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Implementation Of The European Qualifications Framework In The Rail Higher Education

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***Abstract*—Rail transport is the most emissions-efficient major mode of transport. Electric trains powered by renewable energy can offer practically carbon-free journeys and transport. Rail contributes with less than 1,5 % in 2015 on the EU transport sector`s total CO2 emissions even though it accounts for over 8,5 % of the total market volume. Development of environmentally friendly rail transport is one of the real challenges for the higher education. This article point out the role of the rail higher education in the circular economy and the necessity to create global educational programs with partnership with business.**

Keywords—rail, transport, higher education, business, environmental friendly.

I. INTRODUCTION

A well-running transport infrastructure is essential to maintaining the European Union's competitiveness and wealth. Its 28 Member States currently have five million km of paved roads, more than 215,000 km of rail lines and 41,000 km of navigable inland waterways.

The Roadmap to a Single European Transport Area present ten goals for a competitive and resource efficient transport system. Implementing the above vision requires an efficient framework for transport users and operators, an early deployment of new technologies, the development of adequate infrastructure and training specialists with higher education.

In this article an analysis of options for implementing the European Qualifications Framework for Higher Education of railway engineers is proposed..

II. EUROPEAN QUALIFICATION FRAMEWORK

Higher Education contributed substantially to building a low-carbon and resource efficient circular economy. Education and training therefore make a substantial contribution to several EU strategies and initiatives, including the Europe 2020 and Roadmap 2050. For this purpose it is necessary to possess certain competencies defined in the European Qualification Framewok as follows:

- Qualification: a formal outcome of an assessment and validation process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards.
- Learning outcomes: statements of what a learner knows, understands and is able to do on completion of a learning process.
- Knowledge: the outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of work or study. In the context of the European Qualifications Framework, knowledge is described as theoretical and/or factual.
- Skills: the ability to apply knowledge and use know-how to complete tasks and solve problems. In the context of the European Qualifications Framework, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments).

The descriptors defining levels in the European Qualifications Framework (EQF) for the European Higher education are presented in the table 1.

Priority areas for European cooperation in education and training are [6]:

- Relevant and high-quality skills and competences, focusing on learning outcomes, for employability, innovation and active citizenship.
- Inclusive education, equality, non-discrimination and promotion of civic competences.
- Open and innovative education and training, including by fully embracing the digital era.
- Strong support for educators.
- Transparency and recognition of skills and qualifications to facilitate learning and labour mobility.
- Sustainable investment, performance and efficiency of education and training systems.

Quality assurance principles for qualifications referenced to the European Qualifications Framework are as follows [6]:

- addresse the design of qualifications as well as application of the learning outcomes approach;
- addresse the process of certification, ensuring valid and reliable assessment according to agreed and transparent learning outcomes based standards;

TABLE I. DESCRIPTORS FOR THE THIRD CYCLE IN THE FRAMEWORK FOR QUALIFICATIONS OF THE EUROPEAN HIGHER EDUCATION AREA (EQF)

EQF Level	Knowledge	Skills	Competence
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups
Level 7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts including research

- consist of feedback mechanisms and procedures for continuous improvement;
- involve all relevant stakeholders at all stages of the process;
- are composed of consistent evaluation methods, associating self-assessment and external review;
- are an integral part of the internal management, including sub-contracted activities, of bodies issuing qualifications referenced to the EQF;
- is based on clear and measurable objectives, standards and guidelines;
- are supported by appropriate resources;
- include a systematic and cyclical evaluation by external monitoring bodies, based on at least the principles in this annex of internal quality assurance systems related to qualifications;
- include the publication of its evaluation results, including electronic accessibility at national and European level.

III. RAILWAY HIGHER EDUCATION

Teaching railway engineering differs from teaching many other fields of technology. This is caused by the fact that in a railway system all fields of engineering are interconnected and as a result teaching railway science must follow an interdisciplinary approach. In addition, while railroad research and teaching railway science are academic, the railroads are a field of practical application [2].

