

NEW TRAINING SCHEMES FOR THE FUTURE EDUCATION IN TRANSPORT SECTOR

Abstract. Transport is a social sector that is rapidly developing, changing and being influenced to the maximum extent by the technological development and innovation, among others, thus facing problems in staffing its several domains with appropriate and qualified personnel. This fact, makes the need for changes in training and education of future transport professionals. SKILLFUL project vision is to identify the skills and competences needed by the transport workforce of the future and define the training methods and tools to meet them. Paper focuses on mid-term results of the project.

Keywords: transport, professionals, training, technology

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Introduction

The transportation sector employs over 10 million persons in the EU today. At the same time, transport is a social sector that is rapidly developing, changing and being influenced to the maximum extent by the development of automation, electrification and greening of transport, among others, thus facing problems in staffing its several domains with appropriate and qualified personnel. This fact, makes the need for changes in training and education content, curricula, tools and methodologies absolutely imperative, incorporating lifelong learning aspects for the professionals in all transports areas. Additionally, the demographic trends (such as population age) are also going to play a key role over the next years, since large groups of professionals taking retirement should be replaced by younger generation of employees. So, an additional challenge is whether enough professionals having the right skills could be attracted to the transportation sector workforce. (SKILLFUL consortium, 2017)

SKILLFUL project vision is to identify the skills and competences needed by the transport workforce of the future and define the training methods and tools to meet them. Employability is strongly connected by the project to future transport job requirements for all transportation modes and multimodal chains for all levels/types of workers, while all training modes are included and integrated in a balanced way.

SKILLFUL is financed under Horizon 2020, reviewing the existing, emerging and future knowledge and skills requirements of workers at all levels in the transportation sector, to structure the key specifications and components of the curricula and training courses that will be needed to meet these competence requirements

optimally in order to achieve European wide competence development. Project results are verified through wide range of pilot courses from all transportation modes Europe wide. (SKILLFUL consortium, 2017)

1. Future trends and scenarios in transport

A main challenge for the transportation sector is whether it can attract new employees, as well as equip the existing ones with the required skills required for meeting the needs of the already occurring or emerging changes.

During the first project phase SKILLFUL analysed and described the **technological changes** and trends that are expected to occur in transport sector in the short (2020), medium (2030) and long (2050) horizon future and how they are going to affect the employability of the transportation system professionals, together with other trends taking place in parallel, like demographic and socioeconomic changes, etc.

In this first phase more than 125 experts have been interviewed in total (for all sub-categories of future transportation trends), from more than 20 different European countries. Experts have been covering a wide area of positions and professional areas, ranging from the research and university area, to technical fields. As for future of the professionals of European transportation system, the experts have been asked to highlight the professions, jobs and occupations that foreseen to be most affected, by also defining the timeframe of these changes. In parallel, more than 80 relevant reports and documents, as well as scientific articles have been analysed, in order to collect all the information needed about the current and upcoming changes in the European transportation sector.

Among the key transport trends, electrification emerged as the most important factor that will bring changes into the future transportation system of Europe. Electrification is a very relevant theme for road transport in the medium (2020) and long (2050) terms, especially due to its potential contribution to the climate change targets. Digitalization and automated driving are considered to be a relevant theme for all transport modes. In the same context, the greening of all transportation modes is also at a very high ranking. Liquid second generation biofuels, gaseous fuels and synthetic fossil fuels are very relevant to road transport in the short term (2020), especially due to their potential contribution to the climate change targets, while for maritime transport LNG and also other new fuels provide greening possibilities in the medium term (2030), with emphasis also on new generation of inland-waterway vessels that will provide an integrated, energy-efficient, and flexible alternative to road transport. Ensuring the feeling of safety and security of European citizens is also considered to be a very important factor, referred to cause changes in the transport area and its future development. Other driving forces, in diminishing importance order are the following:

- Multimodality, Syncromodality;
- Interdisciplinarity in creation of new solutions;
- New transport vehicle types;
- Globalization of the economy;
- Condition-based megacity traffic management multistakeholder systems. Global traceability for Logistics Optimization;
- Smoother Travel through Electronic Visas (e-Visas) and Smart Airports;
- Novel infrastructure management and maintenance schemes;
- Tube freight transport concepts;
- Impact of 3D printing on production location and logistics.

