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Tailored Training for Building Resilience in Changing Climate: BeWare Project's Approach

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Abstract

The objective of the ERASMUS+ funded BeWare project is to provide education and training for professionals in the construction sector, aligning with the requirements of the European Green Deal. This initiative aims to enhance the resilience of buildings to climate change and extreme weather events, while fostering knowledge, innovation, and value addition in the construction industry. The project's core is the Vocational Education and Training (VET) program, tailored for evolving job market demands.
Benchmarking was conducted to evaluate emerging trends and professional requirements within the BeWare VET program. The main conclusions from the results are as follows: 1) The majority of the 63 analyzed syllabi focus on "sustainable buildings" and "energy," with less attention given to climate resilience and climate change mitigation; 2) the scarcity of training programs addressing these issues underscores the critical need to prioritize building resilience in the face of climate change and extreme weather events; 3) In the context of Construction Industry 4.0, BIM takes a central role, expanding the use of digitized data beyond traditional 2D modeling and; 4) Sustainable building gains momentum, with an emphasis on materials, life cycle assessment, circularity, sustainable development, environmental sustainability, and certification integrated into VET course curricula.

Keywords: Vocational Education and Training; Climate resilience; Climate change; Sustainability.

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1. Introduction

As the climate crisis continues to intensify, there has been a resurgence of interest in the role of Vocational Education and Training (VET) in fostering a greener economy and attaining decarbonization objectives (McGrath and Yamada, 2023). The importance of VET in addressing the climate crisis is emphasized by the European Commission, which notes that the construction sector, a vital component of the European economy, contributes approximately 9% to the Gross Domestic Product (GDP) of the European Union and provides employment for approximately 18 million individuals (European Union, 2016). Realizing innovation within the construction industry is intrinsically linked to the adoption of green and sustainable technologies, as well as embracing digitalization. These advancements are vital in creating a more sustainable, resilient, and inclusive Europe (European Commission, 2020). Despite the growing interest and recognition of the significance of green innovations, the current body of literature underscores a distinct gap in our comprehension of the requisite skills necessary for the effective integration of such innovations (Shamzzuzoha et al., 2022). Addressing this knowledge gap is important to ensure that the construction sector is adequately prepared to contribute to a more sustainable future.

The 2021-2024 BeWare project (http://bewareproject.com/), funded by ERASMUS+, is a two-year and two months initiative aimed at enhancing the skills of professionals in the field of Resilience and Sustainability of Buildings in relation to climate change and extreme weather events. This project recognizes the urgent need to equip professionals in the construction industry with the necessary knowledge and expertise to address the challenges posed by climate change and extreme climate. One of the main components of the BeWare project is the Vocational Education and Training (VET) program, designed to prepare professionals to meet the demands of the evolving job market (Mendes et al., 2022). The program encompasses six comprehensive modules, namely: Ecodesign and Social Needs, Insulation Materials, Nature-based and Waste-based Solutions, Energy Efficiency and Economic Assessment, Digitalization in Construction, and Risk Assessment. The methodology presented is guided by a comprehensive analysis of emerging trends and professional needs, with the following key objectives:

i) Make sure that the content of the syllabi aligns with the current and future job market demands.
ii) Contribute to the development of the BeWare VET syllabi.
iii) Identify the major issues addressed by the VET courses within the scope of BeWare VET program.
iv) Define gaps in subject matter content.
v) Integrate sustainability and resilience concepts throughout the syllabi.

The results and analysis obtained mirror the content of 63 courses across 14 European countries, enabling the identification of the primary issues related to VET course trends, with "sustainable buildings" and "energy" emerging as the most prominent topics.

