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A EUROPEAN PERSPECTIVE ON CIRCULAR ECONOMY FOR FIBROUS COMPOSITES AND TECHNICAL TEXTILES

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Abstract: *This paper presents aspects on circular economy of fibrous composites and technical textiles, in the framework of the Erasmus+ project CircuTex, under reference number 2021-1-ES01-KA220-HED-000032075. The project envisages the following results: 1) An e-learning course on circular economy of fibrous composites and technical textiles will be addressed to HEI students and aims to develop the skills in circular economy practices concentrated in fibrous composites and technical textiles. 2) A virtual laboratory for the implementation of virtual experiments was built, to test and apply experiments related to the circular economy of fibrous composites and technical textiles. The laboratory includes virtual "digital twins" of actual laboratory equipment, enhanced with 3D representations and virtual movement. Students will be able to access the virtual laboratory online through their virtual reality glasses. 3) A roadmap to microcredentials created to work on a quality assurance framework for the elearning course and a methodology to apply ECTS points to the course. Actions for the validation of the course and the issuing of digital certificates with the potential to be included in the new European-wide digital format of "Europass Digital Credentials" will be taken.*

Key words: *Erasmus+, CircuTex, technical textiles, fibrous composites, e-learning course, virtual laboratory, microcredentials*

1. INTRODUCTION

High levels of resources, e.g., water, energy, chemicals, raw materials and fibers are used in the textile industry. Sustainable sourcing of fibers, sustainable production technologies, waste and quality control, etc. are becoming important factors for textile companies in terms of sustainability and circular economy, but they must learn continuously to be able to update their expertise on these issues [1].

The circular economy action plan, promoting waste reduction, empowering consumers, and pushing more environmentally friendly product design, such as by establishing a right to repair was presented by the European Commission in March 2020 [2]. The focus of attention is on the industries that use a lot of resources, such as electronics and ICT, plastics, textiles, and building.

A resolution on the new circular economy action plan was adopted by the Parliament in February 2021. It called for additional steps to be taken, such as stricter recycling regulations and binding targets for material use and consumption by 2030 [3], in order to establish a fully toxic-free, environmentally conscious, and carbon-neutral circular economy by 2050. As part of the circular economy action plan, the Commission published the first set of measures in March 2022 to hasten the transition to a circular economy. Improving sustainable products, educating consumers about being green, and looking over building product regulations, and developing a sustainable textiles strategy are some of the proposals.

Created for functionality rather than for aesthetics, technical textiles serve as a raw material for a variety of industries, including the automotive, geotextile, medical device, and agro-food sectors [4]. Technical textile materials are used in specific industrial applications (earthworks, construction, civil engineering, transport, defense, medical, and healthcare) and have a high level of physical, mechanical, thermal, and/or chemical properties.

Textile reinforcements combined with a binding matrix (typically polymeric) create textile composites, which represent a family of materials used in numerous industrial sectors for load-bearing applications. The word "textile" in this context refers to a knitted structure made of yarns, as well as to fibers, filaments, yarns, and the vast majority of items made from them [5]. Textile composites contain a variety of textile structures, including braids, weaves, knits, and nonwoven fabrics.

Technical textiles are ubiquitous in our daily lives and can be found in a variety of settings, including our homes, hospitals, sportswear, cars, and farms. Technical textiles are a practical option for many applications thanks to technology and contemporary materials. However, there are also detrimental social and environmental effects of the industry. The textile industry uses a variety of dangerous chemicals, contributes about one-fifth of the world's industrial water pollution, and produces an important amount of greenhouse gas emissions, especially during the manufacturing and finishing processes [6]. Technical textiles, which have seen rapid growth in recent years, have received much less attention than has been documented. Businesses, consumers, and the environment have all benefited from opportunities for sustainable production. With regard to textile materials in particular, innovation may lead to circular solutions.

2. CIRCUTEX ERASMUS+ PROJECT - MATERIALS AND METHODS

The EU has emphasized the significance of the shift towards a circular economy; consequently, the European Commission adopted the Circular Economy Package, giving industries specific deadlines to meet very precise targets regarding the same. The creation of a micro-credential approach is also a top priority for the EC in order to strengthen the role of higher education institutions in lifelong learning by facilitating more flexible and modular learning opportunities.