Almost all experts highlighted the importance of digitalization trends in identifying related technologies (i.e. IT and telematics, Cooperative Systems and V2X interfaces, traffic big data handling algorithms and analytics) as the most influential for future Transport Workforce. Few more key enabling and supporting technologies were identified by the experts, such as robotics, security related technologies, etc.

Even more than technologies, **new business schemes** that accompany them are expected to change the working ecosystem of transport. MaaS will push users from ownership to usership; thus creating a number of connected jobs and business opportunities to it. As major relevant business schemes the following have been considered and analysed:

- Retail and (e)commerce development;
- Transport workplace flexibility;
- Do-It-Yourself (DIY) schemes;

- Crowdfunding schemes that allow new transport related applications to emerge;
- Transport on demand schemes that adapt flexibly to the kind and number of passengers or freight to be transported;
- Transport workforce flexicurity;
- Fuel availability schemes that offer energy for transport vehicles available at the specific time and the distinct localization.

The future transport workforce will not only be influenced by the changing and evolving needs of the sector and its associate business schemes and enabling technologies. It will also be shaped by the prevailing **social trends** in Europe, such as ageing of the workforce, resulting in the need to integrate immigrants into the workforce and the fight against the exclusion within certain groups, such as people with disabilities, computer illiterate people, etc. New technology will influence the existing modes of transport. Society will witness a shift in cultural attitudes spreading across the digital society and manifested by ownership and usage of the means of transportation. This will also fundamentally change the way transport will be designed and operated. The total mobility structure is changing (SKILLFUL consortium, 2017).

2. Estimated impact of changes in future transportation employability

All the above changes anticipated in the near or more distant future of the transport sector, as well as those who have already begun to occur to a lesser or greater extent, are expected to affect (in varying degrees) also the sector's employability, creating different conditions for the future transport professionals and new requirements and needs for their compilation and training.

An occupation that is expected to be affected the most is driver (of every kind). Taxi and bus drivers, metro drivers, urban rail drivers, truck drivers, public transport drivers, delivery drivers, etc. are expected to lose many of their duties or professions may even disappear to some extent, mainly due to development of autonomous vehicles and unmanned transportation systems in long term. Additionally, some of blue collar workers, such as stevedores, manual operators, factory workers, machine operators, warehouse operatives, conductors, shunters, loaders/unloaders, etc. are expected to be shortly eliminated or even vanished as professionals' positions, mainly again because of the evolution of automation, digitalization, robotics, full mechanisation of loading/ unloading and other relevant key developments.

On the other hand, several jobs are going to emerge, in order to cover the needs that will progressively occur by the several developments of new driving forces, as well as the elimination of already existing positions. Some representative examples that can be indicatively mentioned are the drones' operators and managers, who

will remotely control vehicles deployed for logistics operations that is a profession expected to emerge in a medium-term horizon; the automated vehicle fleet operators and servicing-maintenance personnel, the shared mobility managers and MaaS operators, as well as the syncromodal specialists, expected to have extensive knowledge on syncromodal sustainable urban systems and on new business models for mobility providers.

Experts indicated that there is a growing need of IT specialists who could create, manage and operate specific transport related software and mobile computerized systems (Gavalas et.al, 2015). In the future, there will be a huge demand of specialists who will analyse and interpret collected transport big data, install sensors in several places (vehicles, infrastructures), maintain the equipment and tele-operate them. Many of the current jobs and tasks requiring physical labour workforce may be substituted by robotics in the future. However, intelligent systems and new technologies will require specialists to deal with them.

Additionally, another technological factor that is expected to affect the future transportation system of Europe is related to the proactive traffic management that covers methods for creating an accurate overall understanding of the current status of the transportation system and predicting changes in traffic conditions. It is a relevant theme, especially for road transport, already in the short term (2020).

Lightweight materials, graphene and nanocoatings are also expected to replace traditional materials in automotive, aviation and marine industries in the future. It is expected that paints, coatings and construction markets will be highly impacted in the next five years by self-healing materials. For example, fibres reinforced composites with liquid self-healing materials can be used in the aviation industry and self-healing coatings and paints can be used on car surfaces and marine assets, such as ships and docks, to protect metal beneath the sea from corrosion.

Moreover, Augmented Reality (AR) facilitates construction and maintenance works by minimizing accidents (e.g. accidentally damaging pipelines, electricity cables, etc.), while already existing AR software and applications allow controlling combinations of visible and invisible infrastructure elements.