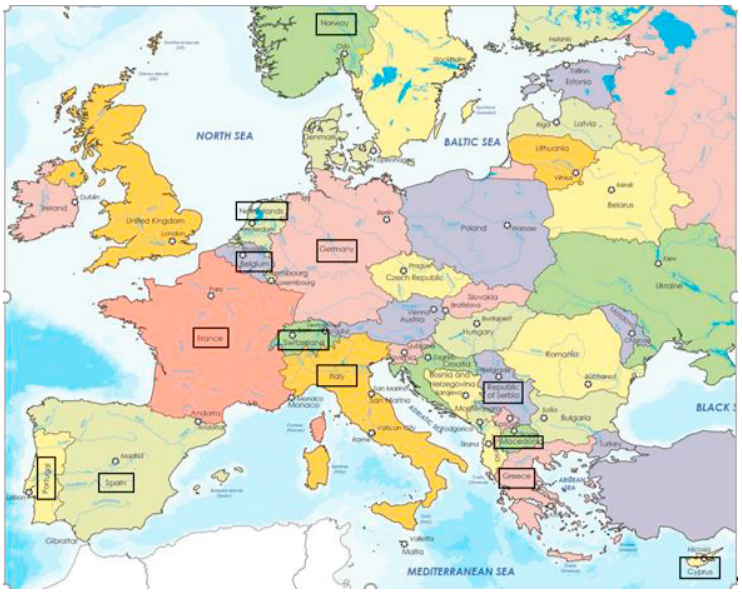
2. Methodology

To gather a broader sample of Vocational Education and Training (VET) offerings across Europe, we initially collected information on seventy-three courses from 14 European countries in 2022. This initial selection aimed to encompass countries with varying socioeconomic conditions and climate types, as illustrated in Figure 1. The criteria employed during the web search for VET courses and their respective syllabi included:

i) VET training programs tailored for a wide range of professionals, including specialized planners, project and civil engineers, architects, auditors for quality standards, company and facility managers, directors of production departments involved in maintenance, owners and managers of micro, small, and medium enterprises, mechanical engineers, as well as public or private contracting authorities.
ii) Courses that provide certification, with durations spanning from 1 hour to one year.
iii) Keyword searches that encompassed terms such as efficiency, sustainability, climate, green, and renovation.
iv) The compilation of data from a diverse array of European courses.

Additional information was gathered to provide characterization of the analyzed courses, including details on their types, delivery methods, providers, cost, and certification options. To facilitate the organization of the course program construction database, all topics were classified into four major categories: "Energy", "Building Information Model (BIM)", "Sustainable Buildings", and "Climate Resilience of Buildings". This classification took into account the

frequency of topics discussed within the courses and their alignment with BeWare aim. After this initial classification, subjects from different courses were grouped into themes based on their similarities in content. This meticulous analysis helped identify trends and shed light on the course content in specific subject areas.



a)

Country	Nº of courses
Belgium	4
Croatia	5
Cyprus	3
France	12
Germany	4
Greece	3
Italy	3
Netherlands	7
North Macedonia	10
Norway	2
Portugal	6
Serbia	7
Spain	7

Figure 1 – a) Geographic location of the countries consulted for the analysis of the courses and b) number of the courses analyzed by country.

3. Results

The majority of the analyzed courses fall into the category of VET, accounting for 92.0% of the total. These courses are typically offered either online (46.5%) or in person (36.6%), and they often employ a hands-on approach (44.4%). The institutions responsible for providing these courses are predominantly private organizations (36.0%) or universities (34.7%). Around 29% of the courses are offered free of charge, and for those courses with durations of 20 hours or less, the average fee is approximately 25 euros per hour. The vast majority of these compiled courses (93.4%) provide certification, which can take the form of either a certificate attesting to the successful completion of the course for trainees who have met the prescribed evaluation criteria, or a certificate confirming attendance for trainees who have not met the evaluation criteria. A noteworthy online course, "Energy Performance of Buildings and NZEB" (Portugal), has undergone 11 re-editions, indicating its popularity. This is followed by "BIM for manufacturers and companies" (North of Macedonia) and "BIM for builders and contractors" (North of Macedonia), both online courses, each having undergone five editions.

Out of the initial consultation of 73 courses, 63 online courses had accessible syllabi information or were VET. As a result, 63 course syllabi were further analyzed. In the analysis of modules from the 29 energy-related courses, the term “design” emerged as the most frequently mentioned concept. Additionally, words like “heat”, “neutral”, “renovation” and “bioclimatic” held significance (see Figure 2a).