The European Erasmus+ project CircuTex has a consortium of 5 European partners (4 universities and 1 Greek company dedicated to learning) being implemented within 2 years starting from March 2022:

- UPV - University Polytechnic of Valencia, from Spain
- KTU - Kaunas University of Technology, from Lithuania
- UNIWA - University of Western Attica, from Greece
- UO - University of Oradea, from Romania
- IDEC - a consulting company, from Greece

The project's goal is to create an online course on the circular economy for technical textiles and fiber composites to assist students in developing their sustainability skills and increasing their awareness of how to lessen the environmental impact of these materials. Additionally, the project

will strengthen the training by building a virtual laboratory that will give students the feel of being present in a real lab. A road map for course validation and accreditation will also be developed as part of the project, and this will produce a set of policy recommendations for the adoption and recognition of micro-credentials in the universities of the project partners.

3. RESULTS

The partners were involved in all planned activities, having various tasks, and the activities within the consortium have been distributed based on their previous work experiences as well as their expressed interest. Even after the project is finished, the activities will be carried out to achieve the project results and achieve the project objective.

3.1. IO1. E-learning course on circular economy of fibrous composites and technical textiles

The project's first output was the creation of a 5-module e-learning course titled "Circular Economy of Fibrous Composites and Technical Textiles," as shown in figure 1.

