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ABSTRACT BOOKLET

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Dual higher education

EXTENDING THE COOPERATIVE STUDY MODEL THROUGH DIGITAL BRIDGES

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Keywords: Future Skills, Competence-development, Dual Higher Education, Reflective-Based-Learning, Curriculum integrated, Evaluation

Introduction

The digital transformation and societal shifts related to AI, pandemics or the digital transformation demand individuals to adapt to increasingly dynamic situations, posing immense challenges for Dual Higher Education Institutions (DHEI) to prepare their students for these emerging issues [1]. In this context, competences that autonomously and effectively navigate complex problem-solving processes, so-called Future Skills, are becoming increasingly significant [2]. DHEIs in particular offer supportive structures for such a Future-Skills-orientation, combining practical experience with theoretical studies [3;4]. A project at the Baden-Wuerttemberg Cooperative State University designed a multi-stage approach with curriculum-integrated didactic structures to systematically foster students' Future Skills development. The pedagogical concept supports students' self-directed development of essential Future Skills throughout their entire academic journey by actively engaging them in hands-on learning opportunities, continuously reflecting on and documenting these experiences. The basis of the Future Skills program, a 3-hour workshop called the Future Skills Module, was designed to empower participants to independently reflect on and learn Future skills and has already been implemented with 1143 students.

Methodology

The evaluation of the workshop took place in two data collection periods (December 2022-January 2023 & December 2023-February 2024) via a standardized online questionnaire. The questionnaire was presented to the students after each workshop in the form of a summative online survey and consists of 30 items divided into the sections: a) socio-demographic data, b) subjective assessment of the individual relevance and the impact of the learning intervention, c) questions on acceptance of the pedagogical approaches, d) questions on the students' assessment of self-efficacy. Self-efficacy was used to investigate whether there is a correlation between the experience of self-efficacy in the degree program and the students' perception of their acceptance of and attitude towards acquiring Future Skills. A 4-point Likert scale was used with the option of selecting ‘no answer’. Problem-centered free text fields were also used to address specific answers on a voluntary basis. After data cleaning and quality check the combined evaluation base amounted to N=744 students out of an original sample of 1143.

Results & Discussion

The evaluation results illustrate the high level of personal significance and the students’ acceptance and increased interest for Future Skills learning interventions.

In general, the students expressed a very positive attitude towards the workshop experience. In the evaluation, it can be stated that the workshop was fun for the students overall, as 65.7% agreed with the statement in the survey. The results also illustrate the positive effect on the understanding of future skills and thus an immediate effectiveness (strongly agree: 47.9%; somewhat agree: 43.7%). The assessments of the importance of learning Future Skills show a similarly high value from the student perspective. In the survey, 83.54% agreed with the statement, which emphasizes the importance that students attach to acquiring Future Skills. The high percentage (77.15%) of students who stated that they did not know what Future Skills were before the workshop is noteworthy. However, it is necessary to check whether this refers to the concept of Future Skills in general or to the conceptualization of the term, which is not necessarily known at a linguistic level. Despite or precisely because of the unfamiliarity of the topic, there is a high willingness to participate in further programs to acquire Future Skills. 69.0% of students would participate if the learning opportunities were integrated into their degree programs, 9.7% of them even voluntarily in their free time.

The great interest in such initiatives is also made clear by the fact that a total of 63.1% of students agree that they were able to identify personally significant Future Skills and thus had a starting point for further engagement with their individual Future Skills development.

Conclusion

This evaluation indicates how the didactic concept presented for Future Skills learning can be used as an example to successfully focus on skills-orientated didactics in DHEIs. Simply imparting knowledge can no longer prepare students for the still unknown social challenges of our time or for the future labor market. The evaluation results of the workshop have shown

the importance students attach to the acquisition of Future Skills. To foster these at universities, traditional teaching methods and educational formats must be re-evaluated and replaced with tailor-made learning experiences that address students' needs, ensuring graduates remain future-ready in an increasingly dynamic educational landscape.

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FROM WORKHORSE TO HIGH-TECH PIONEER: STUDENTS OF THE COOPERATIVE STATE UNIVERSITY RAVENSBURG (DHBW RAVENSBURG) TRANSFORM A KAWASAKI MULE VEHICLE INTO AN AUTONOMOUS, ELECTRICALLY POWERED "EMULE"

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Keywords: Industry 4.0, Interdisciplinary cooperation, International collaboration, Cross culture competences, Best practice & experience

Introduction

Project-based learning (PBL) has established itself as a central pedagogical approach in dual higher education, effectively preparing students for the complex demands of the modern workplace. By linking theoretical knowledge with practical application, this method fosters deep competence development. The eMule project at DHBW Ravensburg serves as an exemplary case study, showcasing the effectiveness of PBL in an interdisciplinary and international context. This project, which involves converting a vehicle into an electrically powered and autonomous system, not only enhances students' technical expertise but also develops essential skills such as project management, teamwork, and intercultural competence

Case presentation

The eMule project at DHBW Ravensburg demonstrates the core principles of PBL in dual higher education. Initially, the project aimed to convert a Kawasaki Mule 610 with a combustion engine into an electrically powered vehicle. The electrification has been successfully completed, and the project has since evolved to focus on system optimization and autonomous driving functions. Students are currently engaged in refining autonomous

driving capabilities, optimizing the battery system, and obtaining road approval for the vehicle.

As a supplementary aspect, the eMule project incorporates a digital twin. This virtual model of the physical vehicle allows students to collect, simulate, and analyse data, supporting advanced experimentation and decision-making. Although not a core objective, the digital twin provides additional opportunities to explore modern industry methodologies such as IoT (Internet of Things) and data-driven decision-making.

Beyond technical aspects, the eMule project integrates multiple educational dimensions. It fosters a simulated corporate structure where students work in teams to manage projects, promoting teamwork, communication, and project management skills essential for professional success. Moreover, students must engage in iterative problem-solving, learning to navigate real-world challenges by developing solutions based on industry standards and practical constraints.

A distinguishing feature of the project is its strong emphasis on interdisciplinarity. Students from various technical disciplines—including industrial engineering, electrical engineering, mechanical engineering, information technology, and embedded systems—contribute their expertise. This interdisciplinary collaboration mirrors the complexity of modern industrial projects, fostering cross-disciplinary communication and problem-solving

International collaboration further enriches the learning experience. Every year, students from countries such as Mexico, Morocco, Spain, and South Africa participate through Bachelor's and Master's theses, bringing diverse perspectives to the project. This global engagement enhances cultural exchange and better prepares students for working in international teams, a crucial competence in today’s interconnected world

Ultimately, the eMule project serves as a model for practice-oriented education that integrates innovation, interdisciplinarity, and international cooperation. By linking academic knowledge with real-world applications, it effectively prepares students for Industry 4.0.

Results & Discussion

The eMule project highlights the effectiveness of PBL by immersing students in real-world engineering challenges within a dual education setting. The hands-on vehicle conversion process enables participants to apply their theoretical knowledge to practical scenarios, reinforcing their technical and problem-solving skills. This experience underscores the core principles of PBL, where experiential learning fosters deeper competence development beyond traditional lecture-based instruction.

Interdisciplinary collaboration has proven to be a key success factor. The integration of students from various technical backgrounds simulates the complex teamwork required in modern industry. This cross-disciplinary problem-solving approach enhances communication and adaptability, preparing students for dynamic and interconnected workplaces.

Additionally, international collaboration contributes to the project's success by fostering diverse perspectives and promoting intercultural competence. The opportunity to work alongside peers from different cultural backgrounds strengthens students' ability to navigate globalized work environments.

The results of the eMule project affirm the value of PBL as a best practice in dual higher education. The seamless integration of academic knowledge, practical application, interdisciplinary teamwork, and international cooperation provides students with a holistic learning experience. This combination equips graduates with the technical expertise and professional competencies essential for future industry leaders.

Conclusions & recommendations

The eMule project serves as a compelling example of how project-based learning (PBL) bridges the gap between academic theory and real-world application. By engaging students in interdisciplinary and international collaboration, the project fosters problem-solving skills, teamwork, and adaptability—critical competencies in the context of Industry 4.0.

To further enhance the effectiveness of PBL in dual education, we recommend expanding international partnerships through joint projects with universities worldwide. Additionally, increased collaboration with industry partners can provide students with even more exposure to real-world challenges. Finally, leveraging digital tools such as the digital twin for broader applications can further enrich the learning experience, ensuring that PBL continues to evolve as a best practice in higher education.

FRENCH-SPEAKING BELGIUM: INFLUENCE OF THE LEGAL FRAMEWORK ON DUAL HIGHER EDUCATION

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Keywords: Dual Higher Education, National Policies, Pedagogical practices, Legal Framework

Introduction

Dual learning in higher education remains underdeveloped in French-speaking Belgium, with only 23 programmes currently in place. The legal framework governing this educational model was only established in 2016 [1], following pilot experiments launched in 2011. This paper examines the impact of the 2016 legal framework on the pedagogical practices of dual learning higher education programmes in French-speaking Belgium, by focusing on two key legal provisions: the restriction of dual education to labour shortage sectors and the specific accreditation and evaluation constraints imposed on institutions.

Case Presentation

Does dual learning mean dual injunctions?

According to Crosas and Puig Calvó [2] dual learning refers to “a continuity of training in a discontinuity of space, time, people, situations and issues”. Within European education policies [3], dual education is put at the service of labour shortages as well as of the needs of companies. Depending on political orientations, it can also act as a tool for social emancipation, opening higher education to students kept from it either for educational or financial reasons.

Highlighting these dual injunctions, Maubant [4] does however question the absence of any real pedagogical thinking on the matter. The existing literature primarily covers the matter of

curriculum design in dual learning and its main challenges: collaboration and alignment between locations, stakeholders and timeframes. What of the act of learning? Does dual education enable learners to find meaning through practice, allowing them to "learn differently"?

As we are witnessing the emergence of dual learning within higher education in French-speaking Belgium, this paper wishes to query lawmakers' decisions as well as the role played by the private sector on the pedagogical orientations currently observed.

A unique political context

The origins of dual learning in French-speaking Belgian higher education are closely tied to an unprecedented political situation: in 2011, the same minister was responsible for both Higher Education (a community-level competence) and Economy (a regional competence).

Driven by professional federations and industry representatives, the government launched four pilot dual learning programmes in 2011. Following a positive evaluation, the 30th of June 2016 decree was passed, which formally regulated dual education in higher education.

However, a close analysis of the decree and its political context reveals two major tensions:

- A strong economic influence, prioritizing business needs.
- A noticeable reluctance from higher education institutions, concerned about the impact of dual learning on the organization of academic curricula.

Several decree measures could enable us to substantiate this hypothesis, we will however only focus on two of them in this paper: the restriction of programmes to sectors experiencing labour shortages (art. 4) and the specific accreditation requirements (art. 8).

Results & Discussion

Restriction

Article 4 states from its outset that dual higher education programs can only be opened within "fields that lead to professions affected by labour shortages, new professions, evolving professions, professions related to sustainability or economic recovery". The development of dual higher education thus depends on economical injunctions and is limited to 8 fields of study defined by the decree (fields that are already obsolete, less than ten years later).

It should also be noted that nursing and teaching courses are not cited within those 8 fields: professions of public and social work, that also experienced labour shortages, were visibly not equally considered as the decree was enacted.

Institutional Resistance

Article 8 reflects higher education institutions' wariness and reluctance, introducing several restrictive measures in the Decree:

- A non-compete clause, preventing competition between dual learning and full-time academic programmes.
- A requirement to prove the added-value provided by the dual learning approach in competence acquisition.

The course's accreditation furthermore requires a certificate evaluation by the dual higher education steering committee (art. 10) in addition to a formative evaluation carried out by the Agency for Higher Education Quality Evaluation (AEQES).

Conclusion & Recommendation

Through these few examples, we have attempted to relay implicit injunctions translated in the current legal framework for dual higher education in French-speaking Belgium. While it does reflect the needs of economic sectors, it also outlines Academia's suspicion of the methodology. These restrictions are currently hindering higher education institutions' freedom and are de facto limiting both dual education's potential growth and pedagogical thinking on the matter.

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ANALYSING THE DEVELOPMENT OF DUAL UNIVERSITY EDUCATION IN SPAIN: TOWARDS A NEW PARADIGM IN UNIVERSITY EDUCATION?

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Keywords: Dual University Education, Spain, dual degrees, dual regulatory framework

Introduction

After more than a decade of development in Dual VET, Dual Education is beginning to reach the university system in Spain. Still in a very early stage, more universities are increasingly embracing the process of adapting their degrees to dual education, realising the need to be more closely linked to the job market and to reduce the persistent mismatch between the degrees offered and the demand from the productive sector. The differences in DHE implementation underline the need for a flexible approach that accommodates standardization initiatives at the EU level [1].

Case analysis

The study includes information of 46 out the of 50 public universities (representing a response rate of 93% of the Spanish public universities) and 14 out of 41 private universities (representing a response rate of 34%) [2]. The project is the result of a collaboration agreement between Fundación Bertelsmann, Mondragon Unibertsitatea and the Social Council Association of the Spanish University System (Conferencia de Consejos Sociales).

Results & Discussion

This paper will present the results of the first-ever project developed in Spain aimed at offering a detailed account of how universities are adapting their programmes to dual

education. Which universities are deploying dual education? In which bachelor's and master's degrees? In what areas of knowledge? Is there a specific regulatory framework for Dual University Education? What trends are observed in the dualization of university degrees? These are the main questions that will be covered in the presentation.

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BOOSTING COOPERATION BETWEEN INDUSTRY AND UNIVERSITY IN KAZAKHSTAN BY DEVELOPING DUAL STUDIES IN THE FIELD OF AUTOMATIZATION AND ROBOTICS

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Keywords: Dual Higher Education, curriculum design, practical training

Introduction

The landscape of industry automatization and robotics (IAR) in Kazakhstan has undergone a significant transformation, driven by the urgent need for skilled professionals and the integration of advanced educational methodologies [1]. The impetus for the DIARKAZ project [2] stemmed from the gap in IAR expertise within Kazakhstan, which was addressed through collaborations with international institutions and non-academic partners. The aim was to create a sustainable, internationally oriented Dual study program that positioned Kazakhstan as a leader in IAR within the West Asia region. The introduction of Dual Education in Higher Education institutions (HEIs) in Kazakhstan was imperative for bridging the gap between academic training and industry needs. This comprehensive approach ensured the sustainability of project outcomes, fostering a permanent impact on both national and regional levels.

Case presentation

Dual Education in Kazakhstan on a system basis was implemented only in colleges. The basis for the introduction of Dual Education within the national educational space was the signing of the Agreement on the implementation of the pilot project “Implementing Dual Learning in Kazakhstan” between the Ministry of Education and Science of the Republic of Kazakhstan and the German Society for International Cooperation in 2013. Consequently, the need for the development of Dual Education in HEIs emerged. To achieve this goal, the DIARKAZ project was initiated, to develop advanced Dual training in HE, to create experimental sites for Dual learning, to determine the peculiarities of training in the system of Dual Education in three different areas, regions of Kazakhstan, and different economic sectors as well. The methodological approach to achieve the planned objectives began with field research and study visits by Kazakh professors and industry tutors to institutions in program countries (AT, DE, SRB) [2]. These visits allowed Kazakh university and company representatives to gain insights into the development, organization, and implementation of Dual Higher Education (DHE) programs. The initial phase focused on defining learning outcomes, competencies, IAR program modules, and contractual documents, as well as other terms for conducting the study program. In the second phase, the training of teachers and industry tutors was crucial, as the quality of training is directly linked to the trainer's knowledge to meet academic standards.

During the implementation phase, it was essential to initiate the accreditation procedure as early as possible, given that this external risk was beyond the control of project partners.

Results & Discussion

The three Kazakh universities collaborated and developed a new, unified study program focused on "robotics and automation." The program was structured according to the Dual Education model prevalent in European countries such as Austria [3] and, Germany. The organizational framework and annual division of the study year deviate from the Central European scheme, adopting a yearly structure instead of semesters.

The newly developed "Industry Automatization and Robotics" study program is offered by the three Kazakh universities and covers 240 ECTS credits.

The curricula encompass common core subjects in "General Educational Disciplines with Optional Components (=Electives)" and "University Components" in both basic and profile subjects, uniformly implemented across all three universities. Additionally, each university offers specialized "Optional Components" in basic and profile subjects tailored to their unique focuses. While the new curricula appeared balanced, it includes a high number of holidays and lacks sufficient time for supervision during and after internships. The concept of developing a curriculum with a common foundational structure and varied specializations across the three university locations is innovative and aligns with the principles of micro-credentialing. This approach provides students with the flexibility to choose their educational path and specialize in robotics and automation.

Incorporating trend-setting ideas, such as integrating social and political sciences into a technically oriented curriculum, fosters the development of social and environmental responsibility among future engineers, depending on the lecture content.