In the context of the fourteen online VET courses focused on Building Information Modeling (BIM), common terms within the course content included “introduction”, “information”, “model”, “project”, “interoperability”, “application”, and “management” (see Figure 2b).

A total of sixteen courses were dedicated to the topic of “Sustainable buildings”, featuring frequently used terms such as “energy”, “construction”, “architecture”, “life cycle” and “materials” (see Figure 2c).

Regarding the four courses centered on climate resilience, the most frequently used words in the course content included “building/buildings”, “sustainable”, “considerations”, “action”, “climatic”, and “comfort”, as depicted in Figure 2d.

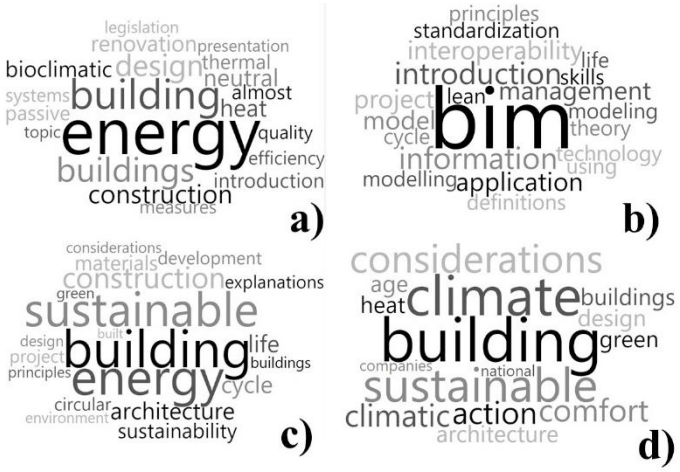


Figure 2 – World cloud of the modules a) of the 29 courses related to Energy; b) of the 14 courses related to BIM; c) of the 16 courses related to Sustainable building; d) of the four courses related to climate resilience.

After this initial screening, a more in-depth evaluation was conducted to classify the 63 VET courses into common categories. This classification was determined based on expert knowledge.

In the context of energy-related issues, the primary topics covered in these consulted courses were categorized into four overarching families. The first category, "Legal Requirements and Current Legislation," covers crucial topics such as energy efficiency standards, performance requirements for new and renovated buildings, nearly zero energy buildings (NZEB), and the foundational principles of energy-neutral and passive building design, with an emphasis on ecological and comfort considerations. The second category, "Evaluation of Energy Performance," explores various aspects, including international protocols for measuring and verifying energy savings, parameters related to heat losses and gains, energy and bioclimatic assessments, calculation methods for energy demands, and the utilization of software tools for energy efficiency. The third category, "Design and Planning" delves into the integration of bioclimatic energy principles into spatial, urban, and environmental planning, offering insights into ecological building and design. Additionally, it covers the design of outdoor spaces and the incorporation of renewable energy sources while considering the behavior of building occupants. Lastly, the "Elements" category examines ventilation methods (natural, hybrid, and mechanical) and the significance of insulation materials in energy-efficient building practices. This structured categorization enhances the understanding and application of energy-related concepts, with a focus on sustainability, efficiency, and environmental considerations.

The courses related to Building Information Model (BIM) have been structured into six distinct themes. The first theme, "Introduction to BIM" provides a comprehensive foundation, covering sustainability in construction, basic principles of BIM, technology and interoperability, and key principles of BIM Level 2, among other topics. The second theme, "BIM Standardization" focuses on the standardization of object libraries and open standards. The third theme, "Design" examines architectural and structural elements, dimensioning of facilities, BIM in design and pre-construction phases, and execution and post-construction workflows. The fourth theme, "Software" explores various BIM production tools and their applications in construction. The fifth theme, "BIM Dimensions" addresses temporal and economic planning, cost control, sustainability analysis, and facility management. Finally, the sixth theme, "The Role of BIM in Construction 4.0" discusses the digitalization of assets, augmented and virtual realities, prefabrication, and various applications of BIM in the modern construction industry. This systematic organization equips learners

with a comprehensive understanding of BIM's principles and applications across the construction lifecycle, from design to construction and beyond.

