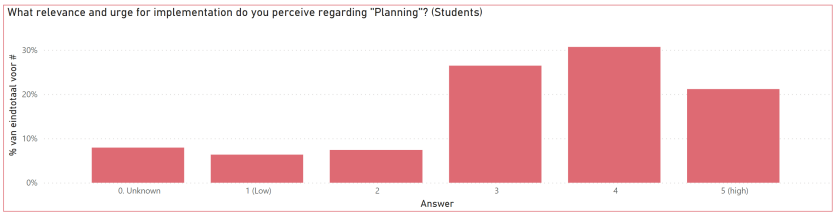


What relevance for implementation do you perceive regarding "Supporting Technology"? (Students)	0. Unknown	1 (Low)	2	3	4	5 (high)
01. Blockchain Technology	5%	10%		19%	33%	33%
02. 5G	10%	19%	19%	29%	24%	
03. Data security	5%	10%	5%	19%	33%	29%
04. Cyber security	10%	10%	5%	14%	43%	19%
05. Cloud	14%	14%	10%	38%	10%	14%
Totaal	**9%**	**12%**	**8%**	**24%**	**29%**	**19%**

Table 8, Students find relevant to implement regarding "Supporting Tech."

Planning

Students think that many subjects are relevant. Most relevant to them are Process Optimization, Master data management and Inventory Optimization. (Table 9)



What relevance and urge for implementation do you perceive regarding "Planning"? (Students)	0. Unknown	1 (Low)	2	3	4	5 (high)
01. Master data management	10%	5%		19%	48%	19%
02. Integrated business planning	10%	5%	10%	24%	33%	19%
03. Sales and Operations Planning (SOP)	5%	5%	5%	38%	29%	19%
04. Collaborative forecast	10%	10%	5%	29%	38%	10%
05. Dynamic Network design	14%	5%	19%	38%	14%	10%
06. Cost-to-serve analysis	5%	10%	10%	24%	43%	10%
07. Inventory optimization	5%	14%		19%	24%	38%
08. Process optimization	5%		5%	14%	24%	52%
09. Predictive maintenance	10%	5%	14%	33%	24%	14%
Totaal	**8%**	**6%**	**7%**	**26%**	**31%**	**21%**

Table 9, Students find relevant to implement regarding "Planning"

3. Conclusion

In regard of content comparing the current study offerings and T&L companies' requirements the following gaps do exist where more focus should be emphasized on the use of technology.

- Digital transformation by means of AI, IoT, big data analysis, blockchain and distributed ledger technology.
- Software driven process changes using drones, blockchain and AI
- Markets domestic commerce changes focusing on e-Commerce capabilities
- Machine driven process changes making use of warehouse robotization, electro mobility, AR/VR, high speed, and last mile delivery optimization (drones)

All considering sustainability and environmental interests.

In regard of transversal skills also here companies' interests are shifting meaning that students entering the labor market should operate more independent showing initiative and creativeness to deal with changing business environments that requires flexibility and social behavior.

For a new curriculum this means that apart from the basic T&L and Supply Chain Management knowledge, the focus should be emphasized on:

- Business Process Optimization
- Data Driven Supply Chain
- Technology Driven Supply Chain
- Sustainability Supply Chain

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Attachments

Appendix-A Questionnaire Companies

Dear Sir or Madam,

In the early days of the IoT technology, many of the big companies engaged in this technological ecosystem set three objectives: That "things would connect to a network"; that "they would then communicate with one another"; and that "they'd be capable of analysing information, making decisions and predicting events". The subsequent development moved so quickly that today we are already reaching the third objective of IoT for which all experts agree that an alliance between IoT and AI is required. Focusing on the industrial IoT, the introduction of AI into IoT infrastructure is a critical element. It is expected a high proliferation in different industrial environments of IoT projects with automatic learning combined with blockchain technology, for which new requirements come into play to advance in aspects such as process efficiency, predictability, and security.

The evident improvement of process efficiency due to the convergence between IoT and AI, is convincing many managers from very diverse sectors, to try new formulas to successfully undertake the inescapable digital transformation of their companies. These new technologies are opening new challenges to many other sectors that will be forced to change completely their organization to survive. 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.