Conclusions & Recommendations

Effective implementation of Dual programs necessitates leveraging existing frameworks and cooperation models established within professional fields and enterprises. This approach, as exemplified by Kazakhstan, ensures a robust foundation grounded in practical experience. Initiating these programs on a small scale, with immediate action, is preferable to extensive planning. This strategy allows improvements and quicker adaptation based on feedback, thereby mitigating risks. Each cooperation agreement must be tailored to the specific strengths and needs of the participating organizations. This individualized approach ensures that each entity contributes to areas where they can offer the most value, fostering a collaborative and effective partnership.

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TOWARDS A MORE OBJECTIVE AND HOLISTIC ASSESSMENT IN DUAL HIGHER EDUCATION, INCLUDING SELF-ASSESSMENT AND CO-ASSESSMENT

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Keywords: self-assessment, co-assessment, rubric, feedback, soft and technical skills

Introduction

Objectively assessing student development and learning in dual higher education (DHE) is challenging due to the lack of uniformity and objectivity in current apprenticeship assessments, tending to be overly positive [1]. Traditional rubrics, while useful, can be weighty and may not fully capture the nuances of dual learning.

To address these issues, this study proposes a more objective assessment rubric to enhance the comprehensiveness of student evaluations. The new rubric introduces diverse perspectives, involving all agents in the process, including student self-assessment and co-assessment between academic and company tutors, providing a more holistic view of student development. Additionally, the study emphasizes the importance of regular tutor feedback during the dual experience.

The proposal includes a coherent and progressive evaluation system across all academic levels, from undergraduate apprenticeships to bachelor's and master's theses. This ensures assessments are adapted to the knowledge and skills acquired at each stage. Training is required for both academic and company tutors to enhance the quality of DHE [2].

Case presentation

The Faculty of Engineering at Mondragon Unibertsitatea (MU) has reviewed the monitoring and assessment in DHE, which covers five dimensions: (1) technical capacity, (2) written communication, (3) oral communication, (4) soft skills, and (5) project impact (economic, social, and environmental). Three milestones are defined:

1. Workplace integration. Student and tutors are introduced, and the training program is reviewed to ensure alignment with the technical skills developed in the degree.
2. Mid-apprenticeship assessment. The student performs a written and oral presentation of their achievements to date. Qualitative assessment and feedback are provided, offering insights for improvement during the remaining project period.
3. Final assessment. The student submits a final report, and presents and defends their work. The assessment panel determines the final grade, as a result of the weighted average of the partial marks across the five dimensions.

This final grade significantly impacts the student's curriculum, in line with the weight of dual activities in their studies. This weight is becoming increasingly important in academic curricula [3]. Therefore, it is crucial that this grade is evidence-based and uniform for all the students. The MU rubrics detail the items for grading each dimension, on a scale from 1 to 10. However, the lack of written evidence to justify these grades does not guarantee a uniform assessment.

Thus, the faculty has designed new rubrics that maintain the five dimensions. Objective facts were identified for grading each item within these ranges: 10-9, 8-7, 6-5, and <5. Tutors assign students to a range for each fact, and determine a grade for the item based on all criteria. This ensures evidence-based grading, which is recorded. As an example, Table 1 provides criteria for the “Creativity, initiative, and motivation” item in the soft skills dimension.

Table 1. Facts for assessing “Creativity, initiative, and motivation”, in soft skills dimension.

10-9	8-7	6-5	<5
Excellent at proposing ideas	Original in some aspects	Lacks original ideas	Does not propose own solutions
Works with enthusiasm	Works with enthusiasm	Poor enthusiasm	Does not show enthusiasm
Highly motivated	Motivated	Partially motivated	No motivated

Face-to-face assessment could be lengthy and tough if each fact had to be discussed. Therefore, tutors present pre-analysed proposals for each dimension. Oral communication is assessed by both tutors in the evaluation session, and they also ratify the final grade for the other dimensions. Integrating student self-assessment and tutor co-evaluation combines all the perspectives that integrate DHE.

Results & Discussion

This work is being validated by academic staff and company tutors. Both groups show increased confidence in grading, and trust in assessment consistency across different

panels. Additionally, this process enhances the involvement of company tutors in student training and strengthens connections with academic staff. Specialised training for company tutors is essential, including the significance of dual activities, roles and responsibilities of each tutor, process milestones, guidelines for feedback, and assessment tools.

Conclusions & Recommendations

- Assessment of dual activities should consider technical capacity, written communication, oral communication, soft skills, and project impact.
- Identifying facts for grading each item ensures objective and homogeneous assessment with recorded evidence.
- Co-evaluation between company and academic tutors, along with student self-assessment, provides a holistic view of student development and continuous improvement feedback.
- Training for both academic and company tutors is fundamental.

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GENERATION Z COMPETENCE DEVELOPMENT AND MENTORING OPPORTUNITIES AT DUAL TRAINING PARTNER COMPANIES

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Keywords: dual training, corporate mentor, generation Z, higher education methodology, skills development

Introduction

The Hungarian model of dual education has emerged as a result of a specific development. The spread of the practice-oriented form of education in Hungarian higher education shows several characteristics.[1] The "Kecskemét model" applied at the John Neumann University is based on close cooperation with companies.[2] The continuous change in labor market demands has a necessary impact on dual training and its methodology. A parallel challenge is that Generation Z has different expectations, specific learning habits, and knowledge acquisition and motivational characteristics related to the world of work.[3] The dual training system, as a practice-oriented and corporate-based higher education training form, creates a unique opportunity to successfully apply the special methodological tools for training and developing the competencies of younger generations.[4] The study, through empirical research and sharing of good practices and methods, seek to answer the question of what competence development and mentoring opportunities and practices have developed at dual partner companies in order to transfer the necessary knowledge and skills tailored to the company's needs to Generation Z employees, and to motivate and encourage the members of the younger generation to innovate, take responsibility and perform in line with the generation's needs.

Methodology

The research aims to examine the changing challenges of the world of work and the specificities of Generation Z by processing the results of professional literature and

research, while the company's solutions are examined through questionnaire research and analysis covering a wide range of dual partners. The results of the research can also contribute to the methodological development of dual training at an international level. According to the research's premise, Generation Z, which includes young people born between 1995 and 2010, has many unique characteristics in terms of knowledge acquisition, learning, and motivation.[3] During the online questionnaire research, 14 questions were asked to investigate whether companies with dual partner contracts with our higher education institution use, and if so, what specific educational methods and competence development tools are used in the practical preparation of Generation Z young people. The questionnaire included check-box and open-ended questions regarding the cooperation between dual mentors and Generation Z higher education students, and the methods used by the mentors and found to be effective.

Results & Discussion

Based on the analysis of the responses received, it is clear that the corporate professionals mentoring students participating in dual training at partner companies have many years of experience in working with Generation Z youth (44% have 1-3, 33% have 3-5, while 11% have over 5 years of experience in working with Generation Z youth), and they themselves perceive the characteristics of Generation Z. Two-thirds of the respondents considered commitment to the company, development of communication skills, development of appropriate motivation, and mastering the corporate work culture to be the most significant challenges for Generation Z youth. Corporate dual mentors consider individual, personal mentoring, development of practical projects, and the use of online materials and personal assessment tools to be effective methods in preparing Generation Z youth. In motivating students, precise definition of objectives, regular feedback and encouragement of teamwork were considered important. Three quarters of dual mentors at companies provide feedback to students on their development weekly or biweekly, and these are mainly personal feedback on progress. Corporate mentors mainly focus on developing competences related to communication and problem-solving skills, project work and teamwork. As a result, they primarily encourage and motivate students to solve specific problems, develop corporate projects and formulate individual proposals. In addition, dual mentors also consider student feedback important, just as they pay attention to the feedback of the university's dual training managers. Corporate mentors also encounter important challenges during the corporate training of Generation Z students. Among these – based on individual free responses – the following are worth highlighting: lack of communication skills, lack of motivation, lack of individual goals and independence, “falling back into their digital world” after completing tasks, “impatience and wanting to achieve everything at once”, a less performance-oriented approach, difficulty maintaining attention, and deficiencies in practical problem-solving skills. They see the solution to these challenges in more practical time spent at the company, closer cooperation between university and company professionals on methodological issues, and the development of knowledge transfer needs typical of Generation Z.

Conclusions

Based on the results of the research, it can be stated that Generation Z has specific knowledge acquisition and competence development needs, which is also perceived by corporate mentors. More effective and efficient dual training requires closer methodological cooperation between the university and the company. The research highlighted that an important aspect in the success of dual training and the effectiveness of practice-oriented training is to take into account the special needs of the younger generations and to further develop our methods accordingly. In line with the objectives of the EU4Dual program, the development and transfer of good practices can also create opportunities for the development of the entire European higher education area and the European dual training system according to common criteria.[5]

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SUPPORT FOR THE IMPLEMENTATION OF THE NEW CONTRACT IN DUAL UNIVERSITY EDUCATION IN SPAIN

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Keywords: Stakeholders, world of work, support, quality, dual contract, regulatory framework

Introduction

This paper presents the preliminary findings of a collaborative initiative between Fundación Bertelsmann in Spain and Mondragon University, with the aim of analysing in a comprehensive way the implementation process of the new dual contract (CFA in Spanish) and the associated regulations governing Dual Higher Education (DHE) in Spain.

University education in Spain is governed by a system that combines national and regional regulations. At a national level, the Organic Law on Universities (LOSU) of 2023 establishes the current general framework and gives legal cover to the concept of dual training. In turn, three regulations, two in the field of education and one in the field of work, define the guidelines for the implementation of the DHE.

On the academic side, Royal Decree 822/2021 [1] on the organisation of university education marks a new milestone by establishing the regulatory framework for the DHE in both Bachelor's and Master's degrees, defining dual education and introducing the Dual Mention as a tool for its development, as well as establishing the conditions for its implementation.

In the field of labour, Royal Decree 32/2021 [2] introduces the contractual framework for dual university training through the CFA. The duration of the CFA contract is between 3 months and 2 years. Only 1 contract will be applied for each training cycle in Bachelor's and Master's degrees. The remuneration of the contract is fixed in the agreement in proportion to the actual working time.

To identify the difficulties, and suggestions for improvement in the process of implementing the CFA, the following section analyses a selection of cases that illustrate the recent experience of Spanish universities.

Case analysis

This research analyses the experience of 10 universities 3 years after the approval of this new regulation. The participating universities have different backgrounds with regard to their experience in dual training. One third of this representation are pioneering universities that have a long history in dual training with offers based on dual pathways implemented prior to the current regulation. The rest are universities that have just started to integrate dual education as a training modality.

The methodology used is developed in three phases. The first phase is based on a questionnaire. The aim of this questionnaire is to collect information on how each university formalises the CFA. This analysis takes into account the structure of the degree plans, together with the details of the information to be considered by the universities and the collaborating companies. The results are shown in a grouped form, and there is no intention to publish the specific approaches of each university.

The second phase is an interview with each university to validate the information included in the questionnaires. In a third phase, a meeting is held with all the universities where proposals for improvement will be validated, good practices will be shared, and experiences will be exchanged.

Results & Discussion

The preliminary results first address the impact of the CFA regulation on the degree structure. It is observed that in most of the degrees considered the pathway and the CFA are only implemented in the last year or during the last phase in one-year Master's degrees. Only in the most experienced universities are there pathways of more than one year's duration [3]. The differences in DHE implementation underline the need for a flexible approach that accommodates standardization initiatives at the EU level [4].

The participating universities consider that they have no difficulties in establishing the coordination mechanisms to be included as an annex to the cooperation agreement between the company and the university. However, it should be noted that there are no reference models to help formalise the training plan, which has led to difficulties in its development and implementation. They identify that the terminology of the CFA in the formalisation process is not clear and that it should be defined more clearly and with examples to help understanding. They also identify the need for support and assistance from the public agency (SEPE in Spanish).

Conclusions & Recommendations

The development of this contractual framework is a key element in the success of dual university training in Spain. The process of elaborating the CFA still lacks adequate information and support for universities and business. The need of a digital management platform that allows all parties to coordinate properly and with the same information to ensure the overall quality of the process is highlighted. As a result of this analysis, a support guide will be developed to assist universities in their collaboration with companies, facilitating the implementation of a key element such as the CFA and its proper integration into Dual University Education in Spain.

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ANALYSIS OF EMPLOYABILITY IN THE SPANISH PROGRAMS OF DUAL HIGHER EDUCATION

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Keywords: employability, self-evaluation, questionnaires, labor insertion rates

Introduction

Although the recent implementation of dual university education is in its early stages in Spanish context, there have been experiences of alternating and dual training throughout the country, from different perspectives, mainly since the adaptation to the European Higher Education Area.

This study presents the preliminary findings of a collaborative research between Fundación Bertelsmann in Spain and the University of Almeria, which aims to investigate the evaluation and quality of students' employability in Spanish dual higher education programs. To this end, questionnaires have been developed so as to provide effective tools to regional, national and university institutions with effective tools for integrating information on quality assessment. In this way, it will be possible to monitor dual degrees in accordance with the regulations.

The methodology adopted makes it possible to analyze employability and the quality of higher education from the point of view of the actors involved: students, company tutors, academic tutors, technical staff and employers. In this way, the study enables higher

education institutions to obtain a framework for self-evaluation of universities in order to improve their actions in the field of employment and employability. The operational definition of the constructions to be evaluated is based on: general employability, employability as labor insertion and employability as quality in the acquisition of competences and training (ANECA).

CASE STUDY

A quantitative study is being conducted to determine the effectiveness of the dual university program at the University of Almería (Spain). This program consists of two different internship periods. The first semester is a curricular internship in which students receive on-the-job training based on the skills and competences required in the second semester courses of the fourth bachelor's degree curriculum, with a maximum of 30 credits. In addition, the second semester is an internship that takes place outside the curriculum and provides students with work experience in their professional field.

The purpose is to study the triple dimensions of employability. The first is employability as labor insertion, taking into consideration the dual university program as the role of market function, giving the possibility to convert the dual program in a job in the same firm of the dual program or in other company. In such a way, this data will show the direct insertion rate of the programs.

Secondly, the analysis of employability as quality in the acquisition of competences and training. In this regard, It is examined the role of dual university education in promoting the development of competences for employability [1, 2]. Finally, the third dimension of employability is the general concept of employability as the current situation of the interviewee.

Some of the items are shown in Table 1, 2 and 3.

Table 1. Some items of General Employability.

General Employability	Level of agreement
Regarding the impact of your dual training on your personal and professional skills, indicate your degree of agreement with the following statements,	1-5
I consider that it has increased my job opportunities.	
It has allowed me to take on new roles or responsibilities	

Table 2. Some items of Quality Employability.

Quality Employability	Level of agreement
With regard to the satisfaction with the dual training period, please answer, marking the corresponding number, your degree of satisfaction with the following questions, following the following scale: • The range of organisations/entities/companies available for dual training • The prior information about the organisation/entity/company and the position to be filled • The prior presentation of the objectives and evaluation criteria of the dual training period in the company • The duration of the dual training period and its temporal location (in the first or second four-month period or yearly). • The reception process during the first days in the company.	1-5

Table 3. Some items of Labour insertion employability.

Labour insertion Employability
Did you stay to work in the company where you did your training stay?
Were you offered the possibility to continue in the host company with an employment contract?
Are you currently working?

The characteristics of the study's sample are shown in Table 4.

Table 4. Composition of the sample by gender and age.

Gender	Number	Min Age	Max Age
Male	88	22	40
Female	81	22	35
Total	**169**		

CONCLUSIONS

The main contribution of this study is that offer a measure of effectiveness of dual university education regarding the triple dimensions of employability, specifically general, quality and labour insertion highlights. The results allow to raise awareness of the importance of dual university education on employability.

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A SYSTEMATIC APPROACH FOR THE INCLUSION OF GENDER ANALYSIS (SDG 5) IN DUAL HIGHER EDUCATION OF ENGINEERING STUDIES

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Keywords: DUAL, SDG5, gender dimension, gender analysis, systematic approach

Introduction

Dual university-industry education is a topic of growing interest. Higher education has changed considerably over the last few decades. On one hand, the 'academisation' of traditional vocational training at different levels, and on the other hand 'vocationalisation' of traditional higher education through the integration of concepts and methods used in the field of vocational training [1]. This refers for example to teaching and learning methods and to different forms of dual studies combining learning pads with working experiences that include internships in the company. The internship experiences give an opportunity to the student to learn how to apply knowledge in the real world and to develop soft skills related to teamwork, autonomy and adaptation to new environments. While for the company the internships are an opportunity to integrate fresh knowledge and new visions to the company's culture. In this sense, topics such as The Sustainable Development Goals (SDG) can be transferred from the higher education to the companies in a natural way during the internships carried out in DUAL programs. With that objective this article presents a pilot experience based on the integration of the SDGs in engineering degrees at MU. This experience proposes to deepen and extend the work methodology for the SDG 5, gender inclusion, in the field of DUAL student internships, promoting the inclusion of gender analysis in engineering projects.

Case presentation

This proposal includes a case study to assess the feasibility of the methodology and tools to systematize the approach of gender analysis in a range of engineering DUAL programs.

Methodology

Engineering degrees on Biomedical Technologies, Design and Computer Sciences took part on the case study analyzing the suitability of the method in different Project Based Learning (PBL) projects developed at the classroom. The methodology and tools to systematize this approach were adapted in order to fit in with the work environment in which the internships are developed.