Finally, during the analysis of data and the interviews of the experts some more technologies that need to be taken under consideration came up, such as the new embedded processors or the Building Information Modeling (BIM). (SKILLFUL consortium, 2017)

3. Future challenges for education

The aforementioned changes and developments in the transportation sector of Europe are expected to bring changes to the employability of the sector. They are expected to cause the alteration of many jobs (sometimes even their disappearance), as well as the emergence of various new occupations. In the light of this, the education and training sector will need to adapt rapidly

and effectively in order to insure training/education provision efficiency and to fulfil new jobs skills and competences requirements effectively. Education will constitute a pivotal role in order to properly drive new potential workers on covering the future and each emerging demand. As a result, new education schemes will become increasingly focused, not just on knowledge, but also on strategic skills that students need to get a job.

In this respect, SKILLFUL project provides a general overview of new and emerging training tools, methodologies, and schemes, which will be the most promising for the transport education provision in the near and distant future. In doing so, new and emerging training facilities were identified and analysed using the broadest possible spectrum at several levels:

- Including a wide knowledge base and relying on multiple knowledge communication channels;
- Including all user groups and areas, such as blue collar workers, white collar workers, engineers, management teams or relevant competent authorities and political boards;
- Considering all forms and levels of education;
- Exploring potential initiatives and innovation proposed by or successfully applied, not necessarily from the transport sector but with emphasis on applicability in the transport sector;
- Exploring potential initiatives and innovation in the whole European region and beyond;
- Considering potential applications to transport workforce education provision for all areas including all transport modes (maritime, rail, road and air), as well as intermodality/cross modality.

To ensure the best coverage of the topic under investigation, the methodology relied on multiple sources of knowledge, respectively:

- A wide consultation of experts – either in the field of transport or education/training or both – from all over the European continent;
- An extensive review of the recent scientific literature;
- A complementary review of literature on local and regional initiative and innovation (grey literature).

Experts were first asked to rate skills and competences importance for the different transport job categories. From this question, it appears that hard and technical skills are of particular importance for low to middle-skilled workers (i.e. blue collar and professional drivers). Of less importance but nonetheless important are language (especially mother tongue mastery), ICT skills and several soft skills such as flexibility/adaptability, proactivity and engagement and interpersonal skills. For the white-collar job profiles, mother tongue mastery, team working/management and proactivity and engagement were rated as very to extremely important while all other skills were seen as fairly important. Noticeable is the fact that technical skills specific to the

job were not seen as the most important. Considering the relative high importance dedicated to soft skills, this suggests however that experts attach higher importance to the skills necessary to an effective adaptation to a rapidly evolving workforce than to technical skills by themselves.

For researchers, engineer and manager all skills categories were rated as very important, with the exception of interpersonal skills which were rated as fairly important (but not very to extremely important) for researchers and engineers. For the decisions making job profiles (i.e. Authorities – politics), almost all skills were rated as very important with the exception of the skills that are specific to a particular job, ICT skills and innovation/creativity. This is quite consistent with the fact that while decision makers have to acquire a broad and general knowledge.

As for the improvements for specific education type/level, the improvements ‘Adding special themes modules’, ‘Wider use of new training methods’, ‘Adequate and sufficient practice training’, ‘Faster adaptation to new legislations, technologies and labour market’ and ‘Better adequation between education, job requirements and industry’ were quite consistently identified for all education type/level. The improvement ‘higher versatility, multiskilling, flexibility and knowledge transfer’ was proposed for the ‘college-university’ category but also – to a lesser extent - for VET education. Finally, the improvement ‘Bigger and more specialized offer for in-house training in company’ was proposed for in-house training. (SKILLFUL consortium, 2017)

4. Most promising existing, new and emerging training/education methodologies

The last aspect considered in research concerned the identification of the most promising training/education tools and methodologies. In total, 12 promising existing, new and emerging tools and methodologies identified by the expert panel in diminishing importance order are the following:

- E-learning (Distance/mobile/connected learning and online learning environment);
- Virtual/augmented reality;
- Gaming environment;
- Human led individualized training (e.g. executive coaching);
- Blended learning;
- Peer led/mentoring learning programme;
- Traditional lectures;
- Networked learning (e.g. social media networking);
- Smart learning technologies: personalized learning processes;
- Scenario/story based learning;
- Training on the job/experiential learning;
- Informal learning.