Notably, courses related to "BIM" and "Green Buildings" addressed topics related to climate dimensions, given the increasing use of BIM for energy design and energy management of buildings. Green buildings, in particular, are oriented toward achieving a circular and carbon-neutral economy.

The courses pertaining to "sustainable building" have been organized into six key themes. In the first theme, "Introduction to Sustainable Buildings" trainees are introduced to the basics of sustainable construction and development, emphasizing the economic, social, and environmental aspects of sustainability. The second theme, "Materials" examines the selection criteria for materials, with a focus on special insulation in bioconstruction and the use of biobased and low-carbon materials. The third theme, "Life Cycle Assessment and Circularity," explores the importance of assessing the life cycle of building materials and achieving circularity in construction practices. The fourth theme, "Climate" covers green building concepts, energy efficiency, and the reduction of CO_2 emissions in buildings, along with considerations for thermal comfort and climatic design goals. The fifth theme, "Sustainability" addresses the financial and collaborative aspects of sustainable renovation and emphasizes the engagement of tenants and homeowners in sustainable practices. The sixth theme, "Environmental Sustainability" centers on broader environmental considerations. Finally, the seventh theme, "Certification and Sustainability" discusses various certification programs, including green seals, energy certification, and Passive house certification.

The topics covered in the climate resilience courses were systematically grouped into four main families. The first category, "Climate Action" addresses the significance of national and international efforts, climate initiatives at the city and sub-national levels, corporate involvement, and the acceleration of climate action. The second category, "Climate Comfort" explores the determination of comfort indices, the fundamentals of thermal comfort, climatic considerations, and their impact on comfort, as well as the effects of overheated living spaces on health and well-being. "Adaptation Measures", the third category, explores strategies for adapting existing building stock, addressing thermal vulnerabilities in various building types, and implementing cost-effective, climate-friendly adaptation measures. Lastly, "Green Buildings" highlights the components of environmentally friendly construction, physiological design objectives, the fundamentals of climate-responsive architecture, climatic analysis, and the intersection of sustainable architecture with climate considerations. This comprehensive categorization facilitates a nuanced understanding of climate resilience and its applications, particularly in the context of building design and construction.

The above classification provides a structured and comprehensive representation of the course topics within the 63 VET courses, enabling a clear and organized understanding of the primary themes and areas of focus. This systematic categorization has been instrumental in shaping the syllabus for the BeWare VET program, which comprises six distinct modules. These modules include Ecodesign and Social Needs, Insulation Materials, Nature-based and Waste-based Solutions, Energy Efficiency and Economic Assessment, Digitalization in Construction, and Risk Assessment. By structuring the courses and content in this manner, trainers are well-equipped to explore, understand, and apply essential knowledge and skills related to energy, climate resilience, BIM, green buildings, and sustainable construction, all while preparing for the challenges posed by a changing climate.

4. Conclusions

This analysis is based on the content of 63 European courses, offering valuable insights into the predominant trends in VET programs. Notably, it highlights "sustainable buildings" and "energy" as the central areas of focus. While these courses do address climate resilience and climate change mitigation, they do not receive the same level of attention. Prioritizing the enhancement of building resilience in the face of extreme weather events and climate change is crucial.

This emphasis is driven by the limited availability of training programs designed to tackle these issues, despite the global commitment of many countries to fulfill the Paris Climate Agreement (United Nations, 2015) and the increasing challenges posed by extreme weather events. It is essential to note that the primary areas covered in this context are thermal comfort and energy efficiency, with relatively less attention given to climate risk assessment.

Within the framework of Construction Industry 4.0, BIM takes center stage. The expansion and utilization of digitized data in the construction sector have paved the way for the broader application of BIM beyond traditional 2D modeling.

Lastly, the concept of sustainable building is gaining momentum, with a growing emphasis on materials, life cycle assessment, circularity, sustainable development, environmental sustainability, and certification as integral components integrated into the curriculum of VET courses. This underscores the industry's commitment to addressing sustainability and environmental considerations in construction practices. The authors believe that the gathered information can assist those who are interested in creating courses related to these topics.

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