- Analysis of the PBL topics for Biomedical Engineering, Design and Product Development Engineering, Mechanical or Computer Sciences Engineering
- Application of the gender analysis methodology in the PBL topics
- Adaptation of the methodology and tools
- Creation of the support material and contrast interview with students

Results and discussion

A guide for the inclusion of gender analysis in engineering projects was created and adapted to include sex and gender variables from the first phases of the engineering projects from different areas.

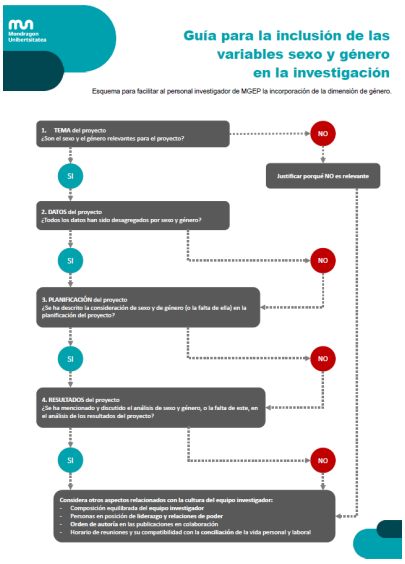

Figure 1. Summary of the guide for the inclusion of gender analysis in engineering projects.

The guide is inspired by other guides identified in the literature [3]. This guide is only four pages long and includes definitions [4], general and specific questions, examples of other projects and a summary scheme at the last page. This short guide was designed in a simple and direct format in order to engage students and to facilitate its propagation and communication among the professionals who work together with the students during their internships in the company. Contrast interviews were carried out with the students and the feedback obtained was positive, some of them highlighted that the guide helped them discovering new points of view that enriched the projects.

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INCREASING EMPLOYABILITY OF ENGINEERING STUDENTS IN CHILE THROUGH THE DEVELOPMENT OF DUAL STUDIES AT THE UNIVERSIDAD DE DESARROLLO

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Keywords: dual studies, experiential learning, critical thinking, employability

Introduction

In Chile, as elsewhere, employability of university graduates is key to advancing the economic development of the country and the single most important goal of institutions of higher education. Despite spending more on higher education as percent of GDP than all other 38 members of the OECD[1], Chile has one of the OECD's highest rates of unemployment overall, as well as of university graduates[2]. A major reason for this is that the university education provided does not match the practical requirements of the labor market[3]. To meet this challenge, seven dual studies programs in engineering have been successfully established since 2020, at the two principal campuses of the Universidad de Desarrollo in Chile (UDD). Our presentation will explain how the UDD, in collaboration with the DHBW in Germany, designed this full-time dual studies program, adjusted it to meet local educational and institutional requirements, and proceeded to increase graduate employability in just five years.

Case Presentation

Based on a successful dual study model developed in Germany, the first full-fledged dual study programs in Chile were launched in 2020 at the two principal campuses of the Universidad de Desarrollo, in Santiago and Concepción. By the end of 2024, 70 students have already graduated and 78 are currently enrolled, with 31% of the student body female.

The aim of the programs is to integrate theory with practice and closely align university education with labor market needs. Currently, seven Bachelor degree programs have been successfully launched at both campuses: Bio-Medical Engineering, Industrial Engineering, Informatics & Artificial Intelligence, Informatics& Innovation Technology, Mining Engineering, Geology, and Civil Engineering.

The curricula for these dual study programs have been developed in collaboration with private sector representatives as well as experts from the Baden-Wuerttemberg Cooperative State University (DHBW) at Mannheim. These curricula include academic supervision of projects at partner organizations, state-of-the-art laboratories, and individualized tutoring of job placement. The engineering programs at UDD are top ranked in Chile and were recently systems-accredited for six years (maximum is 7) by the Chilean Commission (CNA).

Results & Discussion

The dual study approach has been well received by the private sector, with 35 firms and organizations currently training one or more students throughout their two years of study. The benefit for these companies is the ability to access motivated young graduates who are well-prepared for the labor market. This is reflected in the graduates' employability: 76% of the 70 graduates receiving employment contracts with Chilean firms and organizations before or shortly after graduation.

Table 1. Dual Studies Graduate Employment 2023 & 2024; UDD School of Engineering[4].

Immediate Employment after Graduation	Immediate (%)	not Immediate (%)
Class of 2021	73	27
Class of 2022	79	21

Conclusions & Recommendations

Listed below are key outcomes of the ICLAE Dual Studies Program in Engineering so far.

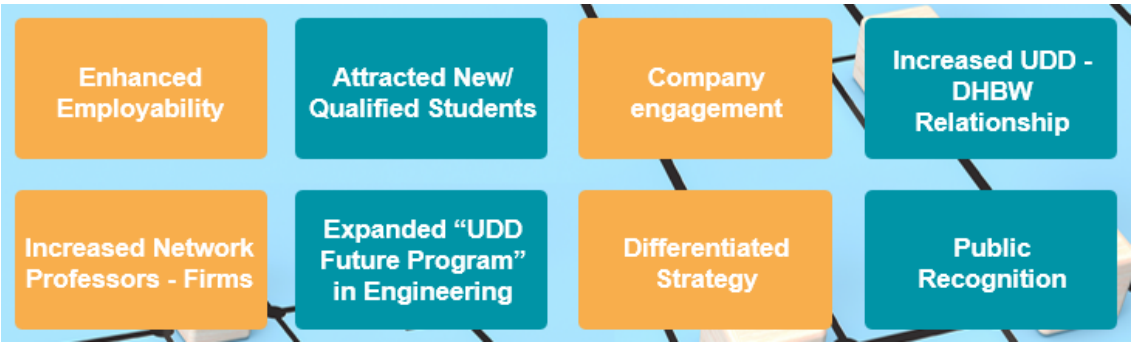

Figure 1. Key Outcomes of the UDD-ICLAE Dual Studies Program.

Over the five years since initiating the dual studies program at UDD include four major lessons learned have been identified. First, such fundamentally new educational offers require that the establishment, organization, funding and execution be part of central strategic planning of the university. Second, the large-scale adjustments in curriculum as well as introduction of intense and on-going collaboration with external partners (the firms that select and employ the students during the program) requires a dedicated team with strong managerial skills. Third, while formal official agreements with other collaborating institutions are vital, leadership and personal engagement is equally important to overcome challenges and develop creative and lasting solutions. Finally, in order for initial success and achievements evolve into sustained improvement in employability, educators and employers should strive to continuously improve the offer and execution, in particular, by leveraging international networks. Our attendance at the EU4Dual 2025 Conference is intended to help other interested institutions use our experience, as well as help us to continue to learn how to improve dual education programs.

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IMPLEMENTATION OF THE DUAL DEGREE IN CHEMISTRY AT THE UNIVERSITAT DE BARCELONA

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Keywords: dual higher education, chemistry, active learning, meaningful learning, curriculum design

Introduction

Our contribution introduces the Dual Program for the Chemistry Bachelor degree, a new initiative designed to enhance the educational experience [0] and employability of students [0] at the Faculty of Chemistry of the Universitat de Barcelona. This program allows selected students to complete their final academic year of studies within the framework of a real-world company, specifically a medium or large firm in the chemistry and biotechnology sectors.

Case presentation

The main objectives of the Dual Program are to provide students with meaningful and applied learning activities, thereby bridging the gap between academic knowledge and practical application. By immersing students in a professional environment, the program aims to improve the quality of employment for our graduate students and offer the university valuable insights into the evolving needs of the job market.

We have adapted the standard curriculum to allow a group of students to carry out 48 out of the 240 ECTS of our Bachelor during their stay in the company. This includes mandatory subjects such as advanced laboratory practice, project management, and the Bachelor thesis, which has a significant research component.

Conclusions

While the curriculum remains consistent with the standard Chemistry Bachelor degree, the Dual Program offers a unique perspective that integrates academic rigor with hands-on experience. This initiative not only enriches the students' educational journey but also positions them for success in their future careers.

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ENTREPRENEURIAL ENDEAVORS AMONG IT DUAL-DEGREE STUDENTS

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Keywords: dual program, IT, business, entrepreneur, employment, economy, innovation, self-employment, challenges

Introduction

Our Bachelor's degree program "Mobile Software Development" ("IT Dual") is organized as a dual study program. The following operational conditions are essential for a comprehensive understanding of this case study:

- The first year of full-time study serves as a preparatory phase designed to equip students with the foundational knowledge necessary for career entry.
- The part-time employment requirements to which the companies and students are bound is 20-24 hours per week starting in the third semester.
- The practice phases of the dual students is accompanied by a university representative and by skilled corporate representative(s) (mentors), which enables the combination of theory and practice.
- Learning goals in the workplace are defined every semester and reflected jointly with the student and the company mentor(s).
- The company mentors need to have the competencies to supervise the students' learning.

Case Presentation

The economic challenges

In addition to challenges such as the dissolution of employment contracts and disparities in students' prior IT knowledge, a more recent concern is the economic situation.

According to a KSV1870 [1] report only 48% of the Austrian companies are currently satisfied with their economic situation. Austria's economy has seen a surge in insolvencies, and many more are expected. Layoffs and the cascading impact of insolvencies on business partners and other companies present a significant challenge.

It can be assumed that the economic situation contributed to the increased difficulty dual students faced in securing a company for their practical training. In a survey conducted among 18 students, 11 responded regarding their job search experience, with one question related to the difficulty of the job search. Three rated the process as very difficult (5), and two as fairly difficult (4) on a scale from (1) to (5).

Operational Pathways

A logical approach to addressing these operational challenges is to increase efforts to expand the network of corporate partners. Additionally, students increasingly demonstrated ambitions to develop their own business ideas, utilizing entrepreneurial pathways as a means of learning. The establishment and didactic integration of an accelerator and incubator within the institute [2], supported by substantial funding for 'green' initiatives, further reinforced students' confidence in pursuing this path.

To assess the students' level of interest in entrepreneurship in the "IT dual" degree program, a survey was conducted in 2024. The feasibility was of secondary importance.

Results and Discussion

At the time of the survey, all students across the three academic years, in total 65 students, were invited to participate, with 18 responding. Half of the respondents were in their final year of studies. Among the five questions posed, the following results are particularly noteworthy:

- Four students expressed interest in entrepreneurship as an alternative to a company-based work placement.
- None were planning to start a business immediately, while five intended to do so

within the next two to five years, and three in five years or later.
- Three of the students who intended to start a business had an idea focused on sustainability, ecology, or social impact.

The interest in entrepreneurship as an alternative to a company-based work placement, but the absence of immediate plans to start a business, is most likely attributable to certain barriers. Among those who intended to establish a business, the most commonly cited barriers were insufficient financial resources (reported six times), followed by a lack of technical expertise (five times). Limited time availability and an underdeveloped business idea were each mentioned four times. Other challenges included insufficient business knowledge (three times), and lack of mentorship, and inadequate infrastructure (2 times).

Conclusion and Recommendations

Of course, one potential approach for students to pursue their business ideas is to start an IT-related venture as a side hustle. With the incubator and accelerator operating in the institute, challenges such as limited financial resources, insufficient business knowledge, lack of mentorship, and inadequate infrastructure can be addressed. A less time-intensive entry into entrepreneurship for those interested would certainly be to find a way to integrate the work on the development of a business idea and the launch of a business as the practical phase. It can be argued that entrepreneurship was not the purpose of a dual program, and that even with the integration of an incubator and accelerator, solutions do not exist with regard to technical mentorship, technical learning goals and employment-based remuneration. To benefit both students and the broader economy, we plan to continue expanding the studies and remain open to discussions on potential pathways.

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POSSIBLE REASONS OF THE STUDENTS DROPPING OUT FROM HIGHER TECHNICAL EDUCATION IN HUNGARY

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Keywords: Higher Education dropout, First-year students, Satisfaction with Education, Academic Exhaustion, Dropout Intention

Introduction

The number of students participating in higher education has been continuously increasing since the last century, but a decline has been observed since the 2000s [1]. Today, colleges and universities must compete for students. On a national level, out of approximately one hundred thousand applicants each year, around eighty thousand (including about ten thousand through supplementary admissions) are admitted to higher education [2]. In undergraduate (BSc) programs, more than a third (36–39%) of students leave without obtaining their final certificate (attrition). The highest dropout rates in BSc programs occur in the fields of computer science (49–55%), engineering (40–44%), and natural sciences (47–50%). In master's (MSc) programs, about one-fifth (19–20%) of students do not complete their studies. The highest attrition rate (24–36%) in MSc programs is observed in the Master of Business Administration (MBA) programs within the field of economics [3]. It means that after enrolling, students leave the higher education institution either within the prescribed semester duration or beyond, without obtaining a diploma. This is detrimental not only to the institution but also to the dropout students, as they sacrifice semesters or even years of their lives in pursuit of an unfulfilled goal.

Case presentation

Reducing attrition is only possible if the underlying causes are well understood. There are two methods to determine the reasons for dropout and find solutions to mitigate it: the

secondary and primary methods. The secondary method allows for the collection of useful but non-specific data, while the primary method provides targeted and relevant information. However, for the primary method to be truly effective, knowledge of both domestic and international contexts is necessary, which is facilitated by the secondary method. Based on the information gathered, a research plan can be formulated, specifically focusing on the GAMF Faculty of Engineering.

The first step involved defining the target group, for which the necessary primary data was obtained from the Academic Affairs Office. To accurately determine the reasons for dropout, the research had to be divided into two parts: Current students and Dropout students.

Different methods had to be applied for each group to obtain useful and clear results. In studying current students, it was assumed that they are aware of the reasons for student dropout, making it necessary to collect data from as many of them as possible. A survey was deemed the most appropriate method for this. Anonymity was ensured to obtain accurate responses. The questionnaire consisted of 40 simple questions (yes/no, multiple-choice with 2–6 options, Likert-scale questions) and 2 open-ended questions. For dropout students, the sample size was smaller, making in-depth interviews a more suitable method instead of surveys. The essence of in-depth interviews is that the conversation follows a structured guide, allowing for more personal discussion. This method is advantageous as it enables interviewees to open up and share valuable insights that might not emerge in a survey.

Results & Discussion

The survey results revealed that most students still live with their families, raising the question of whether parental involvement would be necessary, given that students remain dependent on them. Another finding was that while students strive for independence, financial constraints make it difficult to achieve, similar as Viklund and Elgundi [4] described in their research. To generate additional income, they take up jobs, which often negatively impact their academic performance. If universities could involve students in corporate projects, it would not only provide financial support but also enhance their knowledge through collaborative work. Additionally, it was observed that the number of students coming from secondary schools has doubled, while the number from vocational schools has halved. This shift means that the necessary knowledge for completing university courses is not always sufficient, increasing the risk of failure. A possible solution could be for university lecturers to offer preparatory courses for high school students, with the completion of these courses being considered in both university admissions and studies.

During the in-depth interviews, eight dropout students participated. While this number is not large, valuable insights were still obtained that did not surface in the survey. For example, it was revealed that there is a demand for online classes in correspondence programs. This method was implemented during the COVID-19 pandemic, but unlike at other universities (e.g., ELTE), it was discontinued as soon as in-person classes resumed. Many students

viewed this decision negatively, to the extent that some discontinued their studies because of it.

Overall, the in-depth interviews proved to be highly beneficial, particularly because, towards the end of most interviews, a level of mutual trust developed, allowing for questions that might have been impossible to ask otherwise. Although the number of interview participants was lower than expected, the method was still effective. Therefore, it is recommended that in-depth interviews be conducted for all dropout students at the university.

Conclusions & Recommendations

In summary, the research identified several issues, and potential solutions were proposed, which could yield both short-term and long-term results. Reducing student attrition requires significant effort, and some solutions may be costly, but their impact could be long-lasting, such an example the dual-higher education which has several positive properties [5][6]. The research also highlighted that problems should not only be sought among students but also among university lecturers. Unfortunately, this realization could lead to internal conflicts, but addressing it is crucial for the institution's future sustainability.

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EMPOWERING FUTURE PROFESSIONALS: DEVELOPING WORK INTEGRATED LEARNING IN HIGHER EDUCATION IN FINLAND

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Keywords: Dual Higher Education, Work Integrated Learning, Work Life Collaboration, University of Applied Sciences, Co-development Environments

Introduction

In this paper we present a case study on one Finnish university of applied sciences. The paper examines how higher education institutions (HEI) can establish a deeper connection to work life. The case HEI, Savonia University of Applied Sciences has set a strategic goal to develop a pedagogical model where increasing part of learning will happen in authentic work life environment. Implementing this kind of work integrated education model in practice requires a strategic approach. Establishing a clear vision, mission, and goals is essential for aligning stakeholders and guiding development of education.

Case presentation

In Finland the higher education system consists of universities and universities of applied sciences (UAS). The definition Dual Higher Education does not exist in Finnish higher education system, and the apprenticeship model exists only in vocational colleges, not in higher education. In that sense the Finnish HE system differs from e.g. German and Austrian models, where there are three pillars of higher education, namely universities, universities of applied sciences, and dual higher education [1,2,3].