The Roadmap to a Single European Transport Area optimising the performance of multimodal logistic chains, including by making greater use of more energy-efficient modes, envisages:

- 30% of road freight over 300 km should shift to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050, facilitated by efficient and green freight corridors. To meet this goal will also require appropriate infrastructure to be developed.
- By 2050, a European high-speed rail network has to be comleted. The length of the existing high-speed rail network by 2030 has to be tripled and a dense railway network in all Member States maintained. By 2050 the majority of medium-distance passenger transport should go by rail.
- A fully functional and EU-wide multimodal TEN-T ‘core network’ should be available by 2030, with a high quality and capacity network by 2050 and a corresponding set of information services.
- By 2050, all core network airports should be connected to the rail network, preferably high-speed; ensure that all core seaports are sufficiently connected to the rail freight and, where possible, inland waterway system.

The research on rail higher education indicates that [2]:

- The largest number of university railway programs is found in the German-speaking part of Europe where for more than 100 years railway engineering has been a regular part of the curriculum in civil engineering and transportation engineering. About 45% of the railway courses in the E.U. are offered in the German-speaking part of Europe.
- In some Western European countries, specific university education in railways is rare. One of this is University of transport "Todor Kableshkov", Sofia, Bulgaria. While research work is being undertaken in rail transportation, course work in railways has not been common.
- While the total number of university railway programs in East European countries is quite low, the existing programs are very comprehensive with an impressive number of courses offerings.
- Both the number of enrolled students and the number of teaching staff involved in railway education is much greater than in any Western European country.

The subjects, covered in E.U. Railway courses are presented on figure 1. The leading teaching subject in European railway education is railway infrastructure, with a share of almost one-third of all courses. It is followed by railway operation and rolling stock issues. The percentages between topic areas represent the total of all courses, but not necessarily the typical structure of an individual rail program. However, it does provide a good picture of the relevance of different teaching subjects in Europe. The share of teaching subjects in an individual railway program depends on whether the program is more infrastructure or rolling stock-oriented. In infrastructure-oriented programs, there are also differences between programs that are more construction related and programs that concentrate more on operation and signalling.

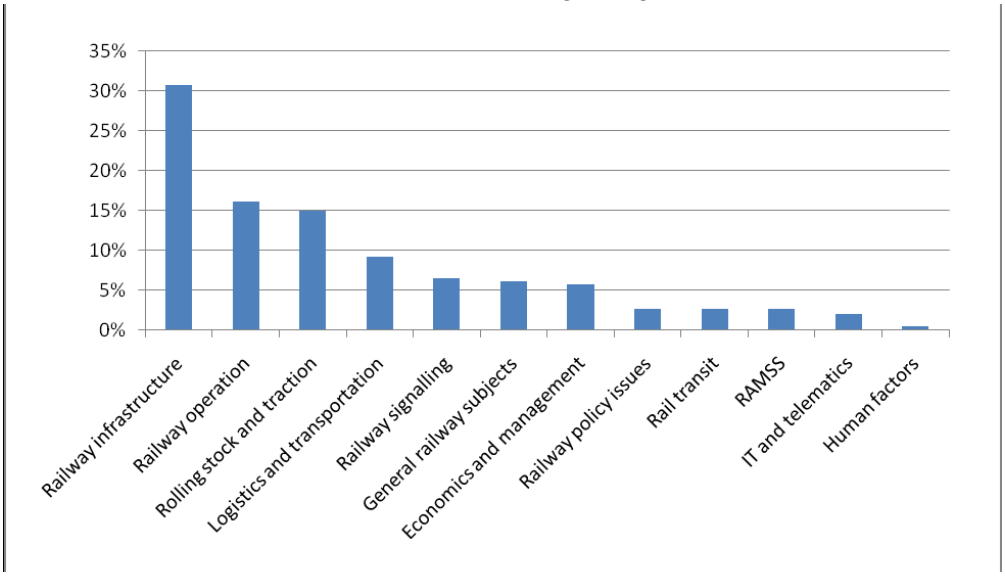

Fig. 1. *Subjects Covered in E.U. Railway Courses [2].*

In the course of the last century, the role of universities has shifted from a simple repository of knowledge somewhat detached from real world towards a central positioning in countries' success and societies' development. With more or less enthusiasm universities have been embracing this new role. Important benefits and synergies may accrue for both universities and industries from their interactions. The benefits to universities are:

