SKILLS AND COMPETENCES DEVELOPMENT OF FUTURE TRANSPORTATION PROFESSIONALS AT ALL LEVELS (SKILLFUL)

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ABSTRACT

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. The vision of SKILLFUL (Skills and Competences Development of Future Transportation Professionals at all Levels) 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. For all the above trends, employability will be strongly connected by SKILLFUL to future transport job requirements for all transportation modes and multimodal chains (which constitute a key transport of the future trend) and for all levels/types of workers, while all training modes will be included and integrated in a balanced way. To achieve this, SKILLFUL aims to review 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.

1 INTRODUCTION

The transport industry directly employs more than 11 million people in Europe (1), accounting for 4.5% of total employment, and represents 4.6% of Gross Domestic Product (GDP). Manufacturing of transport equipment provides an additional 1.7% GDP and 1.5% employment (2). This fact, combined with the continuous technological developments and the ongoing growth of the transport sector, increases the need for continuous education, training and qualification of professionals in this sector.

Over the past few years, a growing tendency towards internationalization of qualifications has been noticed (3). While predominant mainly in areas directly exposed to international competition and cooperation, such as ICT, finances and logistics, this trend has not as yet covered the whole transportation sector, although some International Vocational Education and

Training (VET) qualifications exist or are currently being developed and several countries adapt international influences to meet their own needs and national context (4). Few international initiatives exist for the "core" initial education and vocational programmes in the field of transport. Also, in the University sector joint degrees are based on cooperation between specific Universities but few examples exist where one can speak of Europe-wide common qualifications and standards.

Vocational and academic qualifications have a direct impact on employability. Employability plays a central role in the Europe 2020 strategy, as well as in the Education and Training 2020 (ET 2020) and higher education modernization strategies. According to this benchmark, "by 2020, the share of employed graduates (20-34 year-olds) having left education and training no more than three years before the reference year should be at least 82 %" (5). In this context, the term "graduates" refers not only to those finishing higher education (HE) but also to those graduating with upper secondary or post-secondary, non-tertiary qualifications. Public authorities and higher education institutions have a major role to play in achieving this goal (6).

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 retiring 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. Transport activity is expected to grow, despite the economic recession that characterizes many European countries nowadays. This development and expansion foreseen will also probably increase the pressure on a workforce that is older than the average of the economy and where female employees represent a small minority (with the exception of air transportation for both cases) (7).

The European Commission policy stresses the role of education in equipping graduates with the knowledge, skills and competences they need, in order to succeed in occupations that are changing due to the various developments occurring in the field of transport and other that are expected to happen in the future. It also underlines the importance of involving sector organizations in the design and delivery of education programmes, ensuring that programmes include at least an element of practical work experience. Furthermore, the monitoring of graduates' career development by higher education institutions (HEIs) has also been identified as crucial in increasing the relevance of programmes (6).

So, 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 described above. At the same time, the prolonged economic crisis in Europe has seriously affected the job market characteristics across all sectors and has caused important changes to the overall number of jobs, wages and job stability. The need to adapt to all these changes and go over a more knowledge- demanding transportation sector may be considered as a barrier that needs to be overcome (7).

SKILLFUL is an European Union's Horizon 2020 funded project which aims to contribute to the above described need by critically reviewing the existing, emerging and future knowledge and skills requirements of workers at all levels in the transportation sector, with emphasis on competences required by important game changers and paradigm shifters, such as electrification and greening of transport, automation, MaaS, etc. More specifically, this paper presents the prioritization of the present and future trends of the transportation sector, in terms of affecting the sector's employability, as well as the jobs estimated to be more influenced and the new

occupations that are most probably to emerge, based on an extensive literature review of 120 relevant reports and the realization of 126 interviews from experts of different fields of the transportation sector.

2 METHODOLOGY

For the realization of the aforementioned objectives, 126 experts were interviewed (for all the sub-categories of the future transportation trends), from more than 20 different European countries, covering all Europe (namely, from South Europe: Greece, Italy, France and Spain, from Northern Europe: Sweden, Finland, from Western & Central Europe: Germany, Austria, Poland, Switzerland and Slovakia, from Eastern - Balkan countries: Romania and Bulgaria, etc.).