Finnish universities of applied sciences integrate work life collaboration extensively, from curriculum development to education implementation. They provide pragmatic education tailored to meet the demands of working life with a focus on research and development responding to the needs of the surrounding society [4]. Finnish HEIs have a wide autonomy to develop their pedagogical solutions. Therefore, Savonia has decided to increase work integrated learning, which is based on Dual HE model developed in EU4Dual alliance, but also considers Finnish legislation and higher education system. This model is called Dual 2.0, and it is one of the key concepts of Savonia's strategy for years 2025-2028.

Dual 2.0 model demands strong commitment from work life partners and in this paper, we discuss how this academy-work life collaboration can be created and implemented. Forming strategic partnerships with industry, academic institutions, and other stakeholders is critical for resource sharing, knowledge exchange, and education program innovation.

The main aspects of the Dual 2.0 model are:

1. Strong work life dialogue as part of the curriculum process
2. Co-development environments strengthen work-based learning
3. Practical training and learning in the workplace are contractual
4. EU4Dual alliance provides an international framework for the development of the model
5. Strong connection between theoretical and practical learning
6. RDI ecosystems provide knowledge about the future of work
7. Working life -oriented RDI strengthens the working life -oriented education

Results & Discussion

Dialogue with working life is an essential part of the development and implementation of the Dual 2.0 model. It enables continuous improvement of the program, strengthens collaboration with the working life, and supports students' professional development. The dialogue promotes collaboration and commitment from working life partners. When representatives from working life are actively involved in the development process, they are more committed to the program's goals and more willing to provide resources such as internship placements, expert lectures and co-development environments. This collaboration enhances the program's credibility and attractiveness to both students and employers.

One key aspect of Dual 2.0 model is co-development environments. These environments foster collaboration between HEIs, industry partners, and other stakeholders, creating a space where ideas can be shared, refined, and transformed into practical solutions. By bringing together diverse expertise from academia and industry, this collaboration helps in designing curricula that are aligned with industry needs, thereby enhancing the employability

of graduates. Also, by engaging with industry partners, faculty can stay updated with the latest industry trends and incorporate this knowledge into their teaching.

Conclusions & Recommendations

The Dual 2.0 model offers significant opportunities for enhancing education. It promotes interdisciplinary learning, allowing students to gain expertise in multiple fields and fostering a holistic understanding of their subjects. The combination of practical work experience and academic learning enhances students' employability, giving them a competitive edge in the job market. This model combines also RDI ecosystems as part of education development. Through RDI cooperation, both higher education institutions and working life partners can obtain future knowledge that helps develop the skills needed in future working life.

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THE 24H OF INNOVATION, A DUAL EDUCATION INITIATIVE LED BY ESTIA SINCE 2007

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Keywords: creativity, innovation, hackathon, teambuilding, prototyping

Introduction

Creativity and innovation student's skills training are one of the most complex learning processes for any university and school. However, today there is a big challenge for most of educational institutions to propose multiskilled environment to develop the soft skills of their students [1]. During their teaching program, it's not easy to immerge students to experiment and practice such diversity. Indeed, most of the time, the young people are separate in different schools or university with specific teaching program according to their orientation for engineering, design, marketing, sales, administrative…

Case presentation

Created by ESTIA in 2007, "The 24h of innovation®" http://24h.estia.fr is a 24 hour nonstop challenge to develop creative and innovative concepts of products (mechanical, electronic, software…) and services. The concept of this event is simple: projects and topics are proposed by companies, labs, associations, and they are unveiled at the beginning of the competition. Teams are freely composed of a mix of any volunteers (students, researchers, teachers, consultants, free-lances, employees…). After 24 hours of development, teams present their results in a show of 3 minutes in front of a jury of professionals in the field of innovation. The winner teams receive the "24h of innovation" awards and they receive prizes offered by the sponsors of the event. This concept is as an original way to generate creative ideas for organizations in a few times, considering that the participants have 24 hours to work on innovation developments (such as new products and services, new business model, new communications…) proposed by industrials coming from different sectors, research laboratories, associations, and private persons. The 24h of innovation event is a good opportunity to generate new ideas, to increase the creativity for the benefits of the company. Since 2007, the concept of the 24h has been exported in other places in the world. Since 2007, 26195 participants coming from more than 355 schools & university of 40 different countries have attended one of the 100 editions organized on 5 different continents:

European (24h in France, Spain…), American (24h Canada…), Asian (24h Thailand, India…), African (24h Burkina Faso, Morocco…), Oceania (New Caledonia). More than 1680 projects have been developed for 1320 organisations/companies.

Results & Discussion

The 24h of innovation event is an opportunity for research experimentations involving students' teams. For example, Innovation measurement and evaluation are one of the key points for the development of any innovative projects in their early phases. So, in the scope of the 24h challenge we face also the problem of judgment and evaluation by the different stakeholders of a creative work produced in 24h. In [2][3][4], we propose a comparison of different evaluation methods that were tested during the presentations that were made by the teams during the 2008 edition. The organization of students' teamwork during the 24h event has been analyzed [5 - 8]. Some methods & tool for innovation or ideation have been also tested during the 24h edition [9]. In [10], we collected the data of profile's participants of the we have 14 French 24h's editions in order to characterise the team's diversity during the period 2007-2019. It seems to be obvious that teams with diversity composed of different profiles and school's origin (engineering, design, marketing…) could be considered as a multiskilled team with a strong advantage to perform creative design task compared to a team composed of people coming from the same education organization.

Conclusions & Recommendations

From a practical point of view, the goal of the 24h of innovation is to foster the socio-technical practices of the students that are involved in a short but intensive collaborative period with the use of creativity/design/innovation tools&methods with a hybridization approach [11]. We think that this kind of event helps the young generation to be more creative and more easily integrated in the socio-professional networks that will address more and more sustainable challenges in the future.

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CHALLENGES INVOLVED IN DUAL HIGHER EDUCATION: THE PERSPECTIVES OF THREE DISCIPLINES

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Keywords: teacher training; challenges; network of dual centers; joint mentor training; student assessment

Introduction

The Dualeca network was formed 8 years ago by three universities that offer dual training in education degrees to create a community where universities can share experiences and practices related to dual teacher training. A symposium is held every year to discuss emerging issues. Last year, the purpose of the seminar was to share the challenges faced by each university regarding dual education and to discuss ways to address these challenges.

Methodology

Among the participants, four faculties were related to education, one to engineering, and one to business. First, each university presented two main challenges, and then a total of four strategic challenges were selected and discussed in groups. These discussions were audio-recorded, transcribed, and analyzed by two researchers.

Results & Discussion

A number of challenges were mentioned, including 1) a lack of a stable network of centers where students can participate in dual placements; 2) the need for a joint mentor training program for school teachers and university mentors; 3) the need to design learning experiences between a company and a university; and 4) challenges related to student assessment were also discussed.

Conclusions

In conclusion, we can state that faculties from different fields face similar challenges regarding the dual model.

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SATELLITE EDUCATION MODEL - EXAMPLE OF A DUAL HIGHER EDUCATION MODEL IN FINLAND

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Keywords: Satellite education, Dual higher education, Working life, distance learning, Finland

Introduction

According to the Finnish Government's program, the goals of University of Applied Sciences (UAS) are both digitalization and the strengthening of cooperation between universities and working life. Education must be organized according to the needs of the workforce. Satellite education model has been implemented in Savonia UAS since 2014. The contract-based model originated from regional labor shortages of professionals and need for higher education. In this model, education and working life implement together higher education that produces experts to the needs of working life. In this education model, local people are educated for the needs of regional working life [1].

Case presentation

In the model, students study in their hometowns and participate in theoretical lessons via remote connection. The practical training is carried out at the premises of local employers and partly in Savonia UAS. They also have two intensive weeks at Kuopio UAS per semester. Working life provides for students e.g. internship placements, topics for thesis and guidance.

Results & Discussion

Satellite students are committed well in their studies. Excellent employment opportunities, the opportunity to study in their hometown and the possibility to combine work and study attract students. According to feedback from working life, cooperation with higher education is smooth, responsibilities are clear, and working life receives the professionals it needs. The model has increased cooperation between Savonia UAS and working life partners. It also has enabled the development of staff competence, the production of new knowledge and new solutions for the organization [2].

Conclusions & Recommendations

As a conclusion, the satellite education model is a flexible model of work-life-oriented education in new higher education. The model requires close cooperation with working life and education. Savonia's aim is to be a pioneer of work-life-oriented dual higher education in Finland. Positive experiences have encouraged us to continue cooperation and start new implementations together with working life.

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TEACHING PLM CONCEPTS IN A COLLABORATIVE DESIGN FRAMEWORK USING A PROBLEM-BASED LEARNING APPROACH

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Keywords: Active learning, Problem-based learning, Product Lifecycle Management, Targeted Learning Outcomes, Professor vs tutor role

Introduction

Nowadays, students find it more difficult to stay focused during lectures, for a variety of reasons, such as the proliferation of disruptive digital sources, or a reduced ability to reflect on high-level theoretical concepts.

To make engineering students aware of PLM concepts at bachelor's level, we have chosen to implement an active teaching/learning method based on a Problem-Based Learning approach, structured by the University of Louvain (Belgium) [1]. The aim of this approach, based on the 'Understanding by Design' principles [2], is to enable students to construct the knowledge and skills they are going to acquire, by putting them in "problem" situations.

The teachers first define the 'Targeted Learning Outcomes' and preset them to the students. Then they build and implement a precise sequence of activities combining individual and group work. During this sequence, the teachers no longer become 'knowers' but 'companions', or 'tutors', who do not restrict the students in their taking of initiative and exploring the field of possibilities. They must 'subtly' lead the students to acquire these 'learning outcomes' by their own, and conclude this second phase by a concluding session, validating for the whole students the knowledge and skills developed. The system is rounded off by mechanisms for formative and summative assessments, to ensure that the best possible learning is achieved, based on experience and practice, and to validate the attainment of the targeted learning outcomes. Evaluation concludes the approach.

Case presentation

To illustrate this PBL approach, we implemented it to promote understanding of PLM concepts, using a problem situation based on the tribulations of James Bond and Agent Q, which is a non-industrial context [3]. The aim is for each student to be able to carry out re-design activities (adding components, creating a new version, configuration management), using OnShape CAD software, for a mechatronic product, using the basic concepts of PLM.

The specific Learning Outcomes are being able to design, in collaborative context, a versioned assembly configuration, individually; and being able to distinguish the basic concepts and functionalities of PLM, which are present or absent in OnShape.

The detailed sequence is described in (Figure 1), the whole course lasts 14 hours. After initial tutorials, teams of 4-5 students are defined and a forward phase helps them to identify what they have to learn and what they have to do. Then they work autonomously and individually, and in the backward phase they share their work and produce the deliverables. The restructuring phase is dedicated to collective feedback and their acquisitions validation. The evaluation is based on the work done individually and collectively on the CAD system, by a synthesis of PLM concepts and comparison, then on an MCQ.

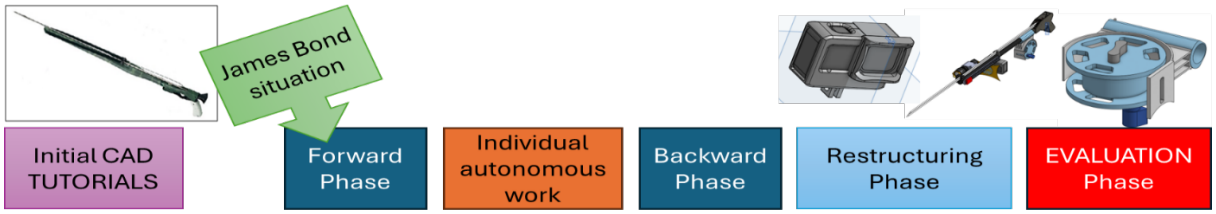

Figure 1. PBL-based implemented pedagogical sequence

Results & Discussion

Several positive findings can be underlined:

- The problem situation stimulates students' involvement by making them active players in their learning process, which is of high interest compared to traditional lectures.
- This situation creates interdependence between team members and so they develop cross-disciplinary skills.
- Better and more complex acquisitions are noticed, based on experience and training: we obtained 80% success after the evaluations, compared to 50% before.

A few points remain to be discussed:

- Real individual involvement during autonomous work: how can we control that each student really works and individually acquire skills.
- The role of the teacher is very important: he must be very close to the students, providing subtle tutoring to guide them, but never giving solutions.
- Is the PLM vs Onshape modality enough to counter the use of generative AI? If AI may generate most of the synthesis, the final comparison must be well-fitted to oblige students to make their own analysis.

Conclusions & Recommendations

We've been experimenting with this PBL approach for 3 years now, and we still see the same enthusiasm from the students, and the same results. However, after 2 years, we realize that they do not remember some of the main concepts, either because of the limitations mentioned above, or because they have a lot more important modules to remember about. Our recommendations are focused on the huge work of design that teachers must achieve in order to control all phases and how students acquire knowledge and skills [4].

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A REVIEW OF THE EFFECTS OF DUAL TRAINING ON THE THREE AGENTS THAT COMPRISE THE TRIAD IN TEACHER EDUCATION

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Keywords: impact of the dual model; teacher training; education degrees; mentoring; school teachers

Introduction

There is limited research on the impact of dual higher education on those involved in it. Therefore, the purpose of this study is to evaluate how the dual model impacts the three agents involved in teacher training (students, school teachers, and university mentors).

Methodology

This aim was achieved through a questionnaire designed by six researchers from three universities in the field of education: Universitat de Lleida, Universitat d'Andorra, and Mondragon University's faculty of Education. A total of 542 responses were collected, of which 371 were from students, 131 from school teachers, and 40 from university mentors.

Results & Discussion

The students rated their dual training experience with a 4,14 on a 1 to 5 scale, while school teachers rated it with a 3,9 and university mentors with a 4,12. In general, students do not perceive that dual training enhances their employability. Results also indicate that school teachers are the most sceptical about dual training. It is perceived that working as a dual mentor is beneficial to their professional development. However, they feel that there is no network of schools that work in a dual model. Lastly, the most regular rates are obtained by university mentors. According to them, dual training strengthens the relationship between theory and practice.

Conclusions

We can conclude that more research should be conducted on possible variables that may increase the satisfaction of school teachers.

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DUAL HIGHER EDUCATION AND IMPACT ON STAKEHOLDERS OF DUAL HE IN SERBIA

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Keywords: Dual education, Higher education, Academy Polytechnic

Introduction

The implementation of the dual study model in Serbia began in 2021 with the aim of strengthening the connection between education and the economy by aligning study programs with the needs of the labor market. This model represents a strategic response to the growing demand for highly qualified personnel with practical skills that can be directly applied in professional settings. The introduction of dual higher education is part of broader educational reforms aimed at increasing employability, reducing the gap between theoretical knowledge and practical competencies, and fostering innovation in teaching methodologies. Data analysis shows that since the introduction of the dual higher education, the interest of students, higher education institutions, and companies has been steadily growing. Companies recognize the potential of dual education in shaping future employees according to their specific needs, while students benefit from early exposure to real work environments, gaining hands-on experience that enhances their professional readiness. Higher education institutions benefit from the opportunity to develop flexible and responsive curricula focused for acquiring current labor market related skills applying dual model of study.[1] The Academy of Applied Studies Polytechnic (Academy Polytechnic) is the first higher education institution in the Republic of Serbia to implement a study program with a dual module. The name of the first accredited study program is "Energy Efficiency and Clean Energy".[1]

Case presentation

The Law of the Dual model of Studies in Higher Education was adopted by the National Assembly of the Republic of Serbia in 2019 (Official Gazette No. 66/2019), and from 2021 dual study programs will be implemented for the first time at higher education institutions. In three years in the Republic of Serbia, the number of higher education institutions of vocational studies that implement the dual model increased by 33.3%.[2][3]

The Academy of Applied Studies Polytechnic was the first to accredit study programs with dual modules. It is the leading higher education institution in the Republic of Serbia in terms of the number of accredited study programs with the dual model, which are implemented trough 22 study programs at the bachelor applied and master applied studies. Study programs with accredited dual modules are implemented in the technical, technological, artistic, social and humanistic fields.[4]The Academy continuously monitors labor market needs and designs study programs accordingly in collaboration with industry.

Results & Discussion

Work-based learning is an integral part of the study program according to the dual model of study that carries a certain number of ECTS and is an organized process during which students at the employer, guided by a mentor, apply theoretical knowledge in a real working environment, have direct contact with business procedures and technologies used in the business world , connect with working professionals and prepare for the world of work.[3]There are four types of higher education institutions (HEIs) in Serbia: universities, Colleges of Academic Studies, Colleges of Applied Studies, and Academies of Applied Studies (which integrate multiple vocational colleges).[5]The total number of higher education institutions enrolling students in the dual study model is 12. The majority consists of Academies of Applied Studies, with 9 institutions offering a dual module.[3]

The Academy of Applied Studies Polytechnic has rich experience in implementing study programs with a dual module.The Academy Polytechnic has also established partnerships and signed dual study model agreements with 52 companies. All study programs have received accreditation from the National Accreditation Body of the National Council for Higher Education of the Republic of Serbia. With the aim of developing and improving study programs in accordance with labor market needs, the Academy Polytechnic has established an Employers' Council consisting of 53 members. The members of the Council participate in the accreditation process of study programs, the development of professional practice programs, the creation of dual study modules, the development of short study programs, and the training of employees in the industry. [4] Students are satisfied because dual education provides them with the opportunity to gain relevant work experience and develop competencies during their studies, enabling them to secure employment more quickly and easily after graduation. On the other hand, employers from various economic sectors have expressed a positive attitude toward the dual study model, emphasizing its effectiveness in integrating theoretical knowledge with practical skills. The feedback has been positive, confirming that this model contributes to the development of professional competencies among students. A survey conducted among graduates of the dual study program at the

Academy Polytechnic revealed that 90% of respondents received a job offer from employers.