Focusing on the T&L sector, the project contributes to enabling ICT & Business students to become the graduates that job market will increasingly require. With the European INCO_SMRT project we would like to evaluate the most relevant challenges for today's T&L organizations. The outcomes of this study should illustrate the different challenges as well as approaches used by companies to meet their increasing market requirements. Thus, the objective of this survey is to show relevant trigger points for companies due to present and future changes in the market and point out which concepts could be an enabler towards an agile, responsive but still an efficient and controllable supply chain today and in the future.

To gain a holistic overview, we need your support. Filling in this survey will take about 15 minutes. We will assure you we will treat your information as strictly confidential. As a gesture of appreciation, we would like to send you a report of our study results.

Please do not hesitate to contact us if you need more information or have any questions or comments.

Thank you in advance for your collaboration and best regards,

Name

Artesis Plantijn Hogeschool, Belgium
Fontys University for Applied Sciences, The Netherlands
UCL Erhvervsakademi & Professionshojskole, Denmark
Universitada Degli Studi Dell'Aquila, Italy

What is the name of your company?	
In which country is your company office located?	
In which industry does your company mainly belong?	
What is your name?	
What is your postion in the company?	

1. If you were to state up to six main pain points / challenges *) in the next 5 years in regard of T&L operation, supply chain, which would they be?		**Additional Remarks**
1		
2		
3		
4		
5		
6		

*) Examples: Increased costs troughout the supply chain; supply chain volatility; increasing resiliency; boosting flexibility; gaining end-to-end visibility; getting value from data; supplier/partner relationships; planning & risk management; sustainable and efficient transport.....

2. To which degree do you consider it necessary to implement the following concepts to get a digitized T&L operation, Supply Chain?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Artificial intelligence *)								
Manufacturing Execution Systems (MES)								
Video recognition								
Virtual & Augmented reality								
Drones for inventory								
Collaborative robots								
3D printing								
Picking robot arm								
Automated mobility								
Automated truck loading								
Automated case picking								
Others (please specify)								
1								
2								
3								
4								

*) Artificial Intelligence (AI) is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals, which involves consciousness and emotionality.

3. What relevance and urge for implementation do you perceive regarding "Visibility"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Blockchain Technology *)								
Internet of Things (IoT) **)								
Big Data Analysis ***)								predictive
Automatic Identification & Data Collection								
Control Tower ****)								
Electronic delivery note (e-Pod)								
RFID								
Track & Trace								
Others (please specify)								
1								
2								
3								
4								

*) A blockchain is a growing list of records, called blocks, that are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree). By design, a block chain is resistant to modification of its data. This is because once recorded, the data in any given block cannot be altered retroactively without alteration of all subsequent blocks.

**) The Internet of things (IoT) describes the network of physical objects—"things" or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

***) Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software. Data with many fields (columns) offer greater statistical power, while data with higher complexity (more attributes or columns) may lead to a higher false discovery rate.
Big data analysis challenges include capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, information privacy, and data source.

****) A control tower for supply chains is a central hub with the required technology, organization and processes to capture and use transportation data to provide enhanced visibility for short- and long-term decision-making aligned with strategic objectives.

4. What relevance and urge for implementation do you perceive regarding "Supporting Technology"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
5G								
Data security								
Cyber security								
Cloud								
Others (please specify)								
1								
2								
3								
4								

5. What relevance and urge for implementation do you perceive regarding "Planning"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Master data management								
Integrated business planning								
Sales and Operations Planning (SOP)								
Collaborative forecast								
Dynamic Network design								
Cost-to-serve analysis								
Inventory optimization								
Process optimization								
Predictive maintenance								
Others (please specify)								
1								
2								
3								
4								

6. Are you planning initiatives / actions to broaden your (digital) improvement direction towards one or more functional area's not being "Planning" in the next 2-5 years?

Yes / No

If so, which other functional area's are these and which new (digital) developments would you consider?