All participants were asked to note whether they define as important (on a scale from 1 to 5) the future changes and trends, already identified by the project, under the 4 main categories below:

- Paradigm shifters and game changers;
- New enabling technologies;
- New services and service bundles;
- Emerging business scenarios and opportunities.

3 FUTURE TRENDS IN TRANSPORT SYSTEMS AND THEIR IMPACTS ON SKILLS AND JOBS

One of the first priorities and considerations of the SKILLFUL project and the activity that will trigger and provide the guidelines for the next activities is the identification of the major actors that will affect the future of the transportation sector in Europe (and at international level too), as well as to conclude on as much accurate prediction as possible about the jobs that are going to be mostly affected, the ones that will probably be reduced or even eliminated, as well as the ones that will emerge; in order to meet future needs that will arise from the developments in the areas of technology, services, business schemes etc. in Transport.

A comprehensive analysis on existing and emerging trends in transport was undertaken in the project.

3.1 Prioritization of Paradigm Shifters and Game Changers

The most important key paradigm shifters and game changers of the Transport ecosystem of Europe was investigated and analysed, in order to get even more insight on emerging systems timeline and functionalities.

Figure 1 below depicts the ranking of the main game changers, as it emerged from the analysis of interviews of 126 transportation experts, according to the extent that each of them is estimated to affect the future transportation sector in general and its employability in particular. More particularly, it depicts their prioritization, on the basis of how important the interviews' participants have considered each of them (in percentage). The same applies to all categories described below.

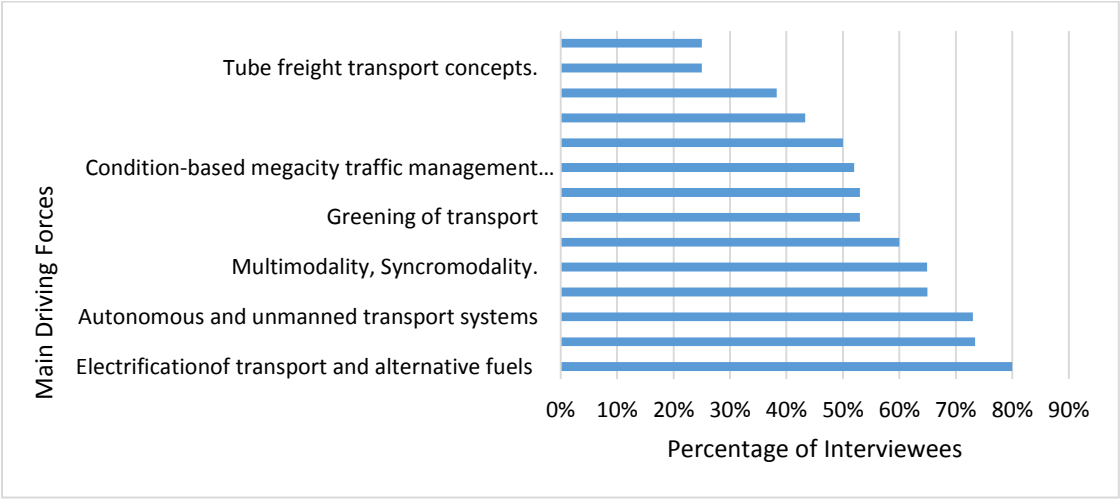

FIGURE 1 Prioritization of the paradigm shifters' and game changers' expected impact on the future Transportation system of Europe

Among the key transport trends, electrification emerged, from the interviews and literature review, 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. For rail transport electrification has been a mature technology for decades, while some development and experiments on electrified aircrafts have also been carried out, but the theme is currently not relevant on a wider scale. Transport infrastructure is also concerned; the new infrastructure should be energy efficient, able to store energy (mainly electricity), and allow the feeding of other energy users like electric cars or urban buses (8, 9).

Another main driving force of the future European transportation system is the Autonomous and Unmanned Transport Systems. 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 (i.e. methanol and ethanol) provide greening possibilities in the medium term (2030), with emphasis also on new generation inland-waterway vessels that will provide an integrated, energy-efficient, and flexible alternative to road transport.

There are many alternative fuels for road and marine transport already in the market in Europe, but neither the supply nor the demand is on a significant level. Biofuels are also considered to be very important for air transport, but only at the long term (2050). Most of the fuels are still on a prototype/testing phase. Critical technologies comprise of biofuel production technologies, qualifications (especially air transport), low-carbon technologies and emission measurements, especially of particles.