Conclusions

Dual education has brought certain challenges, experience so far confirms that dual education in Serbia creates new opportunities and contributes to the development of competencies necessary for the modern labor market. The results indicate that this system has a positive impact on all stakeholders. The further development of dual education requires continuous program improvement, strengthening cooperation between higher education institutions and the business sector, and adapting to the changes brought by digitalization and technological progress.

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IMPLEMENTATION OF LEARNING PATHWAYS FOR ADVANCED MANUFACTURING

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Keywords: Micro-Credentials, Integrated-Engineering, Advanced-Manufacturing, Collaborative Learning Factory, Learning Pathways

Introduction

Rapid technological advancements (e.g., Industry 4.0, Industry 5.0, AI, robotics) are serious Challenges for Industry. Skills mismatch and workforce shortages as well as growing complexity of systems requiring interdisciplinary expertise. Numerous job profiles demand:

- A complete and relevant degree
- A specialization in special technology
- Ability to work in a team, communication, presentation, ...
- Language skills

This means that a typical job requires specialist knowledge, skills and personal factors. Knowledge skills can be taught; abilities can be trained, and personal skills can be developed.
It is of strategic importance to enhance productivity and competitiveness. Supporting sustainability goals and digital transformation as well as societal change. Graduates of the Integrated Engineering program will be able to lead in innovation to meet the future skills [1].

Case presentation

In the first year of study, typical engineering [2] knowledge is provided, in the 2nd year there is a supervised introduction to application and in the 3rd year there is a specialization in special technologies with the accompanying strengthening of skills and the development of applied language skills.
Dual micro-credentials bundle different skills. As a rule, a theoretical basis is supplemented by practical implementation. Micro-credentials MC [3] help to maximize flexibility in technological focuses. The special characteristics of MCs: short and flexible, assessed, proof of competence and

its recognition in the teaching company form central building blocks for this.

Building partnerships between universities, manufacturing companies, and policymakers leads to a high Stakeholder Engagement. Co-designing curricula with input from industry experts and academic leaders as well as the students' needs. Mapping interdisciplinary skills required for advanced manufacturing roles in curriculum development.

By developing specialized content for Integrated Engineering students, such as systems theory, data science, and advanced technologies with incorporating micro credentials are used to address specific skill needs efficiently. Investing in cutting-edge equipment and training facilities, providing financial and administrative support to students and educators.

Establishing a shared industrial training environment where learners collaborate on hands-on, team-based projects (e.g. In the Collaborative Learning Factory).

Promoting innovation and problem-solving through real-world simulations enables Integrated Engineering students to work on interdisciplinary projects. The Collaborating Learning Factory from the LCAMP project [4] forms a building block along the technology chain to define cross-functional learning units.

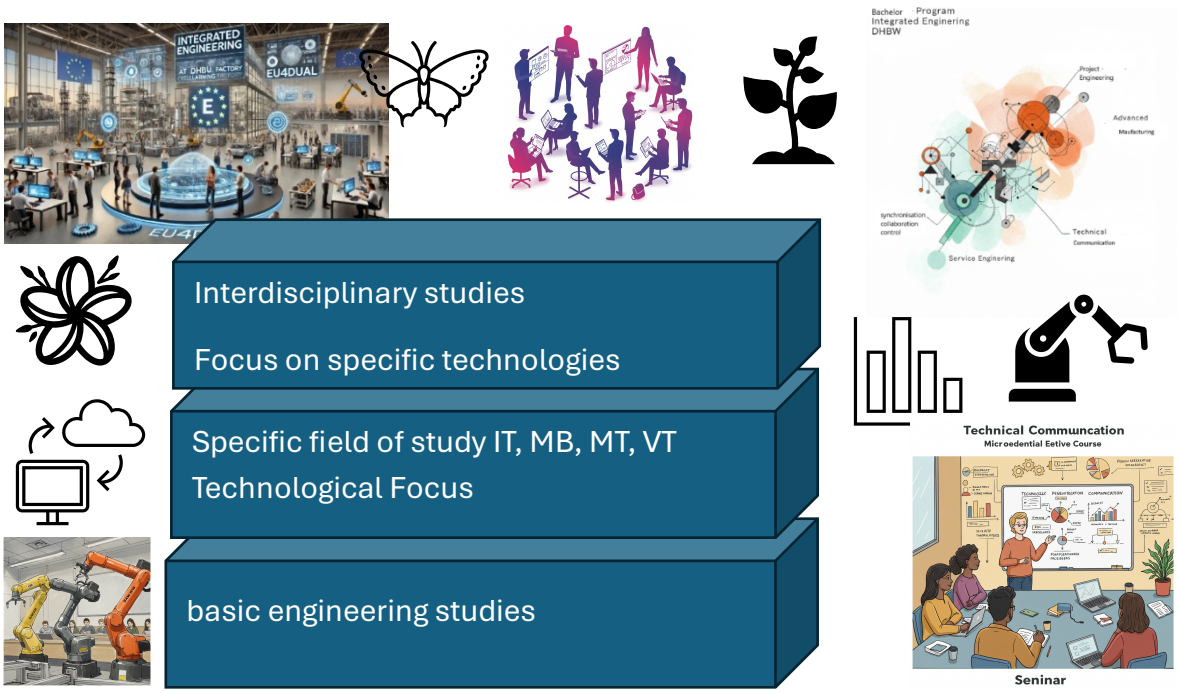

Figure 2. Layered concept for further development of Integrated Engineering with learning Pathways.

Results & Discussion

In order to plan learning paths, it must be possible to locate the micro-credentials in a competence area. A special metric allows algorithms to find qualified learning paths that lead from an initial qualification to a job profile. In the context of our bachelor's programs, the starting point is usually

the Abitur, the target qualifications are based on the technological orientations of our dual partners. Key figures are the EQF level, the level of expertise and the technological domain. Ordered according to specialist knowledge and personal skills, a coordinated profile can be evaluated.

Conclusions & Recommendations

This paper shows the Importance of advanced manufacturing in modern industry. The Relevance of Integrated Engineering in addressing interdisciplinary challenges and the role of learning pathways in equipping engineers with the skills for advanced manufacturing.

- Continuous Feedback and Improvement:
- Regular evaluation of learning outcomes.
- Adapting to evolving industry needs and technological trends.

Integrated Engineering could become a pilot course that flexibly combines future requirements with a lean organization.

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WHICH FORMAT DO LEARNERS OF MICROCREDENTIALS REQUIRE TO PARTICIPATE IN ATTRACTIVE, PROSPERING MC-OFFERS? DECISIVE DIFFERENCES AND CERTAIN NEEDS OF DUAL LEARNERS, AS ONE OF THE MC USER GROUP

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Keywords: Dual Higher Education, MicroCredentials, Flexibility, dual learners, re- and upskilling

Introduction

MicroCredentials (MC), short and targeted learning offers, are provided by an increasing figure of suppliers in various delivery modes. MCs can be offered in highly asynchronous formats using solely digital formats to cater self-paced learning, up to densely scheduled courses requiring on-site presence. Implementing duality and the combination of theoretical and practical educational formats in MicroCredential offers is not yet widespread. Dual learners represent a new target group for the MicroCredentials market, as this group of MC users requires flexibility to harmonize with their working life. This research paper aims to identify attractive and beneficial formats demanded by dual learners.

Methodology

The results presented are based on a survey conducted by the DHBW Heidenheim with employees and dual alumni in the region performed in November 2024. Among a demographic section of questions, the survey encompasses queries concerning the delivery modes of MicroCredential courses regarding the time frame, as well as criteria referring to learning formats, type, offer sequence and further attributes. The survey findings of potential dual MC learners provide an insight into how dual programmes should be designed to offer attractive MC courses and open accessibility for re- and upskilling.

Results & Discussion

The survey for MC learners in Heidenheim comprises a total of 164 participants, including dual students and alumni. According to the DHBWs survey results, a tendency towards scheduling courses over a longer period consisting of only few weekly hours can be identified.

As there cannot be found discrepancies between the different age groups, sectoral differences in the answers to this question become apparent. Particularly dual learners referring to the sector of information and communication technology (ICT) present the highest figure and consent of scheduling MC courses over a longer period (69 %) rather than organizing them in block formats of several consecutive days (23 %). However, the DHBW survey respondents did not indicate to schedule the MC courses according to semesters or trimesters, only 16 % agreed on this option. Moreover, the findings display a high willingness of prospect participants to spend their evenings for re- and upskilling via MCs, e.g. 52 % of employees referring to manufacturing sector and 77 % percent of ICT-members. 56 % of participants of the age group 18-30 declare themselves for scheduling course in the evening rather than on weekends (26 %).

Most respondents agreed on the non-negotiable attributes of MCs, being transparent, recognized, flexible and short learning offers (see figure 1).

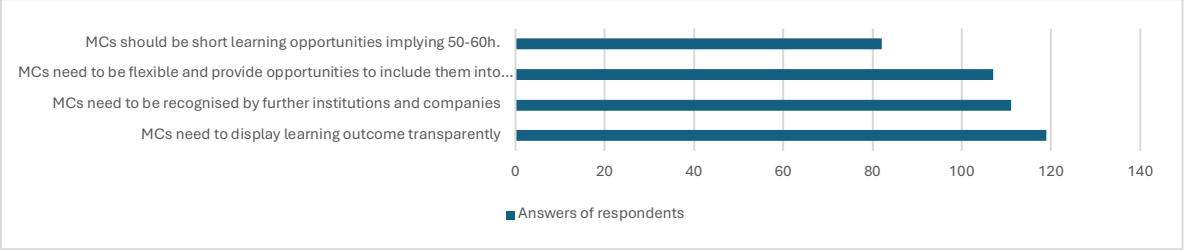

Figure 1: Non-negotiable attributes of MC courses

Regarding the MC type, a clear tendency towards digital formats in comparison to in-presence formats can be found. Particularly participants referring to the healthcare sector declare themselves in favour of virtual formats with 66 % in comparison to 25 % of healthcare indicating performing MC courses in presence. The healthcare sector as well as the service sector present high demand of stacking MCs to acquire qualifications (65 %, 69 %).

In the area of delivery modes of MicroCredentials concerning duration, teaching type and form, there are only few comparable survey results, however differences between concepts of universities and online platforms as providers can be identified [1]. HEIs usually offer

alternative credentials (AC) in a synchronous format requiring in presence attendance of participants, especially in metropolitan areas with good infrastructure. According to the OECD report, HEI providers of MCs utilise their own facilities, hence why the courses are mostly offered in the evenings or on weekends and can therefore be provided for free or at low costs for the learners [1]. MCs provided by HEIs often follow the traditional time frame of a semester or trimester. In comparison, online platforms, providing ACs foster asynchronous formats, including fully virtual formats and a high level of flexibility [1]. According to a survey from Coursera in 2023 with a total of 5.000 learners, 66 % of the respondents indicated their reason to participate was based on gaining credits towards a degree [2].

Conclusions

Dual learners require a high level of flexibility to integrate MC offers into their working and study life. As a result, the findings of the DHBW Heidenheim survey indicate a tendency towards virtual MC formats for dual learners, preferably scheduled in the evenings over a longer period of time consisting of only few weekly hours. The next step of this case study implies further surveys with dual learners to identify suitable examination forms and opening up the survey to partner countries in EU4Dual for international comparison.

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EMPOWERING COMMUNICATION SKILLS THROUGH STORYTELLING: A WORKSHOP-BASED MICROCREDENTIAL FOR THE MODERN LABOUR MARKET

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Keywords: Dual Higher Education, MicroCredentials, Effective Pitching, Storytelling, Extemporaneous Speaking, Innovative Teaching Method, Professional Upskilling, Generation Z Skills, External Stakeholder Inclusion, Regional Collaboration

Introduction

In today's rapidly evolving labor market, employers increasingly demand "future skills" like resilience, teamwork, effective communication and adaptability beyond technical expertise to thrive in interdisciplinary environments. Therefore, higher educational institutions face pressure to prepare students as highly skilled professionals for the continuously changing labour market, imparting both current professional skills and transversal competences.

Recognizing this need, this article introduces an innovative MicroCredential course designed to empower students with critical communication skills. Focusing on storytelling and pitching, the program strategically blends theoretical insights with interactive workshops, enabling students to craft concise, persuasive messages for diverse audiences. This is especially vital in interdisciplinary teams, where precise communication and audience-appropriate messaging are decisive factors for success [1]. By mastering these skills, graduates will be better prepared to navigate the complexities of the modern workplace.

Case presentation

The MicroCredential course (MC) will be piloted as a one-week intensive summer school equipping participants with a future-oriented skillset through innovative pedagogical methods that exceed traditional communication training.

The course emphasizes contextual awareness and well-structured content to enable effective as well as engaging pitch delivery and is based on the framework for strategic entrepreneurial storytelling by Key and Duening [2] using context, content and execution for effective communication. To address the increasing need for critical judgment and evaluation skills regarding AI [3], data literacy training is included. In addition, the MC fosters adaptability and spontaneity – essential competences in today's world of continuous change and ambiguity [1].

Each element of the MC systematically addresses key communication challenges identified in research. By integrating these theoretical foundations into practical, hands-on workshops, the program delivers a comprehensive skill-building experience aligned with employer needs.

On day one, the course starts with teambuilding activities to build rapport among participants, followed by a kickoff workshop introducing essential pitching concepts. Participants immediately apply these concepts in “Slide Karaoke”, a spontaneous presentation exercise where unfamiliar slides are presented, requiring adaptability and quick thinking under pressure.

Over the next three days morning workshops and subsequent practice sessions progressively build participants’ communication toolkit. Learners apply each day’s lessons in structured "elevator pitches", recorded for detailed self-assessment and compeer feedback. Group discussions reinforce learning and provide insights on participants’ continuous progress.

Day two focuses on context-based communication and slide design principles, enabling participants to tailor messaging and create visually compelling presentations. Day three combines storytelling techniques with data literacy to transform complex information into persuasive and accurate narratives. Day four introduces appreciative criticism and the "one-way-critic" methodology, enhancing the ability to process constructive feedback for deeper reflection.

The program concludes with final pitches demonstrating integrated communication skills acquired throughout the week, followed by a final feedback session and a lightning round for sharing key insights. This approach empowers participants to develop compelling narratives, master audience engagement, and embrace constructive feedback as essential elements of their professional communication growth.

Results & Discussion

While concrete results from the pilot implementation are pending, the anticipated outcomes and evaluation methodology have been carefully designed to measure the effectiveness of this approach.

The module will be assessed through a pre-post design with repeated measures, evaluating confidence and competence at multiple stages. A comparative analysis of initial and final pitches will offer valuable insights into skill acquisition, advancement, and application.

Conclusion & Recommendations

This MicroCredential course offers a novel approach to developing critical future skills by bridging the gap between academic theory and workplace application. Through its structured, workshop-based format centered on storytelling and pitching, the program addresses a key need in dual higher education: equipping students with the communication skills demanded by today's employers.

The presented model provides a transferable framework for other institutions seeking to enhance students' future skills development. This framework can be adapted by incorporating industry-specific case studies into the storytelling workshops, tailoring the "Slide Karaoke" activity to address discipline-specific challenges, or integrating local employers into the feedback sessions.

Furthermore, sharing comprehensive results and refined recommendations following the summer school pilot will contribute to the growing body of knowledge around innovative approaches to developing future skills in dual higher education contexts, fostering a collaborative ecosystem for enhancing graduate employability.

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INNOVATIVE APPROACHES TO DESIGNING SUPPORTIVE POLICIES TOWARD DUAL HIGHER EDUCATION

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Keywords: policy innovation, piloting, micro-credentials, higher education, Slovenia

Introduction

Higher education policies are crucial for national educational development since universities are the environment where new generations are equipped to navigate respectfully towards nature and technology while gaining the right balance of practicum and theory.

Reforming professional higher education is one of the key priorities of transforming and developing Slovenian society into Society 5.0. A key document outlining the intentions is the *Resolution on the National Programme of Higher Education to 2030* [1], with subsequent action plans [2] and crucial guidelines for reforming professional higher education [3]. This presentation outlines the results of the latter reform, which can greatly assist in testing the loose approach and later positioning dual education in Slovenia.

Case presentation

The post-COVID era led to a demand for change in various spheres, and the *Recovery and Resilience Plan* (RRP) has addressed them. In the case of the Republic of Slovenia, it encompasses fields ranging from transport, food and farming to higher education.