Funtional area	New developments	**Additional Remarks**
1		
2		
3		
4		

7. In the future (2-5 years) - what degree of automation do you use in these area's?

	Not relevant / not applied	Manual	Semi automated	Automated	Fully automated	Unknown	**Additional Remarks**
Storage							
Palletising / de-palletising							
Boxes / case picking							
Unit / detail picking							
Internal transport							
Trucks loading / unloading							
Shipment sorting							
Value added services							
Others (please specify)							
1							
2							
3							
4							

8. Please picture your company over the next 2-5 years. What are relevant trigger points in the next two to five years for your organization and to what extend do you want to leverage the related possibilities with your T&L operation, supply chain?

	Not a relevant topic	No leverage for the organization	Weak leverage expected	Moderate leverage expected	Strong leverage expected	Very strong (business) leverage expected	Unknown	**Additional Remarks**
Risks / interruptions								
Government regulations/ compliance								
Sustainability								
Collaboration (*)								
Collaborative Network Organizations (**)								
Transparency in the supply chain								
Decentralization								
Digitization of business processes								
Business analytics								
Automation								
Others (please specify)								
1								
2								
3								
4								

(*) Sharingtransport capacities, facilities, contracts, expertise etc.

(**) A **collaborative network organization** is a network consisting of a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals (s.a. competing supply chains), and whose interactions are supported by computer networks.

9. Please picture your company over the next 2-5 years. What are relevant trigger points <u>for change</u> in the next two to five years for your organization and to what extend do you want to leverage the related possibilities with your T&L operation, supply chain?

	Not a relevant topic	No leverage for the organization	Weak leverage expected	Moderate leverage expected	Strong leverage expected	Very strong (business) leverage expected	**Additional Remarks**
Changed consumer behavior							
Individualization							
Customer service							
Demand fluctuations							
Omnichannel distribution strategy							
On shelf availability							
Complexity reduction							
Cost pressure							
Working capital reduction pressure							
Economic and financial perspective							
legal and regulatory perspective							
Demographics / staff shortages							
Others (please specify)							
1							
2							
3							
4							

10. What skills are you looking for when hiring university graduates to start working in your company in the field of T&L operation, Supply Chain?

	1 (low)	2	3	4	5 (high)
Entrepreneur					
Communicative					
Team player					
Creative					
Independent					
Social					
Decisive					
Perseverance					
Initiative					
Flexible					
Energetic					
Loyal					
Results-oriented					
Others (please specify)					
1					
2					
3					
4					

11. Do you have any additional comments for us?

Appendix-B Questionnaire Alumni

Dear Sir or Madam,
In the early days of the IoT technology, many of the big companies engaged in this technological ecosystem set three objectives: That "things would connect to a network"; that "they would then communicate with one another"; and that "they'd be capable of analysing information, making decisions and predicting events". The subsequent development moved so quickly that today we are already reaching the third objective of IoT for which all experts agree that an alliance between IoT and AI is required. Focusing on the industrial IoT, the introduction of AI into IoT infrastructure is a critical element. It is expected a high proliferation in different industrial environments of IoT projects with automatic learning combined with blockchain technology, for which new requirements come into play to advance in aspects such as process efficiency, predictability, and security.
The evident improvement of process efficiency due to the convergence between IoT and AI, is convincing many managers from very diverse sectors, to try new formulas to successfully undertake the inescapable digital transformation of their companies. These new technologies are opening new challenges to many other sectors that will be forced to change completely their organization to survive. 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.
Focusing on the T&L sector, the project contributes to enabling ICT & Business students to become the graduates that job market will increasingly require. With the European INCO_SMRT project we would like to evaluate the most relevant challenges for today's T&L organizations. The outcomes of this study should illustrate the different challenges as well as approaches used by companies to meet their increasing market requirements. Thus, the objective of this survey is to show relevant trigger points for companies due to present and future changes in the market and point out which concepts could be an enabler towards an agile, responsive but still an efficient and controllable supply chain today and in the future.
To gain a holistic overview, we need your support. Filling in this survey will take about 15 minutes. We will assure you we will treat your information as strictly confidential. As a gesture of appreciation, we would like to send you a report of our study results.
Please do not hesitate to contact us if you need more information or have any questions or comments.
Thank you in advance for your collaboration and best regards,
Name
Artesis Plantijn Hogeschool, Belgium
Fontys University for Applied Sciences, The Netherlands
UCL Erhvervsakademi & Professionshojskole, Denmark
Universitada Degli Studi Dell'Aquila, Italy

What is the name of your company?	
In which country is your company office located?	
In which industry does your company mainly belong?	
What is your name?	
What is your postion in the company?	
What is the name of your University?	
In which year did you graduate?	
What is the main subject of your study?	