The key responsible actors for this Paradigm Shifter are EU and National level authorities, vehicle, vessel and aircraft fleet operators, consumers, bio- and fossil fuel industry, vehicle industry.

3.2 Prioritization of New Enabling Technologies

During the research and analysis that was conducted in the context of this project, the most critical emerging technologies for the transportation applications were also identified.

Figure 2 presents the ranking of such emerging technologies, according to the extent to which they will affect the future transportation sector of Europe in general and in terms of its employability in particular.

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.

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 (10). 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.

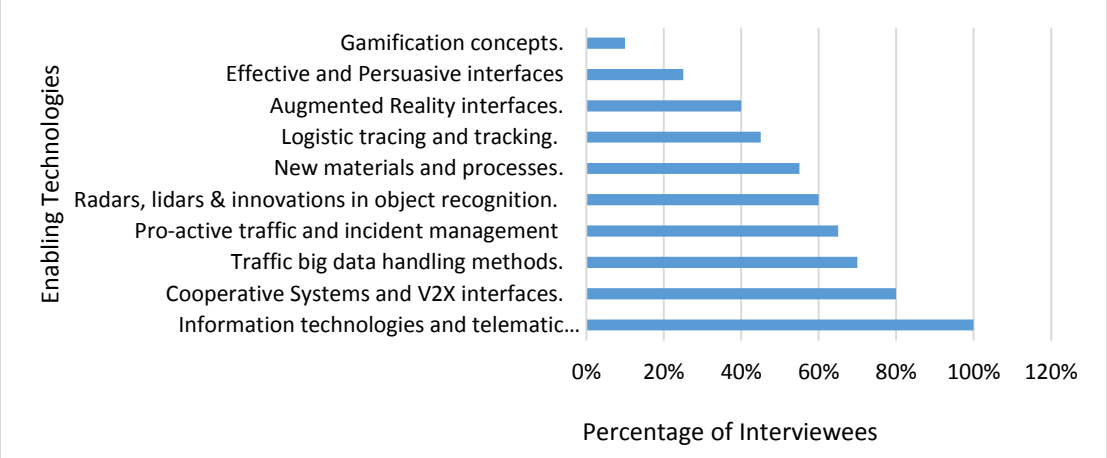

FIGURE 2 Prioritization of new enabling technologies' expected impact to the future Transportation system of Europe

Many of the current jobs and tasks requiring physical labor 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 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).

3.3 Prioritization of New Services and Service Bundles

An efficient transport system needs to be in the centre of every flourishing city. However, the majority of today's transport networks are the continuation of earlier systems, created to serve societies with different characteristics. Since then, certain driving forces have changed the way people think and thus travel. Such forces have increased the need of the society for transportation efficiency and seamlessness, which are crucial elements of the modern transportation systems.

Thus, as the Transportation sector moves steadily from products to services, emphasis has also been devoted in the identification of relevant emerging novel service concepts and bundles and to the determination of the extent to which each of these services will affect the future transportation system of Europe and in which way. The services that have been mainly examined and analysed (not exhaustively though) are the following ones:

- Mobility-as-a service (MaaS) enabling services (carpooling, car sharing, DRT and FMS schemes, etc.);
- Personalisation of services;
- Mobile services on the cloud;
- Context aware services;
- Support for on-the-fly decision making;
- Multimodal trip planners and routers;
- Payment mechanisms to facilitate easy transfers across different modes;
- Integration of social media into Public Transport;
- Novel tourism/recreational services, incorporating travel and mobility services;
- Integration of infrastructure-based and in-vehicle services.

According to the feedback provided by the interviewees, the prioritization of those major forces that will affect the job market, affecting professionals' positions in several timelines is presented in Figure 3 below.