To effectively merge the flexible and quickly changing characteristics of practicum into formal study programmes, the Slovenian HE ministry launched 38 pilot projects within the RRP, where four public HE institutions experiment with integrating modern, flexible and applied methods, theories, technologies and practices into the existing study programmes to update and revise all of the curriculums. While the foci of the groups differ extensively, their very cores remain linked to reforming educational procedures within each institution respectively, specific experiments taking place, or new educational directions emerging from them while taking into consideration that a special feature of Slovenia is that professional study

programmes are part of the universities and not polytechnics – with RRP we also strive to make a greater distinction between professional and academic programmes.

Results & Discussion

The pilot projects put forward the majority opinion that a longer practicum is necessary, which is a good trigger for dual system development. Regardless of RRP focusing on reforming professional study programmes and secondly on a plethora of other activities, we recognise the need to explicitly test the dual programmes, which is predicted in a new cohesion instrument. Another issue to resolve is providing enough companies willing to participate in the dual system. Namely, more than 90% are medium- or small-sized and claim to be difficult to take students or apprentices for practicum. Thirdly, despite the general support of various chambers, the questions of payment (either the employer or the state) remain unanswered.

The piloting results bring a variety of options to upgrade and leverage evolving dual practices, such as practical windows, guest lecturers from the economic sector, funding for student-economy partnerships (i.e. with additional ministry-funded programs to link university and economy sector, such as 15.2 million € worth *Problem-based learning for students in the workplace: economy, non-economy and non-profit sector in the local/regional environment 2024-2027* [4]), etc. The piloting showed there is room for improvement in the areas of interdisciplinarity, behavioral barriers on institutional levels and true flexibility. The pilots have endeavoured to overcome these barriers or tried to identify solutions for them, which was deduced from various workshops (2022–2025).

Importantly, universities created connections with employers. Jointly they co-created micro-credentials and revised some study programs. This networking is very important in the context of possible dual systems since the universities created links with companies and thus networks of partners for dual systems. On the other hand, during the piloting period, the companies expressed the need for various trainings (for up-skilling and re-skilling). While identifying developmental gaps, the university developers and the economic sector also participated in policy sandboxes to assist the ministry in reforming the Slovenian *Higher Education Act*, which now incorporates an article on micro-credentials, also officially leaning and leading towards greater connectivity of theory and practice with while-studying and life-long learning frames.

Conclusions & Recommendations

Based on the results the universities started to transform in a sustainable way pedagogically by trying to adapt even more to market, employment and environmental needs; the ministry on the other hand enabled the platform for joint discussions and co-creating support mechanisms. But at the same time they both identified that (i) progress has been made in aligning institutional initiatives with strategic national objectives, but (ii) certain gaps remain in keeping the ambition to transform the system fully.

Bridging the gap of flexibility in teaching, quality assurance and prompt responsiveness to economic, digital and societal demands while prioritising teaching excellence with

institutional resilience remains of paramount importance. Professional study programmes are important for the labour market, and the RRP came at the right time since we provided the opportunity to the universities for a bottom-up approach, experimenting and networking with commerce. To achieve that, innovative approaches such as pilot projects within RRP allow us to plan, test and adapt the flexibility of national higher education while accommodating and building on the EU guidelines for green and digital transition.

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AN ALTERNATIVE MODEL OF DUAL EDUCATION IN THE DEVELOPMENT OF THE FINANCIAL SKILLS OF STUDENTS

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Keywords: dual education, labour market, finance, stock market

Introduction

In many countries higher education is based on the principle of dual education, which combines theory and practice in the workplace [1]. Students spend part of their education in school and part directly in the workplace. Such an education system allows a smooth transition from the role of an apprentice to that of a fully qualified employee. Dual education benefits all participants [2]. A key benefit for students is the removal of barriers to accessing the labour market while continuing their education. From the employer's point of view, the undoubted advantage of dual training is the faster familiarization of the new employee and the reduced training time. The economy also benefits from this system, as school leavers become better prepared employees [3]. A typical dual training process requires cooperation between the school or college and the employer [4]. If there is a shortage of suitable employers in the region willing to take on apprentices in a particular area of training, young people may have to look for other development opportunities or abandon their ambitions. There is also an intermediate solution where the school or college takes responsibility for organizing work experience. However, this approach is essentially an extension of general academic education with practical elements. Nevertheless, such arrangements can provide students with a minimum of exposure to an area of the economy that would otherwise be inaccessible to them. The study presented in this paper concerns the training of investment skills of students of Koszalin University of Technology and students of regional secondary schools using the XStation5 platform and in cooperation with a financial institution in Poland. The introduction of work-based learning elements within dual education in the field of finance can have a significant impact on preparing young people for future challenges in the labour market, as well as contributing to a better understanding of the complexity of the economic environment [5]. As a result, dual education and cooperation with the financial sector can become a springboard for young people's success in the labour market.

Case presentation

Investing in young people's economic and financial literacy is crucial not only for their individual development, but also for the well-being of society as a whole. Improving education in this area is an investment in the future of students, which translates into greater financial stability, better career choices and overall economic stability.

Activities carried out at Koszalin University of Technology, which are part of the trend towards a practical approach to economics and finance and the development of practical skills, include:

1. National Competition for Young Investors. The National Competition for Young Investors will be held in 2023, 2024 and 2025. The competition is supported by major financial institutions in Poland, including the Warsaw Stock Exchange. The competition is aimed at secondary school students and participants invest virtual money via the XStation5 investment platform. The students' task was to achieve the highest possible return on the chosen market of shares and ETFs. The aim is to promote stock market education. It's important to interest students in the principles of stock markets, investment and decision-making under conditions of risk and uncertainty.

2. The Stock Exchange School. The Stock Exchange School is organised by the Koszalin University of Technology in cooperation with the Warsaw Stock Exchange Foundation. The aim of the courses is to make participants aware of the fact that the stock exchange is a good place to build up savings, especially in the long term. Students receive microcredentials. The courses are taught by experienced stock market practitioners with stock exchange broker and/or investment advisor certificates and academic experts.

3. The workshops and seminars are held by XTB Brokerage House. The workshops and seminars are held by analysts from XTB Brokerage House and cover the practical aspects of using the XStation 5 platform. So far, 16 workshops have been held at the Koszalin University of Technology. More than 300 students have attended the training courses. Participation in the training courses enables students to develop a range of practical skills related to investing and analyzing financial markets.

4. Santander Universidades programme. Together with Santander Bank S.A., we run projects to support young talent and education. The Santander project includes training for students, from language courses to the use of artificial intelligence in finance. Santander Bank also supports the development of young talent by funding scholarships for outstanding achievements in social, artistic, sporting and scientific fields.

Results & Conclusions

Participants in training courses organized at Koszalin University of Technology acquire practical skills in stock market investment, financial analysis and making informed investment decisions. By participating in the Young Investor Competition, participants learn the basics of economics, stock market principles and investment risks. In the practical part of the training, they apply their knowledge by investing virtual funds on the XStation 5 platform. The Stock Exchange School programme develops skills in fundamental and

technical analysis, company valuation and investment portfolio management. In addition, training sessions conducted by experienced XTB brokers enable participants to practically master the platform's analytical tools, including the interpretation of technical indicators, position management and the use of various tools to support investment decisions. The knowledge gained can be applied in many ways in the student's professional life, particularly in the financial, economic and investment industries. Knowledge of stock market principles and the ability to analyse stock markets can be extremely valuable to future financial analysts, stockbrokers, investment advisers and fund managers. Practical knowledge of analytical tools such as technical indicators and fundamental analysis supports sound financial decision-making, which is also important for entrepreneurs and business managers. The ability to manage risk and be financially efficient is also useful in the banking sector and when working for consulting firms. Practical skills allow participants to adapt better to dynamic market conditions, but also increase their chances of investment success.

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ANALYSING THE INFLUENCE OF WORK EXPERIENCE ON STUDENTS' SOFT SKILLS: A QUANTITATIVE STUDY

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Keywords: Soft skills, Interpersonal skills, Career-related skills, Work experience, Dual Higher Education

Introduction

Soft skills, defined as non-technical, interpersonal and career-related skills, play a crucial role in shaping the professional identities of graduates [1]. Since these skills are best cultivated in practical environments, higher education institutions are increasingly adopting various educational strategies, such as Dual Higher Education (DHE) programs [2], to foster their development. [3] Nevertheless, non-formal workplace experiences may also influence the acquisition of these skills. [4] In this context, this article examines whether prior work experience has an effect on student soft skills, with a specific focus on social competencies, efficacy beliefs, flexibility, lifelong learning, and oral and written communication.

Methodology

A quantitative study was conducted involving 709 students enrolled in two bachelor's degree programs in social sciences. Using a cross-sectional approach, data was gathered via an online questionnaire at the beginning of the 2024-2025 academic year across all four levels of the bachelor’s degree. The questionnaire, based on the SECQ Questionnaire [5], included the previously mentioned soft skills, along with some demographic variables and questions about prior dual and work experience.

Results & Discussion

Preliminary findings reveal significant differences in social competences, lifelong learning, and communication among students with prior work experience, though the relationship varies depending on gender and degree year.

Conclusions

These results indicate that work experience and educational strategies, including practicums and DHE programs, may influence student perceptions of their soft skills. However, further research is necessary to evaluate the impact of these strategies on the development of these skills among students.

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DEVELOPING AN INSTRUMENT FOR ASSESSING SOFT SKILLS

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Keywords: Dual Higher Education 1, Work-based learning 2, soft skills 3, pilot study 4

Introduction

Dual Higher Education integrates academic learning with practical workplace training, emphasizing the development of both technical and soft skills. Soft skills are critical for students' success in professional environments [1,2]. Special emphasis should be placed on soft skills at universities as there seems to be a gap between the employers' expectations and the university graduates' skills [3]. Companies need employees who can solve problems quickly and creatively [4]. The term soft skills entail a range of non-technical skills that relate to how individuals work and interact with others [3]. However, measuring soft skills can be challenging due to their subjective and intangible nature.

Methodology

Objectives

The primary aim of this pilot study is to construct and empirically test an online instrument to assess different aspects of soft skills in higher education. Our research questions are related to the instrument, the structure, and dimensions of soft skills.

Participants

185 full time students answered the questions: male (N=114), female (N=71). The number of students from different faculties were the following: GAMF Faculty of Engineering and Information Technology (N=106), Faculty of Economics and Business (N=68), Faculty of Horticulture and Rural Development (N=11).

The instrument

Microsoft Forms online platform was used to design the questionnaire. The survey was anonymous, and voluntary. Part 1 – general questions: We asked the students about their gender, age, the faculty they study at, which semester they spend at the university, whether they are dual students or not, whether they have a permanent workplace or not. Part 2. – The respondents indicated how important soft skills are at the workplace. A 6-point Likert scale was employed: 1 – not important – 6 –very important. 10 dimensions of soft skills were selected: teamwork, communication, time management, foreign language skills, presentation skills, creativity, critical thinking, stress tolerance, autonomy, and adaptability [1,2,3].

Part 3. – The students were asked to indicate their perception of their level of the skills in each area using the 6-point Likert scale. The students had to evaluate themselves on the following scale: How true the following statements are for you: it is never true (1) – it is always true (6).

Results & Discussion

The psychometric properties of the questionnaire show an acceptable reliability: Cronbach's Alpha: 0.75. The analysis of the whole sample indicates that students place primary importance on communication (5.41), time management (5.10), stress tolerance (5.24), autonomy (5.15) and adaptability (5.03). Our research reveals that the students evaluate themselves better in teamwork (4.17), communication (4.15), stress tolerance (4.43), autonomy (4.37) adaptability (4.37), and time management (4.05). However, they find themselves slightly weaker in foreign language skills (3.65), presentation skills (3.88), creativity (3.98) and critical thinking (3.98).

Soft skills through a gender lens

Both male and female students give a high priority to communication skills, stress tolerance and autonomy. However, time management seem to be more important to male students than female students. The self-evaluation showed that both male and female students identified foreign language communication and presentation skills as abilities to be improved. Also, male students identified time management, female students specified creativity as a skill to be developed.

Students studying in different semesters

Students studying in their 6th semester value communication skills, foreign language skills and autonomy higher than students studying in the 2nd and 4th semester. Regarding self-evaluation, the students seem to show a slight improvement in almost every soft skill except time management and foreign language skills.

Dual and cooperative learning

Dual students put greater importance on soft skills than non-dual students especially on teamwork, communication, presentation skills, critical thinking, and stress tolerance. Also, dual students evaluate themselves higher than non-dual students in 5 soft skills i.e. teamwork, communication, creativity, presentation skills and autonomy. The students who have a permanent workplace attached higher importance to teamwork, communication skills, time management and foreign language skills. Also, they evaluated themselves slightly higher than the students who do not have work experience in skills e.g. teamwork, communication skills, time management, autonomy, adaptability and stress tolerance.

Conclusions

Our pilot study showed that the students attach great importance to communication, time management, stress tolerance, autonomy and adaptability. Male and female students generally gave similar answers. Both male and female students indicated that foreign language, communication and presentation skills are to be improved. Soft skills become slightly more important for students during university years and their skills improve in most skills. Students studying in dual and cooperative education give higher importance and value themselves higher in soft skills.

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DUAL EDUCATION IN CYBER SECURITY

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Keywords: High education, Dual education, Cyber Security, Law regulations, IT technologies

Introduction

Higher education in Information Security is very demanding. Access to confidential data, working with various sensitive IT technologies, and student discipline are problematic in this type of education.

Several ethical issues in information security are related to business ethical issues: Privacy Protection of data, Trust, Control, Accessibility, Confidentiality, Responsibility on businesses to use ethical codes of conduct, Data integrity, Consent Transparency, Availability, Accountability, Autonomy, Ownership, Usability [1]. Humans are the cybersecurity weakness in business due to human error and their significant lack of cybersecurity knowledge [2]. This weak point is something cybercriminals use to target companies and achieve their goals. There is a general belief in (businesses and international bodies) that cybersecurity awareness and education should be improved [3].

Oneway corporations can properly treat this problem and take clear steps toward implementing information security measures is to introduce stricter legal regulations at the state level in cyber security. The lack of professional staff has led companies that provide services in the field of information security to engage in dual education in this area. This approach enables students to adapt to practical skills faster and develop appropriate ethics for work in this field, but it also opens many issues.

Case presentation

With the application of new versions of the laws of the Republic of Serbia related to the protection of personal data and cyber security, companies have come to the position of engaging some of their employees in jobs where they will actively participate in the application of cyber security. Companies that provide services in the field of information security found their interest in engaging in educating employees of client companies to simplify the job of implementing and maintaining information security measures in those companies and raise it to a higher level. Therefore, it is necessary to teach employees skills from various previous educations in the field of information security, using the correct approach and appropriate ethics. In cooperation with a company that provides services in the field of cyber security and the Academy of Applied Studies Polytechnic, the Academy created a vocational study program in cyber security with a classic and dual study model. The academy fully complied with the company's requirements regarding the curriculum.

The scenario of the dual study model has been the main problem of the cooperation between the Academy and the company since the beginning of the collaboration. Providing company workplace access is impossible due to the protection of confidential technologies and the client's corporate data. On the other hand, students in the beginning of dual education do not have an ethical approach to information security. Through the cooperation between the company and the Academy, a computer laboratory was formed in the academy, equipped with the necessary hardware and software that enables the implementation of various scenarios of cyber security measures with the possibility of remote access to the laboratory from the company. Student mentors from the company are engaged in the laboratory through physical and remote access.

Creating different scenarios by the company's experts allowed the students to get closer to the actual working conditions in this field. The cooperation of academic mentors and mentors in the company created an atmosphere in which the company provides services to the Academy in the field of cyber security, and the students are both observers and participants. A comprehensive picture of students was created by controlling and monitoring their progress in developing knowledge and skills, discipline, self-awareness, responsibility, and ethics. In a real working environment with the presence of professionals for a certain period, the students clearly show all their behavior anomalies. With suggestions and timely corrections, students adapt to the rules and strict discipline that govern the application of information security measures in corporations.

Results & Discussion

The presented approach in dual education allowed us to create a safe environment for students in the dual education model in the field of cyber security by satisfying all legal frameworks that regulate this area. Through the intensive control of students and monitoring

the development of practical skills, the student mentors obtain a clear insight into their behavior, discipline, and code of ethics. Developing an appropriate ethical approach also requires a certain maturity of students because they must accept specific rules of conduct that apply to cyber security after completing their studies.

Conclusions & Recommendations

Implementing dual education in cyber security is not impossible. The understanding of the Academy and the company that provides services in this area enabled the simulation of actual working conditions in laboratories with the participation of experts from the partner company.

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Future of work

EXPLORING THE POTENTIAL OF SERIOUS GAMES AND VIRTUAL REALITY FOR ENHANCING NURSE TRAINING SIMULATION

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Keywords: Virtual Reality, Nurse Education, Realistic Learning, Hands On Learning Opportunities, Empower Nurses Education

Introduction

Today's medical industry suffers a shortage of nurses. The World Health Organisation (WHO) anticipates that the current demand of 4.5 million human resources is to increase by a further 33% by the end of 2030 (Boniol et al., 2022).