- Placement and sourcing of students - deeper university-industry interactions create good opportunities for student internships that could easily result in permanent jobs after graduation. The rail industry can also be a valuable source of students for graduate or other courses and thus feed universities' classrooms. On the other hand, graduates with rail exposure during their studies are better prepared to contribute to the company immediately upon hiring and possess higher potential to remain with the employer.
- Insight into industry needs - universities get a better understanding on the actual requirements and demands placed by the industry that could encourage improvements to the curricula and identify new research opportunities.
- Research and continuing education opportunities for faculty - industry's problems and challenges are an endless source of new research opportunities and collaboration projects tend to be more beneficial and valuable for both parties.

The benefits to industry are:

- Customised education and training - universities can provide customised courses (or workshops) at special fees.
- Influence on academic programs - industry may comment and advise on the curricula and course content so that it better meets their needs.

- Access to new knowledge - a strong interaction with universities may open the door to industries to access new technologies, models, techniques, materials, or processes, etc. before other competitors

- New revenue sources – industries may develop new products and markets based on academic research outputs. In addition, universities may leverage industry to access certain types of funding.

Challenge to the implementation of the European Qualifications Framework in the rail higher education are many. Several reasons can be identified that contribute to the difficulties [3]:

- University-industry interaction is not included in university's promotion and rewarding schemes.

- Heavy teaching loads do not leave time for engagement in university-industry interactions.

- University career development does not require interaction with industry and many faculty staff have never held a position outside of the university environment.

- University research is valued in terms of publication record and not on their practical nature for industry application.

- University research timing is not suitable for the industry's rhythm. University develops research on long term cycles and expectations, whereas industry's goals are short term oriented.

- Economies are highly volatile and dynamical, and industries are always exploring and introducing new services and products. This economic paradigm requires permanently new knowledge, skills and, ultimately, competences; and both new and experienced employees are expected to keep up to date with such evolutions and requirements.

As the rail transportation industry involves several disciplinary and it is more globally focused, the educational programs must also provide a global or international focus. According to Alan Parkinson, students with global competence should be equipped with a wide set of abilities [3]. The most important abilities include:

- appreciation to other cultures;

- proficiency in working in or in directing a team of ethnic and cultural diversity;

- ability to communicate across cultures;

- effective dealing with ethical issues arising from cultural or national differences;

- engineering practice in a global context, whether through an international internship, a service-learning opportunity, a virtual global engineering project or some other form of experience.

To prepare the students with these abilities, emphasis should be placed on three areas of education:

- foreign culture appreciation and understanding;

- communicating in foreign language; and

- real-world practice in a global context.

Global competence refers to the knowledge, skills, and dispositions necessary to navigate and succeed in today's interconnected world. Globally competent individuals are life-long learners, have an appreciation for cultural differences, an ability to understand and consider multiple perspectives, critical and comparative thinking skills, problem solving abilities, comfort with ambiguity and change, and understand globally significant issues.

IV. Conclusions

- When composing train schedules energy consumption for traction has to be taken into account. In this way considerable energy savings can be obtained.

- To build a well-functioning European Transport Area with a competitive and resource efficient transport system is necessery to develop a global competence framework for raiway ingeneers and for ingeneers in oder mode of transport.

- It is recommended the universities to establish strong interactions and synergies with industry to decrease the competence gap between them.

- Standardized programs for railway engineering education for both conventional and high-speed rail transport have to be elaborated..

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