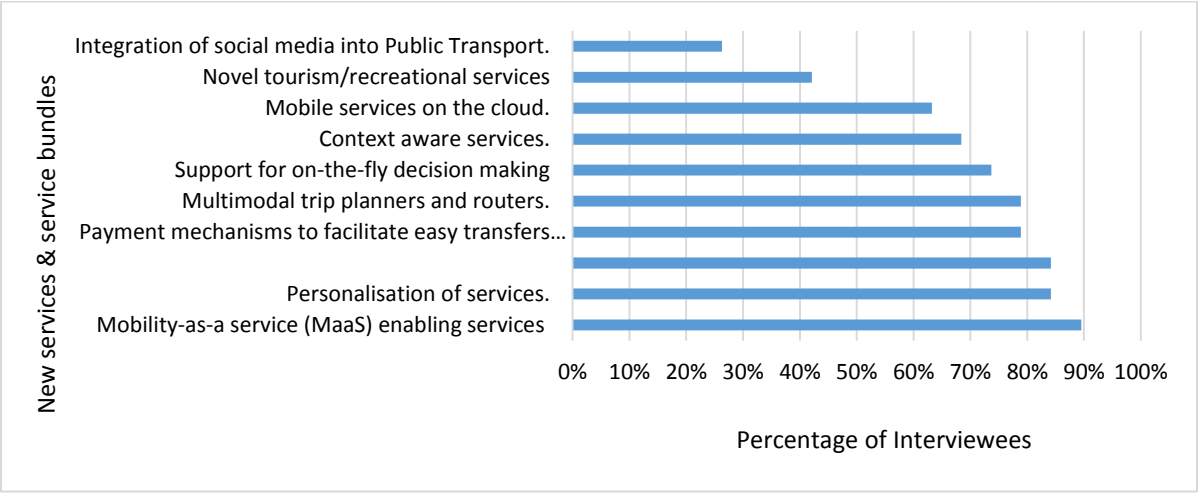

FIGURE 3 Prioritization of new services' expected impact to the future Transportation System of Europe

Additionally, some more key services have also emerged from the interviews and the literature review, as important influence forces. For example, the multimodal trip planner, which allows customers to plan their journeys in advance using an app which requires coordination between different transportation modes and is also related to the on-the-fly decision making services. This will require personnel for cross-modal applications and services planning and support.

A significant example of that is the Opticities project (http://www.opticities.com/) which aims to integrate multimodal data from public and private transport operators, as well as other mobility data from different sources in a unique platform that allows a common use of the information, as well as sharing of data with third parties' usage. Another example is the MaaS-London, which is an integrated platform that includes registration and package selection, intermodal journey planning, booking, smart ticketing and payment functions so that the entire chain of transport can be managed in this centralised platform (11).

The trend toward car sharing should nonetheless make automotive OEMs consider reconceiving their mission, at least in part. While continuing to serve as manufacturers and distributors of personally owned vehicles, OEMs should also experiment with providing mobility services and devise new business models accordingly. By 2021, 35 million users will book 1.5 billion minutes of driving time each month and generate annual revenues of €4.7 billion. Europe will be the biggest revenue-generating region, followed by Asia-Pacific and North America. The UbiGo transport broker service developed in Gothenburg, Sweden, is very interesting in this field. The service offers easy, flexible, reliable, priceworthy everyday travel, without having to own a car (or a 2nd car). UbiGo positions itself against car ownership, not against car use per se. Findings suggest that potential early users (innovators/early adopters) are initially motivated by curiosity, but that this must be transformed intopractical motivations such as convenience and economic advantage if the users are to remain motivated to using the service.

Rolling stock on-board energy storing as a way of removing the pantograph/catenary interaction, requires new capabilities in power electronics and autonomous driving, calling for specialization of the workforce, which will experience a shift from performing tasks on the field to monitoring machines doing those same tasks.

Autonomous driving could also be integrated in the definition of new services like for example for goods delivery: the car could go alone to pick up all the items you have ordered by internet while being at work or while attending an appointment.

The driver training process will be also impacted: the learning of theory should be more and more done with web based systems with self-learning process and the practical training courses should also integrate the new functions of connected and autonomous vehicles. Driving schools will need to adapt themselves to this and propose new services like specific training, after driving training.

3.4 Prioritization of Emerging Business Scenarios and Opportunities

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 that changed the home furniture area some decades ago and are now migrating to the choice of vehicle and infomobility services sectors;
- 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;
- "Feel safe, feel secure";
- Transport workforce flexicurity;
- Fuel availability schemes that offer energy for transport vehicles available at the specific time and the distinct localization.

The prioritization of these new business schemes, together with some additional ones that occurred during the analysis, based on the impact each one of them will have on the jobs of the transportation sector, is presented in Figure 4 below.