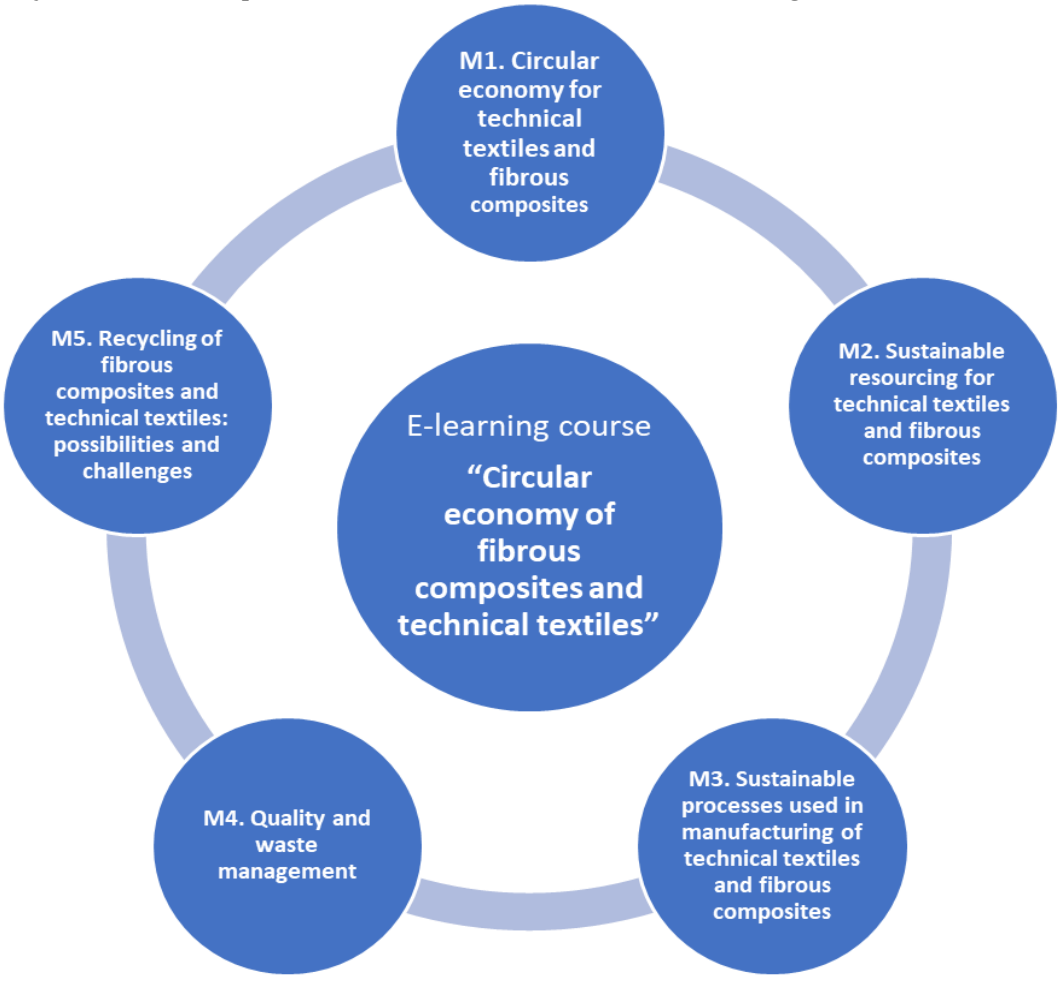

Fig. 1: The modules of the e-learning course

In this way, the project will aid in promoting awareness of the environmental difficulties associated with the use of technical textiles and fibrous composites in the textile industry, as well as their impact on climate change.

The CircuTex project aims to address the need for specialized training on the circular economy for fibrous composite materials and technical textiles by integrating circularity into the curricula of the partner universities. To achieve this, it will develop and deliver and an online course to help students of textile engineering and related degrees develop management and innovation tasks related to the circular economy and the sustainable growth of textile industry companies. The course's goal is to help HEI students become more proficient at using circular economy and sustainability practices in the creation, manufacture, use, and recycling of fibrous composites and technical textiles. The project is anticipated to improve educators' sustainability competencies as well as those of the students who will be taking the course. The e-learning program will also be based on learning outcomes, better meeting the needs of students enrolled in textile-related programs at the participating universities. The e-learning course will use online assessment tools to determine whether students have met the learning objectives. It will last for one semester and be a supplement to the students' fundamental studies. The students will improve their comprehension of how to apply sustainability measures to fibrous components and technical textiles.

3.2. Virtual laboratory for the implementation of virtual experiments

A virtual laboratory will be created for the second intellectual output and added to the online course. The virtual laboratory's specifications and graphic designs, as well as the experiments that will make up the course material, have already been developed (see figure 2)

Fig. 2. Virtual laboratory

Through the virtual laboratory, participants in the online course will be able to test and implement experiments related to the circular economy of fibrous composite materials and technical textiles.

The lab will have virtual reproductions of real lab equipment that have been developed with 3D renderings and motion. Furthermore, workshops will be held at the universities of the project partners, giving students the chance to use virtual reality technology to enter the virtual laboratories. Students will be able to conduct virtual experiments through the lab, without having to be physically present in a real laboratory. They will use their virtual reality glasses devices to access the online virtual lab.

3.3. Roadmap to microcredentials

The roadmap for micro-credentials is the third output. We will develop policy recommendations for the introduction of microcredentials in partner universities. It will be developed a methodology for applying ECTS points to the online course. The partners will make efforts to validate the course and issue digital certificates that may be included in the new digital "Europass Digital Credentials" format at the European level. Finally, partners will offer a set of policy recommendations in support of the European approach to micro-credentials.

4. CONCLUSIONS

The most prevalent production model in today's textile industry utilizes resources to create products that are used and then thrown away. This model is unsustainable and has a negative impact on climate change and biodiversity, putting the world in danger. Due to the very low percentage of separate collection and recycling of textile products, the majority of them are disposed of in landfills. Europe has created an action plan for a circular economy that includes the textile industry. Professionals in the textile industry need specialized training in the circular economy in order to acknowledge the use and end-of-life phases of a textile product.

It is essential that future graduates enhance and expand their knowledge of sustainability and circular economy through learning and training. Therefore, technical textiles and fiber-based composite products will be more sustainable and under a circular model, able to be reused and recycled in an efficient and environmentally friendly way.

CiruTex project will improve the target groups' competencies in recycling methods for technical textiles and fibrous components as well as circular economy. - The circular economy concept will gain students' interest and attention by incorporating the topic of recycling fibrous components and technical textiles into laboratory activities. This will also encourage their active participation in the solution of environmental problems.

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