In the context of the review of the literature, 150 papers and reports were reviewed and analysed (112 from the scientific literature and 38 from the grey one) covering all the training tools, methodologies and schemes thought to be relevant for the SKILLFUL objectives.

Overall, the new and emerging tools and methodologies identified through the literature review were quite similar to those pointed out by the expert panel with some very few exceptions. Indeed, from the expert consultation, it appears that some standard educational tools/methods – that are not necessarily new (e.g. traditional lectures and/or human led individualized training) – are still of great importance and may still usefully be adopted in combination with more recent technologies.

The two major lessons learned from this review are on the one side the necessity to base learning on multiple resources, medias and techniques - as known as the blended learning approach - to insure learning performance and engagement into it and on the other side the necessity to place the learner as a central and active agent of his/her learning – process implicitly understood, for example, under the heutagogical, the authentic/active and/or the discovery-based learning approaches.

Blended learning may be conceived as a new way of education that depends on the use of multiple education resources (typically blended face-to-face learning with other information technology based features) which makes it a powerful approach for creating educational programs that can take into account the individual differences between students and bring different learning methods (Azhar, Mustapa, Ibrahim, & Yusoff, 2015).

Among the recognized and expected benefits of a successful blended learning approach are: increased active and authentic learning experience and performance, enhanced engagement and motivation, broader knowledge and skills (e.g. soft skills) acquisition, etc. (Canning, 2010). Finally, it is important to note that the benefits of a particular blended learning scheme will primarily depend on the components that are included into it (collaborative/peer-led components will, for example, enhance soft skills such as negotiation of communication skills).

Learner as a central and active agent of his/her learning: more and more, the pedagogical models suggest that the learnings should be conceived as active and proactive processes with a central place offered to the learner constructing his/her own learning experiences. In doing so, the learning experience is thought to be more authentic and leading to an increased learning engagement, motivation and autonomy from the learner as well as to increased performance and broader knowledge acquisition – as, for example, critical thinking, self-reflection, metacognition and soft skills (Blaschke & Hase, 2016).

Another major benefit is that it involves the learner in realistic requirements and scenario work practices that are aligned to authentic situation and hence better

prepared them for personal life accomplishment and for the workplace and to become a lifelong autonomous learner. As compared to traditional educational models – with the learner considered as a passive recipient of learning content – this implies a major revolution and an essential mental shift in the way teachers and learners roles have to be considered.

All 12 tools, methods and supportive technologies presented above are thought to serve the purpose of these two components (i.e. blended learning and placing the learner at the center of his./her learning) and to facilitate their effective implementation. However, each of these categories present benefits and drawback and cannot be seen as a panacea for meeting all learning requirements. Instead, it is the well-designed and well-thought combination of several methods – adapted to the learning content as well as to the learner needs – that ensured effectiveness.

It is important to note that the rapid developing technology will increasingly impact future workforce skills and competences development in two ways: firstly, as it exerts pressure for change because the new technologies demand a new set of skills and, secondly, as it provides opportunities for transforming pedagogy because it provides access to information, networks for communication, and new means of presenting learning (Hannon et al., 2011).

5. Trainer and trainee competences requirements

The revision of the existing, emerging and future knowledge and skills requirements of workers at all levels in the transportation sector, with emphasis on competences required by expected future changes and paradigms, was performed during the first project phase. Based on this gained knowledge, further work was aimed to structure the key specifications and components of the curricula and training schemes that will be needed to meet these competence requirements optimally, with emphasis on multidisciplinary education and training programmes. With this respect project aimed at designing novel training/education schemes of which several will be tested as pilot training courses by SKILLFUL partners.

It was also necessary to develop quality criteria - for each training scheme, both in term of trainees' competence development and of trainers' capability building in accordance to new and expected emerging trends in the transport sector as well as in the educational section (using new training tools and methodologies).

In a traditional view, teachers and trainers of transport courses are experts who have a profound knowledge of their subject. However, internationalization, multimodality and interdisciplinary, as well as increasing emerging future trends in the transport sector make it necessary that such trainers and teachers develop a broader view on transport issues and acquire more interdisciplinary competences.

For example, transport engineers tutors will increasingly need to acquire basic knowledge on traffic psychology and behavioural science while driving

instructors of professional drivers will in a near future need to acquire a better knowledge and understanding about emerging automotive technologies and about electrification aspects.