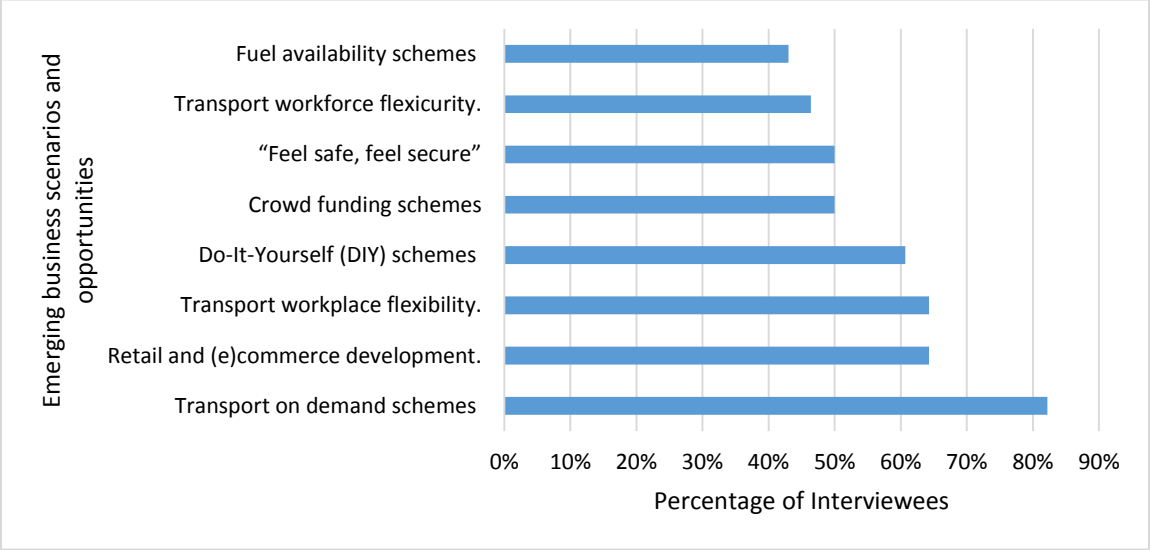

FIGURE 4 Prioritization of new business schemes' expected impact to the future Transportation system of Europe

As can be also seen in the graph above, a new concept in the general area of employability is presented and this the flexicurity of the workforce. Flexicurity is an integrated strategy for enhancing, at the same time, flexibility and security in the labour market. It attempts to conciliate employers' need for a flexible workforce with the need for security and the confidence that they will not face long periods of unemployment. The EC has already taken various actions and has identified a set of common flexicurity principles, exploring how countries can implement them through four components:

- flexible and reliable contractual arrangements;
- comprehensive lifelong learning strategies;
- effective active labour market policies;
- modern social security systems (12).

The flexicurity scheme definitely also applies and is necessary for the proper staffing of the European transportation sector. However, this approach can be proved to be quite complex and requires for a certain structure to the education and on-the-job training systems (13), issue that is undertaken by the SKILLFUL project.

4 CONCLUSIONS

The changes that will occur in the transportation sector are inevitable given the way and the speed at which things are evolving, not only in the transportation field, but in general.

All these developments related 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.

Novel transport market driving forces (such as electrification, development of alternative fuels, autonomous driving digitalization, circular economy & recycling and industry 4.0, etc.), new technological advancement or further evolution of already existing technologies (such as the evolution of information technologies and telematic applications, the AR, the AI, Cooperative Systems, V2X interfaces and RES etc.), new business schemes that accompany them (such as Transport on demand schemes, DIY schemes, retails and e-commerce development, added value services in automated vehicles, reduced lifetime of cars/ vehicles due to heavier use through MaaS etc.), as well as the emergence and promotion of new transportation services (such as MaaS new payment mechanisms, personalization of services, etc.) are expected to change the working ecosystem of transport and with it the sphere of professional jobs and occupations within it.

The results presented in this paper are part of the first step of the SKILLFUL project, namely "Identification of Future Trends/ Needs & Best Practices. This will lead to the identification of future trends and the impact on jobs that are likely to affect the European Transportation system, as well as the identification of existing and/ or emerging relevant training methodologies and approaches. The other steps of the project are the following:

- Step 2: Development of Training Schemes & Definition of Profiles and Competences
- Step 3: Verification and Optimization of training schemes
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