Student nurses face various challenges, especially when it comes to gaining hands-on practice due to ratio imbalance between mentor resources and number of students. The high volume of students and rising medical issues overpower the limited time mentors are given, creating an issue for all involved: mentors, students, and patients. From one hand, the student is not receiving the individual attention required to fully understand and have room to ask questions, and- in cases of placements- the patient is put in an even more uncomfortable situation of waiting and uncertainty at a vulnerable time. (Attard Cortis & Muir, 2024; Vella et al., 2023).

Mentors require experience in the field but not teaching knowledge. In cases where mentors are selected to shadow student nurses but lack the proper techniques to

guide them, room for errors multiply and can potentially even create cycles of bad treatments and generational habits. Miscommunications and misunderstandings have no place in the medical field and the education system must ensure to minimise the risk and maximise the resources. (Attard Cortis & Muir, 2024; Vella et al., 2023).

The quality of education is one of the various key improvements that could be implemented to remedy this, as a lack of involvement and impactful mentorship in a nursing student's scholastic journey can greatly affect both their general experience and long-term retention (Nydahl et al., 2024).

A way to improve learning is to give the student the opportunity to have access to hands-on learning without the constant need of a mentor, teacher, or patient. VR simulations are a way to do this and benefit the learning experience through various aspects.

The advantages of VR simulations include- but are not limited to- being able to be used anywhere and anytime, and require minimal equipment. Medical scenarios may be repeated as necessary, giving the student the tools to learn at their own individual pace. Furthermore, the simulation can be developed to handle many different treatments and scenarios which can be very complicated or else require rare treatments. Further, VR simulations allow the student the possibility of making mistakes without serious repercussions on the patient, lessening the pressure of the experience and prioritising learning. (Garcia-Pazo et al., 2023; Plotzky et al., 2023; Raab et al., 2023).

The above are only a few of the issues today's student nurses face. Table 2.1 below delves further.

Methodology

This study presents a holistic approach to the use of virtual reality (VR) as an immersive educational tool to teach and train prospective nurses. The approach employed focuses on using VR as part of class-based training that can provide detailed immersive simulations during classroom training and beyond. The preliminary prototype focuses on evaluating the efficiency and accuracy which VR could provide in an immersive, accurate, and virtual medical training simulations, and thus concurrently improve the skill sets required by nurses.

Discussion

Using this software, nursing students have the facility of experiencing both hands-on and theoretical practice prior to real-life clinical placements, as well as an added flexibility to their pace of learning with minimal resources required, repeating scenarios and many other benefits that can enhance the future of learning for nurses.

Table 2.1 Summary of VRS Integration and Solutions

Learning Issues	Virtual Reality Solutions
Increased student-to-mentor ratio	Allows the student to be indepen- dent, with scalable simulations.
Lack of experienced mentors teach- ing student nurses	Provides standardized, high-quality realistic scenarios with great guid- ance.
Uneven experience clinical scenario exposure	The same experience for every scenario exposure.
Hospital overcrowding hence no space for students	Space to learn can be anywhere which could be class or home
Waste from disposables while learn- ing	Eliminates need for physical dispos- ables since VR is the only equip- ment needed.

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BRIDGING ERAS: ECO-LINGUISTIC PATHWAYS FOR ACADEMIC WELL-BEING IN INDUSTRY 5.0 WORKPLACES

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Keywords: Industry 5.0, academic workplace, well-being, intergenerational adaptation, digital transformation

Introduction

The rapid digitalization associated with Industry 5.0 is profoundly reshaping academic workplaces, introducing new challenges that affect employees across different generational categories, including Baby Boomers, Generation X, and Millennials. While technological advancements promise efficiency and sustainability, they also generate disparities in digital competence, potentially leading to exclusion, stress, and workplace dissatisfaction. Universities and research institutions must adopt inclusive strategies that bridge generational gaps, ensuring that all employees, regardless of their digital proficiency, can thrive in evolving professional environments. This paper explores eco-linguistic approaches to foster academic well-being, emphasizing the interplay between language, digital adaptation, environment and workplace sustainability.

Methodology

The study employs an interdisciplinary approach, integrating eco-linguistics, organizational psychology, and digital transformation theories. A qualitative analysis of scholarly literature, workplace case studies, and policy recommendations is conducted to assess the impact of digitalization on academic well-being. Some theoretical contributions from Halliday's systemic functional linguistics, Stibbe's narratives of care, as well as Zhang's intergenerational learning framework provide the foundation for constructing an inclusive

workplace model. Data collection includes semi-structured interviews with faculty members across different age groups to identify specific challenges and best practices in digital adaptation.

Results & Discussion

Digitalization and Generational Challenges

The digital transformation of academia disproportionately affects different generational cohorts. While younger faculty members (Millennials and Gen Z) often adapt seamlessly to new digital tools, older generations (Gen X and Baby Boomers) may experience technological barriers, leading to workplace stress and reduced job satisfaction. A balanced digital ecosystem must accommodate diverse learning curves and provide continuous professional development opportunities.

The Role of Eco-Linguistics in Workplace Adaptation

Eco-linguistics provides valuable insights into how language influences perceptions of technological change. Inclusive workplace communication—framed through positive narratives of adaptability, collaboration, and support—can mitigate digital resistance. Drawing from Stibbe's concept of ecolinguistic narratives, academic institutions should employ supportive discourse that reinforces accessibility and shared responsibility rather than deficit-based language that marginalizes employees struggling with digital adaptation.

Biophilic Design and Mental Well-Being

Building on Halliday's linguistic perspectives, a stress-free academic workplace should incorporate biophilic design principles, integrating natural elements such as plants, open spaces, and daylight access. These factors have been shown to enhance cognitive function, creativity, and emotional resilience, crucial for faculty members adapting to an increasingly digital work environment.

Digital Support Frameworks and Mentorship

Zhang's research on intergenerational learning highlights the importance of reciprocal knowledge exchange between experienced scholars and tech-savvy younger colleagues.

Universities should implement mentorship programs where faculty members collaborate on digital competencies, ensuring knowledge transfer that benefits all generations. Additionally, dedicated digital support teams can offer tailored training and troubleshooting assistance, fostering a culture of inclusion and continuous learning.

Conclusions

The transition to Industry 5.0 presents both challenges and opportunities for academic workplaces. Addressing generational disparities in digital literacy through eco-linguistic principles, biophilic workplace design, and structured mentorship programs can enhance well-being and productivity. Universities must cultivate inclusive digital environments that support faculty members at all stages of technological adaptation. By embedding holistic and sustainable strategies into institutional frameworks, academia can align technological progress with human-centric values, ensuring resilience and inclusivity in the evolving educational landscape.

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FOSTERING SUSTAINABILITY AWARENESS OF AVIATION STUDENTS BY MODIFYING THE CURRICULA

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Keywords: Sustainability, Aerospace Engineering, Curricula, Theses Topics.

Introduction

Aviation industry faces significant sustainability challenges, including high CO_2 emissions, reliance on fossil fuels, and environmental noise pollution. Efforts to mitigate these issues involve advancements in fuel efficiency, development of sustainable aviation fuels (SAFs), and the exploration of electric or hydrogen-powered aircraft. However, achieving long-term sustainability in aviation requires global collaboration, regulatory support, and significant technological innovation to balance environmental concerns with the industry's continued growth. The related workforce for these challenges is of utmost importance and currently poses a bottleneck. Adequate graduates from aviation bachelor's and master's degree programs are highly welcome and the aviation institute of FH JOANNEUM exhibits a very promising trend:

Whilst about ten years agon with a lack of lectures addressing sustainability aspect in aerospace, there were also hardly any theses addressing sustainability aspects in aerospace proposed by students. With curricula changes both in the bachelor's and master's degree programs, the number of final theses addressing these sustainability challenges has steadily increased. The presentation here offers a quantitative and surprisingly positive correlation between number of lectures with "green" content and the number of "green" theses. The curricula changes can thus hopefully serve as a role model for other STEM degree programs.

Methodology

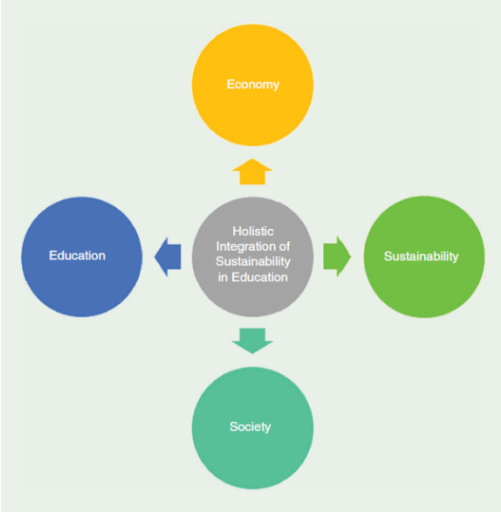

Figure 1. Holistic approach for curriculum development [1]

It is well-known from publications, e.g. [1], that a holistic approach needs to be chosen in order to develop and offer a competitive curriculum with sustainability aspects (Figure 1). A detailed stakeholder analysis has been performed at FH JOANNEUM's aviation institute. This is a mandatory part of the continuous quality assurance process.

Results & Discussion

To integrate sustainability into curricula requires strategic planning and interdisciplinary collaboration (e.g. [2] and Figure 2 [3]). Science courses can cover topics like novel types of fuel, while technology education emphasizes sustainable design. Engineering classes can focus on real-world sustainability challenges, encouraging students to create eco-friendly solutions. Mathematics can incorporate environmental data analysis, fostering quantitative understanding of sustainability. Project-based learning and interdisciplinary collaboration help students grasp the interconnected nature of sustainability issues. The aviation institute has established sustainability labs (H_2, fuel cells, sustainable fibers etc.) and supports research in these areas. In summary and as a "toolbox" to embed sustainability into the aerospace engineering education, the following tasks can be stated and prepare students to develop innovative solutions for global environmental and social challenges:

- Empower aviation students to tackle sustainability challenges through practical, project-based learning.
- Integrate sustainability across STEM disciplines to emphasize its importance.
- Establish sustainability labs for research.
- Incorporate environmental data analysis into mathematics courses.
- Organize field trips and invite guest speakers of sustainable industries for practical insights.

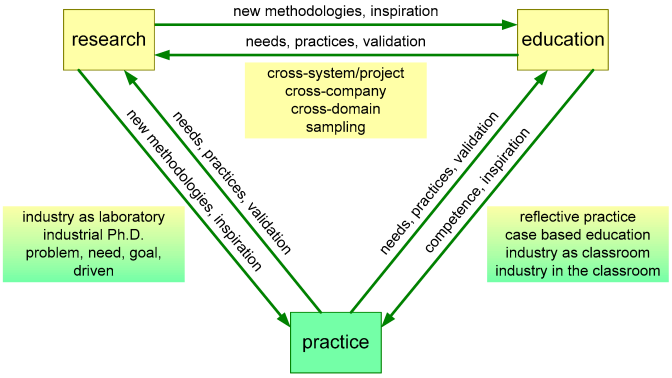

Figure 2. Interaction between practice, curriculum and research [3]

4. Conclusions

Integrating sustainability into curricula of aerospace engineering education equips students with the skills to develop innovative, eco-friendly solutions. By embedding ecological responsibility into the bachelor's and master's degree programs, the aviation institute of FH JOANNEUM prepares graduates for future problem-solving to tackle global challenges. It is quite noteworthy that only small but dedicated measures are sufficient to trigger an increased interest in sustainability amongst the aviation students both in their course work as well in the academic theses. This approach fosters a more sustainable future in aviation.

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WELL-BEING AT WORK AND STUDY: LESSONS FROM VOCATIONAL STUDENTS ON BALANCING EMPLOYMENT AND EDUCATION

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Keywords: vocational students; mental health; work-life balance; industry 5.0; sustainability

Introduction

The dual responsibility of full-time studies and part-time employment presents significant challenges for vocational students, particularly in terms of academic performance and wellbeing (Aleidi et al., 2020; Verulava & Jorbenadze, 2022; Zhang & Yang, 2020). The increasing prevalence of term-time employment among full-time students has raised concerns about its impact on learning outcomes, personal development, and psychological well-being (Perna, 2023). While higher education institutions strive to provide academic support, the reality remains that financial necessity and the desire for professional experience drive many students into part-time work (Kosi et al., 2013).

Malta presents a unique context as tuition fees are waived for full-time undergraduate students, and maintenance grants are provided by the government (Government of Malta, 2023). Nevertheless, despite these financial provisions, many students report that the cost of living, personal expenses, and familial responsibilities necessitate additional income sources (Fenech & Raykov, 2018). As a result, a significant proportion of undergraduate students take up part-time work, often in industries unrelated to their field of study. Research has shown that students working over 20 hours per week experience declining academic performance and increased stress levels (Yanbarisova, 2015), making it crucial to examine the broader implications of student employment within the local vocational education sector.

The impact of employment on student performance has been widely studied in university contexts, yet limited research has been dedicated to vocational students undertaking higher education degrees. This study addresses this gap, investigating how employment affects the well-being and academic achievement of vocational students pursuing Level 6 degrees in Health and Social Care and Early Years at the Institute of Community Services (ICS) within the Malta College of Arts, Science and Technology (MCAST).

Methodology

This study employed a mixed-methods convergent parallel design (Creswell, 2003) to investigate the educational needs of students enrolled in a degree programme at MCAST. A qualitative focus group with Key Informants (n=7), including Deputy Directors, Institute Coordinators, Mentors, and the Chaplain, provided contextual insights that informed the development of a Likert-scale needs assessment questionnaire. This instrument was disseminated among two student cohorts (n=193), yielding a 69% response rate (n=133). To complement these findings, semi-structured interviews were conducted with ten randomly selected students across nine classes, allowing for an in-depth exploration of their perspectives. These interviews combined induction and deduction, flexibility, and reflexivity (Babbie & Mouton, 2001), with probing techniques enhancing data richness (Alordiah & Oji, 2024). Triangulation of quantitative and qualitative data served as a validity check ensuring methodological rigour (Creswell, 2003). Ethical clearance and confidentiality measures were strictly observed throughout the study.

Results & Discussion

The findings of this study highlight several key themes related to the employment needs and academic performance of full-time vocational students. Firstly, financial necessity is a major driver for student employment, with many participants working part-time to cover living expenses, study-related costs, and social activities. While tuition fees are not an issue in Malta, students still face financial pressures that necessitate employment.

Secondly, the relevance of part-time work to academic studies varies. Some students strategically choose employment that aligns with their field of study, allowing them to gain practical experience, enhance their career prospects, and bridge the gap between theory and practice. Others engage in unrelated work, primarily for financial reasons, which may have a more adverse impact on their studies.

Another key theme is the impact of employment on student well-being. Many students report experiencing fatigue, stress, and mental health challenges, particularly during assessment periods. Despite this, most students do not skip lectures, arrive late, or report significant concentration issues in class.

Finally, students have developed various coping strategies, such as time management techniques and budgeting, to balance their academic and employment commitments. However, they also call for greater institutional support, such as more flexible schedules, studyrelated work opportunities, and increased financial aid.

Conclusions

These issues underscore the need for human-centric, sustainable approaches to work and education. The research carries significant implications for education and employment, particularly within Industry 5.0, which prioritises sustainability, resilience, and human-centric principles. Academic institutions should adapt curricula and assessments to better reflect working students' realities and enhance resilience-building support. Employers are encouraged to offer flexible working arrangements and mental health resources for young employees to manage competing demands of work and education. Coordinated efforts to address financial, social, and psychological pressures are essential for aligning educational and employment practices with Industry 5.0, fostering student well-being and academic success.

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NAVIGATING THE FUTURE OF WORK: THE ROLE OF PERSONAL BRANDING IN HIGHER EDUCATION FOR STUDENTS

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Keywords: personal branding - reputation - career development - higher education – self-evaluation

Abstract

As the work landscape evolves, personal branding has emerged as a critical competency for students navigating their career paths. This paper explores the role of personal branding in higher education and its implications for preparing students to thrive in the future workforce by examining current trends and challenges in the job market. This study highlights the importance of higher education institutions integrating personal branding into their curricula. The research adopts an exploratory approach utilizing both qualitative and quantitative methods. This mixed-methods approach allows for a comprehensive understanding of how personal branding impacts students' career readiness and their future professional identity. The findings suggest that a robust focus on personal branding not only provides students with essential skills but also fosters resilience and adaptability in an increasingly competitive job environment. This paper advocates for a comprehensive approach to personal branding in higher education, positioning it as a fundamental element of career readiness

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LEVERAGING LLM AND GAN FOR SYNTHETIC DATA GENERATION: A NOVEL ARCHITECTURE FOR MARKET RESEARCH

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Keywords: Artificial Intelligence (AI), Machine Learning (ML), Market Research, Data Scarcity, Survey Alternatives, Synthetic Data Generation, Synthetic Data Architecture, Large Language models (LLM), Generative Adversarial Networks (GAN), Design Science Research (DSR), Laboratory Experiment, Cross-Industry Adaptability, Data Democratization

Introduction

The scarcity of high-quality data poses significant challenges in product development, especially for niche applications like beer brewing. In this case study, we propose a conceptual architecture combining LLMs and GANs to generate survey-like data without needing to conduct real surveys, addressing data limitations in small-scale industries [6,8]. While LLMs theoretically enable context-aware descriptor generation and GANs such as WGAN-GP provide sophisticated data synthesis [1,5], the framework remains untested, with inherent risks of mode collapse and LLM hallucinations requiring mitigation.