At the same time, recent progress in the education fields implies a major revolution and an essential mental shift in the way teachers and learners roles will have to be considered in the future. The role of the teacher is reinvented, no longer seen as a knowledge holder but rather as a learner partner and having at his/her disposal various powerful new educational tools and technologies for insuring the best adequacy between learning contents/settings and the learner's needs and previous experiences.

Teacher/trainer quality refers to all teacher-related characteristics that produce favourable educational outcomes. Besides these general consideration, a plethora of references and studies have considered discrete and specific components of teacher quality. These various aspects are usually categorized into three main dimensions, namely:

- **Knowledge**, including teachers' subject-specific content knowledge, subject-specific pedagogical content knowledge, and subject-unspecific psychological-pedagogical knowledge;
- **Skills**, relevant for the teaching profession as pedagogical skill, content-related practical skills, soft skills, and, of increasingly importance in the recent years, digital/ICT skills;
- **Personal dispositions** including the values, beliefs, commitments, and professional ethics that influence their behaviours toward students, families, colleagues, and communities.

Bearing in mind rapidly evolving context both in the field of transport and in the field of education, the full list of requirements for each training course/module have been recommended, utilizing a wide consultation within the Consortium Partners and with external stakeholders and experts. The list also considers expected changes in trainer competences – in short, medium and long-term future – but also expected changes regarding teaching resources and modalities.

In accordance to requirements of trainers, also the minimum requirements of trainees have been defined for each training module/scheme. As compared to the current minimum requirements, emerging relevant requirements have been detailed here also considering the emerging trends in the fields of transport and of education and highlighting the expected changes and additional needs in the future (e.g. on ICT literacy, technological knowledge background, soft skills). (SKILLFUL consortium, 2017)

6. Pilot courses

The main objective of SKILLFUL project is to design appropriate training/education modules for key actors in the Transport sector to fulfil their emerging and foresighted required competences and skills in the most

cost-efficient, modular and coordinated ways. In the context of previous steps, five types of training/educational schemes for various types of workers in all transport modes were designed to be tested as pilot training by partners as follows:

- **Transport infrastructure operators' training schemes.** Operators need new skills and competences to catch up with emerging technologies. For them life-long learning, with emphasis on new technologies, constitutes a necessity. But they typically have very little available time as they work under pressure and in tight shifts. Thus, for them webinars and other ICT-based training (and certification through web proctoring) schemes might be more appropriate;
- **Young scientists' seminars** as a joint initiative of ECTRI, FERSI and FEHRL from all Transportation sectors;
- **Lifelong training schemes** for low to middle-skilled segments of transport professionals;
- **Interdisciplinary thematic courses** on key technologies, services and trends with a cross modal dimension and/ or where important know-how can be transferred from one mode training to another one;
- **Pan-European Transport master curriculum.** A first core syllabus will be realised towards a Pan-European Transport Engineering master. This will include several modules, in accordance to the relevant future requirements. Trials of trans-national specialty courses will be tested to allow students from one country to attend courses from another university within their master degree.

In total 16 pilot courses will be tested in period 2018-2019.

Conclusions

1. All developments, relate to and affecting transportation, whether they relate to technological discoveries and developments, or to social and economic factors, directly affect also the employability, as well as the education and training needs of professionals in the transportation sector;
2. Some existing occupations are expected to change, fall dramatically or even disappear, some new professions are going to make their appearance to meet any emerging needs;
3. A number of gaps have been identified in relation to training. At the same time, a number of new training tools and technologies have also been identified;
4. The availability of technology in the education sector means that approaches using Virtual Learning Environments are now more possible: opening the potential to allow workers to retrain and up-skill. In addition, there have been a number of developments in relation to gamification and simulation which could be adopted in training for automation or in relation to cybersecurity;

5. It is expected that a number of these methodologies will be tested in the pilot training courses. The impact of these methods has not generally been quantified so pilots will offer an opportunity to test the methodologies;
6. More information on project can be found at <http://skillfulproject.eu/>

Acknowledgment

This paper is published within the implementation of the project SKILLFUL – Skills and competences development of future transportation professionals at all levels, funded under Horizon 2020 – Research and Innovation programme.



H2020-MG-2016-SingleStage-INEA – GA no. 723989.

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SKILLFUL consortium 2017 Deliverable D3.1 Proposed
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