1. If you were to state up to six main pain points / challenges *) in the next 5 years in regard of T&L operation, supply chain, which would they be?		**Additional Remarks**
1		
2		
3		
4		
5		
6		

*) Examples: Increased costs troughout the supply chain; supply chain volatility; increasing resiliency; boosting flexibility; gaining end-to-end visibility; getting value from data; supplier/partner relationships; planning & risk management; sustainable and efficient transport.....

2. To which degree do you consider it necessary to implement the following concepts to get a digitized T&L operation, Supply Chain for your company?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Artificial intelligence *)								
Manufacturing Execution Systems (MES)								
Video recognition								
Virtual & Augmented reality								
Drones for inventory								
Collaborative robots								
3D printing								
Picking robot arm								
Automated mobility								
Automated truck loading								
Automated case picking								
Others (please specify)								
1								
2								
3								
4								

*) Artificial intelligence (AI) is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals, which involves consciousness and emotionality.

3. What relevance and urge for implementation does your company perceive regarding "Visibility"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Blockchain Technology *)								
Internet of Things (IoT) **)								
Big Data Analysis ***)								predictive
Automatic Identification & Data Collection								
Control Tower ****)								
Electronic delivery note (e-Pod)								
RFID								
Track & Trace								
Others (please specify)								
1								
2								
3								
4								

*) A blockchain is a growing list of records, called blocks, that are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree). By design, a blockchain is resistant to modification of its data.

**) The Internet of things (IoT) describes the network of physical objects—"things" or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

***) Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software. Data with many fields (columns) offer greater statistical power, while data

****) A control tower for supply chains is a central hub with the required technology, organization and processes to capture and use transportation data to provide enhanced visibility for short- and long-term decision-making aligned with strategic objectives.

4. What relevance and urge for implementation does your company perceive regarding "Supporting Technology"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
5G								
Data security								
Cyber security								
Cloud								
Others (please specify)								
1								
2								
3								
4								

5. What relevance and urge for implementation does your company perceive regarding "Planning"?

	Not relevant for my company. No testing	No proof of value after testing	Relevant but no implementation foreseen	Relevant and will be implemented in the near future	Relevant and in process of implementation	Relevant and already implemented	Unknown	**Additional Remarks**
Master data management								
Integrated business planning								
Sales and Operations Planning (SOP)								
Collaborative forecast								
Dynamic Network design								
Cost-to-serve analysis								
Inventory optimization								
Process optimization								
Predictive maintenance								
Others (please specify)								
1								
2								
3								
4								

6. Is your company planning initiatives / actions to broaden your (digital) improvement direction towards one or more functional area's not being "Planning" in the next 2-5 years?

Yes / No

If so, which other functional area's are these and which new (digital) developments would your company consider?

Funtional area	New developments	**Additional Remarks**
1		
2		
3		
4		

7. In the future (2-5 years) - what degree of automation does your company use in these area's?

	Not relevant / not applied	Manual	Semi automated	Automated	Fully automated	Unknown	**Additional Remarks**
Storage							
Palletising / de-palletising							
Boxes / case picking							
Unit / detail picking							
Internal transport							
Trucks loading / unloading							
Shipment sorting							
Value added services							
Others (please specify)							
1							
2							
3							
4							

8. Please picture your company over the next 2-5 years. What are relevant trigger points in the next two to five years for your organization and to what extend do expect your company will leverage the related possibilities with their T&L operation, supply chain?

	Not a relevant topic	No leverage for the organization	Weak leverage expected	Moderate leverage expected	Strong leverage expected	Very strong (business) leverage expected	Unknown	Additional Remarks
Risks / interruptions								
Government regulations/ compliance								
Sustainability								
Collaboration (*)								
Collaborative Network Organizations (**)								
Transparency in the supply chain								
Decentralization								
Digitization of business processes								
Business analytics								
Automation								
Others (please specify)								
1								
2								
3								
4								

(*) Sharingtransport capacities, facilities, contracts, expertise etc.

(**) A **collaborative network organization** is a network consisting of a variety of entities (e.g. organizations and people) that are largely autonomous, geographically distributed, and heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals (s.a. competing supply chains), and whose interactions are supported by computer networks.

9. Please picture your company over the next 2-5 years. What are relevant trigger points for change in the next two to five years for your organization and to what extend do you expect your company will leverage the related possibilities withtheir T&L operation, supply chain?

	Not a relevant topic	No leverage for the organization	Weak leverage expected	Moderate leverage expected	Strong leverage expected	Very strong (business) leverage expected	Additional Remarks
Changed consumer behavior							
Individualization							
Customer service							
Demand fluctuations							
Omnichannel distribution strategy							
On shelf availability							
Complexity reduction							
Cost pressure							
Working capital reduction pressure							
Economic and financial perspective							
legal and regulatory perspective							
Demographics / staff shortages							
Others (please specify)							
1							
2							
3							
4							

10. Based on what you learned at your university, how well were you prepared to start your first job in T&L operations, Supply Chain?

	1 (not)	2	3	4	5 (very well)	Why?
From a skills perspective						
From a knowledge perspective						

11. How do you characterize the learning environment of your university?

	1 (not at all)	2	3	4	5 (very much)	Why?
Demand based						
Course based						
Research based						
Open						

12. Do you have any additional comments for us?

Appendix-C Questionnaire Lecturers

Dear Sir or Madam,
In the early days of the IoT technology, many of the big companies engaged in this technological ecosystem set three objectives: That "things would connect to a network"; that "they would then communicate with one another"; and that "they'd be capable of analysing information, making decisions and predicting events". The subsequent development moved so quickly that today we are already reaching the third objective of IoT for which all experts agree that an alliance between IoT and AI is required. Focusing on the industrial IoT, the introduction of AI into IoT infrastructure is a critical element. It is expected a high proliferation in different industrial environments of IoT projects with automatic learning combined with blockchain technology, for which new requirements come into play to advance in aspects such as process efficiency, predictability, and security.
The evident improvement of process efficiency due to the convergence between IoT and AI, is convincing many managers from very diverse sectors, to try new formulas to successfully undertake the inescapable digital transformation of their companies. These new technologies are opening new challenges to many other sectors that will be forced to change completely their organization to survive. 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.
Focusing on the T&L sector, the project contributes to enabling ICT & Business students to become the graduates that job market will increasingly require. With the European INCO_SMRT project we would like to evaluate the most relevant challenges for today's T&L organizations. The outcomes of this study should illustrate the different challenges as well as approaches used by companies to meet their increasing market requirements. Thus, the objective of this survey is to show relevant trigger points for companies due to present and future changes in the market and point out which concepts could be an enabler towards an agile, responsive but still an efficient and controllable supply chain today and in the future.
To gain a holistic overview, we need your support. Filling in this survey will take about 15 minutes. We will assure you we will treat your information as strictly confidential. As a gesture of appreciation, we would like to send you a report of our study results.
Please do not hesitate to contact us if you need more information or have any questions or comments.
Thank you in advance for your collaboration and best regards,
Name
Artesis Plantijn Hogeschool, Belgium
Fontys University for Applied Sciences, The Netherlands
UCL Erhvervsakademi & Professionshojskole, Denmark
Universitada Degli Studi Dell'Aquila, Italy

What is the name of your university?	
What is your name?	
What is your field of expertise?	

1. If you were to state up to six main pain points / challenges *) in the next 2- 5 years in regard of T&L operation, supply chain, which would they be?	**Additional Remarks**
1	
2	
3	
4	
5	
6	

*) Examples: Increased costs troughout the supply chain; supply chain volatility; increasing resiliency; boosting flexibility; gaining end-to-end visibility; getting value from data; supplier/partner relationships; planning & risk management; sustainable and efficient transport.....

2. Which of the following concepts do you envision to be important in the next2- 5 years in the field of T&L operation, Supply Chain?

	1 (Low)	2	3	4	5 (High)	Unknown	**Additional Remarks**
Artificial intelligence *)							
Manufacturing Execution Systems (MES)							
Video recognition							
Virtual & Augmented reality							
Drones for inventory							
Collaborative robots							
3D printing							
Picking robot arm							
Automated mobility							
Automated truck loading							
Automated case picking							
Others (please specify)							
1							
2							
3							
4							

*) Artificial intelligence (AI) is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals, which involves consciousness and emotionality.

3. What relevance and urge for implementation do you envision companies will have in the next 2-5 years regarding "Visibility"?

	1 (Low)	2	3	4	5 (High)	Unknown	**Additional Remarks**
Blockchain Technology *)							
Internet of Things (IoT) **)							
Big Data Analysis ***)							
Automatic Identification & Data Collection							
Control Tower ****)							
Electronic delivery note (e-Pod)							
RFID							
Track & Trace							
Others (please specify)							
1							
2							
3							
4							

*) A blockchain is a growing list of records, called blocks, that are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree). By design, a blockchain is resistant to modification of its data. This is

**) The Internet of things (IoT) describes the network of physical objects—"things" or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

***) Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software. Data with many fields (columns) offer greater statistical power, while data with

****) A control tower for supply chains is a central hub with the required technology, organization and processes to capture and use transportation data to provide enhanced visibility for short- and long-term decision-making aligned with strategic objectives.

4. What relevance and urge for implementation do you envision companies will have in the next 2-5 years regarding "Supporting Technology"?

	1 (Low)	2	3	4	5 (High)	Unknown	**Additional Remarks**
5G							
Data security							
Cyber security							
Cloud							
Others (please specify)							
1							
2							
3							
4							

5. What relevance and urge for implementation do you envision companies will have in the next 2-5 years regarding "Planning"?

	1 (Low)	2	3	4	5 (High)	Unknown	Additional Remarks
Master data management							
Integrated business planning							
Sales and Operations Planning (SOP)							
Collaborative forecast							
Dynamic Network design							
Cost-to-serve analysis							
Inventory optimization							
Process optimization							
Predictive maintenance							
Others (please specify)							
1							
2							
3							
4							

6. Do you envision companies to plan initiatives / actions to broaden their (digital) improvement direction in the next 2-5 years towards one or more functional area's not being "Planning"?

Yes / No

If so, which other functional area's are these and which new (digital) developments would you consider?

Funtional area	New developments	Additional Remarks
1		
2		
3		
4		

7. In the future (2-5 years) - do you envision companies to increase their degree of automation in these area's?

	Not relevant / not applied	Manual	Semi automated	Automated	Fully automated	Unknown	Additional Remarks
Storage							
Palletising / de-palletising							
Boxes / case picking							
Unit / detail picking							
Internal transport							
Trucks loading / unloading							
Shipment sorting							
Value added services							
Others (please specify)							
1							
2							
3							
4							

8. Do you envision relevant trigger points in the next 2-5 years for companies to adapt change and to what extend do you expect companies to leverage the related possibilities with their T&L operation, supply chain?

	nt topic	No leverage for the organizatio n	Weak leverage expected	Moderate leverage expected	Strong leverage expected	Very strong (business) leverage expected	Unknown	Additional Remarks
Risks / interruptions								
Government regulations/ compliance								
Sustainability								
Collaboration (*)								
Collaborative Network Organizations (**)								
Transparency in the supply chain								
Decentralization								
Digitization of business processes								
Business analytics								
Automation								

Changed consumer behavior								
Individualization								
Customer service								
Demand fluctuations								
Omnichannel distribution strategy								
On shelf availability								
Complexity reduction								
Cost pressure								
Working capital reduction pressure								
Economic and financial perspective								
legal and regulatory perspective								
Demographics / staff shortages								
Others (please specify)								
1								
2								
3								
4								

9. What skills do you envision to be important for companies when they would like to hire university graduates to start working for them in the field of T&L operation, Supply Chain?

	1 (low)	2	3	4	5 (high)
Entrepreneur					
Communicative					
Team player					
Creative					
Independent					
Social					
Decisive					
Perseverance					
Initiative					
Flexible					
Energetic					
Loyal					
Results-oriented					
Others (please specify)					
1					
2					
3					
4					

10. Do you have any additional comments for us?

Appendix-D Questionnaire Students

Dear Student,
In the early days of the IoT technology, many of the big companies engaged in this technological ecosystem set three objectives: That "things would connect to a network"; that "they would then communicate with one another"; and that "they'd be capable of analysing information, making decisions and predicting events". The subsequent development moved so quickly that today we are already reaching the third objective of IoT for which all experts agree that an alliance between IoT and AI is required. Focusing on the industrial IoT, the introduction of AI into IoT infrastructure is a critical element. It is expected a high proliferation in different industrial environments of IoT projects with automatic learning combined with blockchain technology, for which new requirements come into play to advance in aspects such as process efficiency, predictability, and security.
The evident improvement of process efficiency due to the convergence between IoT and AI, is convincing many managers from very diverse sectors, to try new formulas to successfully undertake the inescapable digital transformation of their companies. These new technologies are opening new challenges to many other sectors that will be forced to change completely their organization to survive. 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.
Focusing on the T&L sector, the project contributes to enabling ICT & Business students to become the graduates that job market will increasingly require. With the European INCO_SMRT project we on the one hand would like to evaluate the most relevant challenges for today's T&L organizations. On the other hand we would like to find out current students interrests in light of their future expectations when graduated and starting their first job.
To gain a holistic overview, we need your support. Filling in this survey will take about 15 minutes. We will assure you we will treat your information as strictly confidential. As a gesture of appreciation, we would like to send you a report of our study results.
Please do not hesitate to contact us if you need more information or have any questions or comments.
Thank you in advance for your collaboration and best regards,
Name
Artesis Plantijn Hogeschool, Belgium
Fontys University for Applied Sciences, The Netherlands
UCL Erhvervsakademi & Professionshojskole, Denmark
Universitada Degli Studi Dell'Aquila, Italy

What is the name of your university?	
What is your name?	
What is your field of expertise?	

1. In light of market and industry changes in the coming 2-5 years, which of the following logistics / supply chain concepts and technologies would you be interrested in to learn?

	1 (Low)	2	3	4	5 (High)	Unknown	Additional Remarks
Artificial intelligence *)							
Manufacturing Execution Systems (MES)							
Video recognition							
Virtual & Augmented reality							
Drones for inventory							
Collaborative robots							
3D printing							
Picking robot arm							
Automated mobility							
Automated truck loading / case picking							

*) Artificial intelligence (AI) is intelligence demonstrated by machines, unlike the natural intelligence displayed by humans and animals, which involves consciousness and emotionality.

Blockchain Technology *)							
Internet of Things (IoT) **)							
Big Data Analysis ***)							
Automatic Identification & Data Collection							
Control Tower ****)							
RFID							
Track & Trace							

*) A blockchain is a growing list of records, called blocks, that are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (generally represented as a Merkle tree). By design, a blockchain is resistant to modification of its data. This is

**) The Internet of things (IoT) describes the network of physical objects—"things" or objects—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the Internet.

***) Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software. Data with many fields (columns) offer greater statistical power, while data with

****) A control tower for supply chains is a central hub with the required technology, organization and processes to capture and use transportation data to provide enhanced visibility for short- and long-term decision-making aligned with strategic objectives.

5G							
Data security							
Cyber security							
Cloud							
Master data management							
Integrated business planning							
Sales and Operations Planning (SOP)							
Collaborative forecast							
Dynamic Network design							
Cost-to-serve analysis							
Inventory optimization							
Process optimization							
Predictive maintenance							
Others (please specify)							
1							
2							
3							
4							

2. What skills do you envision to be important for companies when they would like to hire you as university graduate to start working for them in the field of T&L operation, Supply Chain?

	1 (low)	2	3	4	5 (high)
Entrepreneur					
Communicative					
Team player					
Creative					
Independent					
Social					
Decisive					
Perseverance					
Initiative					
Flexible					
Energetic					
Loyal					
Results-oriented					
Others (please specify)					
1					
2					
3					
4					

3. Based on what you learned at your university, how well were you prepared to start your first job in T&L operations, Supply Chain?						
	1 (not)	2	3	4	5 (very well)	Why?
From a skills perspective						
From a knowledge perspective						

4. How do you characterize the learning environment of your university?						
	1 (not at all)	2	3	4	5 (very much)	Why?
Demand based						
Course based						
Research based						
Open						

5. Do you have any additional comments for us?