Case presentation

Protecting privacy and reducing dependence on limited real data remain pressing challenges [3]. Synthetic data offers a promising solution by artificially generating data through algorithms [9] or simulations [7,10] that mimic the characteristics and patterns of real-world data. Two standout technologies driving this field are LLMs and GANs. LLMs, trained on vast text corpora, excel at producing contextually coherent language content through structured prompting [2] which can be leveraged for synthetic data generation [6,13].

Meanwhile, GANs leverage adversarial training between generator (which mimics real-world data) and discriminator (which evaluates authenticity) to generate realistic synthetic data [4].

Although both technologies are promising individually, there is little research exploring their combined use. Recent papers investigate the usage of LLMs and GANs for tabular data generation, where the LLM acts as the generator and Proximal Policy Optimization is used to improve the quality [11]. In other frameworks LLMs are fine-tuned with converted case specific data and GANs are used to increase the dataset size, but they are not used consecutively [12]. Other approaches use a Diffusion Model based reinforcement learning approach and delegate each subtask to the most suitable generative model [14]. Most research focuses on Visual/ Image generation models rather than text generation.

To the best of our knowledge, there is no current research that suggests our structure of LLMs and a GAN. As other studies focus on using multiple models to fulfill the subtasks or do not have a focus on the use case of market research.

Results & Discussion

The proposed LLM-GAN architecture (Fig. 1) utilizes a multi-phase process combining reasoning and planning with adversarial synthesis. LLMs are employed to simulate profiles and realistic data patterns based on contextual prompts, followed by a GAN refining these outputs to ensure diversity. This architecture demonstrates theoretical potential to eliminate the need for conducting surveys while ensuring adaptability across industries.

However, several challenges emerged during conceptual development. Firstly, despite the use of a gradient penalty approach in WGAN-GP, the mode collapse remains a significant concern, as it may limit the variety of synthetic outputs. Secondly, LLM-generated descriptors have been observed to occasionally exhibit hallucinations, producing attributes that are inconsistent with consumer expectations, necessitating the implementation of manual curation protocols. Thirdly, since LLM outputs rely on pre-training patterns, synthetic data may reflect past information without capturing current trends.

The transferability of architectural methodologies needs to be inquired given that only one use case will be analyzed in our planned research. While the concept is applicable to similar domains, such as coffee or wine, the effectiveness may vary based on the prompting strategies and hyperparameter optimization methodologies. Moreover, ethical considerations concerning cultural bias in LLM-generated preferences merit consideration, as synthetic profiles may unwittingly perpetuate stereotypical associations [6].

From a methodological perspective, the planned DSR approach enables the iterative refinement of the architecture's parameters, while laboratory validation assesses the quality of the generated data.

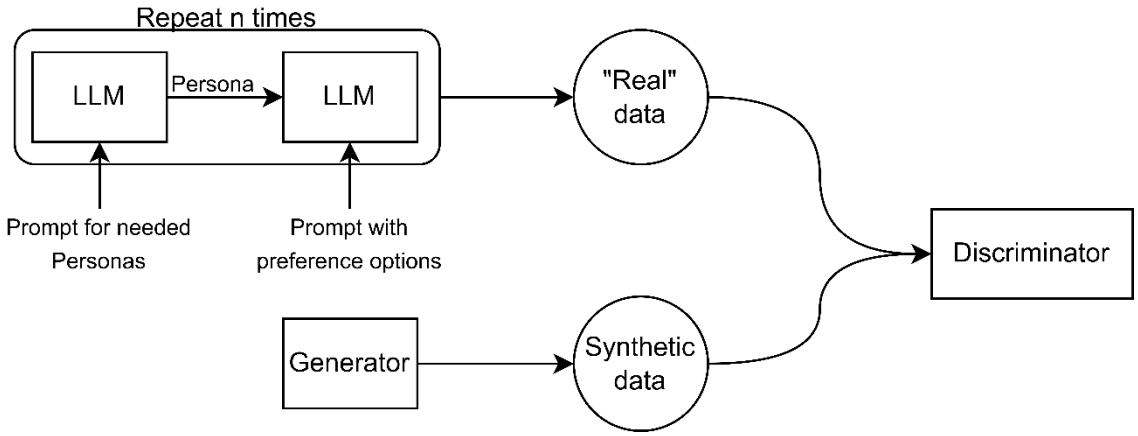

Figure 1. Broad overview of the proposed architecture

Conclusions and Recommendations

This case study presents a novel, use case data-free framework for generating synthetic survey-like data, leveraging the contextual descriptor generation of LLMs and the refinement capabilities of GANs [6,8]. While the design addresses the challenge of data scarcity in product development, its practical effectiveness remains untested, as the focus is on conceptual development rather than experimental validation. The anticipated technical challenges, such as GAN mode collapse and LLM hallucination, emphasize the necessity for rigorous hyperparameter tuning and domain-specific constraints to ensure output coherence [1,5].

Future work should prioritize empirical testing of the framework through controlled laboratory experiments to assess its viability. Hybrid architectures integrating Variational Autoencoders or diffusion models could mitigate the diversity limitations of stand-alone GANs. Collaboration with small and medium sized enterprises recommended to define industry-specific quality benchmarks, while ethical guidelines need to address biases in LLMs. Transparent documentation of prompting strategies and synthetic data provenance is essential for reproducibility.

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EXOSKELETONS - POTENTIALS AND HURDLES ON THE INDUSTRIAL SHOPFLOOR

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Keywords: exoskeletons, usability, shopfloor, technology acceptance, inclusion

Introduction

Digitalization enables and gives rise to a wide range of new technologies proposed to optimize or simplify activities in various areas of (work) life. One of these technologies is exoskeletons, which are designed to reduce physical strain and provide equal opportunities. By actively supporting certain activities or passively redirecting physical forces, the aim is to protect different parts of the body or compensate for physiological differences, for example, between men and women, in body size or strength (Ott et al., 2022). Research highlights several benefits of exoskeleton use: Task-specific support in static tasks (Baldassarre et al., 2022), significantly reduced repetitive strain and fatigue, enhancing productivity, worker well-being (Gräf et al., 2024; Qu et al., 2021). In addition to the advantages mentioned, there are challenges in integration processes and hurdles in terms of employee acceptance of the technology, potential muscle atrophy from prolonged dependency, increased energy expenditure from restricted movement patterns in certain designs and discomfort from poorly fitted devices (Lakshmi (Dawn) D. Robertson et al., 2020). In consideration of the aforementioned points, a considerable number of companies are contemplating the incorporation of exoskeletons into their manufacturing processes and determining their applicability for employees. In the Smart Production Lab, a learning factory, an analysis is conducted to assess the compatibility of various exoskeletons for utilization within industrial environments. This analysis is conducted within an experimental framework, thereby enabling the identification of parameters for evaluating exoskeletons.

Methodology

Considering both the promising benefits and notable challenges of exoskeleton integration, standardized assessment criteria are essential yet currently lacking. To address this, a structured evaluation framework for assessing passive exoskeletons under realistic

industrial conditions is being developed, aimed at helping companies determine their practical applicability. The initial step involves gaining a clearer understanding of suitable experimental setups for exoskeletons and identifying relevant evaluation parameters. For this purpose, an experiment will be conducted. The experimental setup involved nine participants aged 21-30. The participants tested two passive exoskeleton models across three distinct experimental scenarios:

1. Assembly Task with Chairless Chair Exoskeleton: Participants assembled and disassembled wooden components with screws, guided by instructions on a workstation.
2. Floor Tiling Task with Auxivo Lift Suit 2.0 Exoskeleton: Participants arranged movable squares into a straight line on the floor, working on hands and knees.
3. Carrying Task with Auxivo Lift Suit 2.0 Exoskeleton: Participants transported trays of mineral water bottles (from A to B without obstacles).

To address the limitation of nine young and healthy participants, Experiments II and III were additionally conducted using two simulation suits: a back-pain simulator and an aging suit that restricted sensory perception and mobility.

Results & Discussion

Based on the conducted experiments, it can be summarized that exoskeletons generally improved comfort and provided beneficial support in physically demanding tasks. In Experiment I, despite initial discomfort and instability, participants quickly adapted, benefiting from improved ergonomics and reduced neck and shoulder strain. Experiment II demonstrated the Auxivo Lift Suit's comfort and effectiveness, particularly when combined with the back-pain simulator, noticeably reducing pain and incorrect postures during tasks. Similarly, in Experiment III, the Auxivo Lift Suit facilitated lifting tasks and mitigated the limitations imposed by an aging suit, helping participants perform tasks more stably and comfortably. However, scenarios without exoskeleton support highlighted greater physical strain, incorrect postures, and coordination challenges, emphasizing the importance of task-specific selection and proper workplace integration of exoskeletons. Based on the conducted experiments, exoskeletons generally improved comfort and provided beneficial support during physically demanding tasks, especially when physical limitations or simulators (aging suit or back-pain simulator) were introduced.

Conclusions & Recommendations

Based on the findings of the experiments, it was decided to focus future research on the development of a comprehensive analysis tool for the evaluation of exoskeletons, recognizing that there are many different aspects to their use. The next steps in our research will therefore be the creation of a theoretical framework with a multi-perspective view of exoskeletons, addressing ergonomic and physiological factors, functional and technical evaluation, workplace integration, user acceptance and usability, as well as economic viability and sustainability.

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ARTIFICIAL INTELLIGENCE AND THE ISSUE OF GENDER EQUALITY IN THE POLISH LABOUR MARKET – INTERSECTIONALITY OF WORK IN THE ERA OF SOCIETY 5.0

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Keywords: artificial intelligence, gender equality, bias, intersectionality, AI substitutability

Introduction

Researchers disagree on which industries are most vulnerable in terms of Artificial Intelligence (AI) substitutability, and whether this process will affect women or men to a greater extent. Nevertheless, as the case of Poland shows, women are more vulnerable to being replaced by AI in the labour market, according to the conclusions of the report of the Polish Economic Institute (PEI) [1]. The aim of this study is to analyse the impact of AI on gender inequality in the labour market in Poland, and to identify which professional groups are most vulnerable to these disproportions. The analysis will use the concept of intersectionality, which is a paradigm of the sociology of science. Intersectionality by definition refers to the intersection of various, overlapping forms of discrimination [2]. As the available analyses show, this concept shares many analytical priorities with science and technology studies [3] and its use seems to be justified in research on the impact of modern technologies on social inequalities also in the labour market.

Methodology

This study used mixed methods, both qualitative and quantitative. The research gap was identified using VOSviewer, which generated a keyword map. On its basis and clusters were identified, covering two categories of overlapping concepts (1): artificial intelligence, equality, gender and (2) bias, intersectionality. Thus, there exists a research gap between research on intersectionality and analyses of gender equality and artificial intelligence.

The next steps in the research process involved to collect data on the situation on the labour market in Poland, divided into labour market sectors and gender, and analysis of reports and available source material. Using available tools, a linear regression model was created. It was based on a set of the following variables: (a) dependent variable – AI

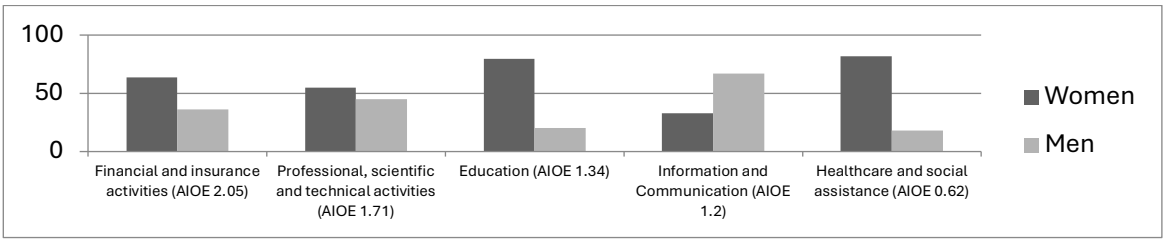
substitution index (AIOE: based on data from the PEI report), (b) independent variable – gender, (c) independent variable – labour market sectors.

The next methodological goal is to build a model that will take into account the gender variable as a significant factor influencing AI substitution on the labour market in Poland. For this purpose, it will be necessary to take into account the characteristics and roles (including stereotypical ones) attributed to women and men, as well as the structure of education and remuneration within the gender category. This data set, in comparison with the labour market sectors and professional groups, and the characteristics and skills assigned to them, will enable a much more accurate identification of the groups most exposed to being replaced by AI.

Results & Discussion

Available data from the Central Statistical Office (GUS) [4] on sectors in the labour market by gender were compared with analyses from the PEI, which identified labour market sectors most exposed to AI substitution (AIOE). Based on this data, five labour market sectors most exposed to AI substitution can be identified. The highest degree of substitution concerns two sectors: financial and insurance activities (AIOE 2.05) and professional, scientific and technical activities (AIOE 1.71). In both of these areas, women constitute the majority among the employed (63.84% and 54.96%, respectively). In the next three sectors, this level is slightly lower: education (AIOE 1.34), information and communication (AIOE 1.2), healthcare and social assistance (AIOE 0.62). In the fields of education and healthcare and social assistance, women clearly predominate among employees (79.69% and 82.05%, respectively), while in the case of information and communication, men predominate (67.09%) [1] [4].

Figure 1. Gender breakdown of workers in sectors at highest risk of substitutability by AI



Source: own work

On this basis, it was possible to initially verify the research hypothesis, which states that (H_1) in the case of the Polish labour market, there is intersectionality of work with regard to gender categories and labour sectors. Additionally, based on the linear regression model, a significant effect of the gender variable on the substitutability by AI in the labour market was identified, with women appearing to be more vulnerable than men. This conclusion differs from the results of Petersen et al. (2023) [5], concerning the case of Canada, where male-dominated professions are most vulnerable to AI substitutability. Based on this, it is possible to deduce that the structure of the labour market will determine the AI substitutability in the

gender category. Therefore, it is necessary to identify individual professions within the labour market sectors. This will allow for the verification of which professions are more vulnerable to being replaced by AI, and to check whether, in the case of Poland, they are represented more extensively by women or men.

Conclusions

Artificial Intelligence (AI) is often presented as a neutral tool. However, much evidence confirms its impact on deepening not only gender bias, leading to discrimination and marginalization [6], but also on to disproportionate and negative effects on social groups that have historically faced the most obstacles in the labour market. The direct implications of AI on existing jobs or professions largely depend on whether the new technology is a substitute or complements employee skills. Without a doubt, gender disparities in education and the ability to use AI and modern technologies generate unequal benefits in terms of competitiveness on the labour market, especially in those areas where AI and modern technologies are used.

However, concerns about AI bias emerge as early as the pre-application stage [7] and the recruitment process. This is because job advertisements are targeted at specific groups based on the algorithm of a given platform [8] and recruitment tools that embed stereotypes and prejudices are increasingly used by employers in the recruitment process.

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BATTERY SENSOR FAULT DIAGNOSIS SYSTEM DEDICATED TO BUILDING MICROGRIDS

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Keywords: Fault diagnosis, Sensor fault, Early fault detection, Model-Based, Hybrid Method, Battery, Building Microgrids.

Introduction

Energy and sustainability are two of the biggest challenges facing the world today. The tool for reducing greenhouse gas emissions is energy transition. As part of the energy transition, microgrids in buildings have a key role in addressing energy use challenges to improve sustainability and maintain resilience. The BBSS (Battery-Based Storage System) plays a key role in microgrids, and the real-time early diagnosis of battery sensor faults is mandatory to ensure the safety and reliability of the storage[1]. Considering that prevention is the core objective of human security, this paper presents a fault diagnosis solution proposed for an energy storage system based on lithium batteries. The battery sensor faults can appear due to external or internal causes [2]. The risks associated with battery faults, such as overcharging, over-discharging, overheating, thermal runaway, fire and incorrect control commands due to incorrect currents, can cause catastrophic problems affecting human safety. Due to the faults in the battery sensors, the battery management system does not receive the correct operating status (temperature and SOC), this can lead to further cascading faults, accelerating battery degradation [3],[4],[5]. Different methods have been proposed to fault diagnosis task, 3 large groups of methods can be mentioned: Data-drive, Model-Based and Knowledge-based [5]. Each method has its advantages and disadvantages, the combinations of the two strategies Model Based and Data driven to

improve fault diagnosis [6]. Hybrid methods aim to enhance diagnostic results by leveraging the advantages and avoiding the limitations of their consisting techniques. This research aims to develop a hybrid (model-based-data-driven) fault diagnosis and isolation (FDI) system to detect, isolate and identify BBSS sensor faults in a building microgrid.

This paper presents the methodology in section 2, the results and discussion in section 3 and ends with a brief conclusion of the research that has been carried out.

Methodology

The methodological approach adopted in this study is a mixed methodology based on the fault diagnosis process, which mainly integrates model-based and data-based strategies that complement each other. Through this strategy it is possible to overcome the difficulty of developing more accurate models and at the same time work in a complementary way, retaining the intuitiveness of a model but explaining the observed data [7]. The methodology is carried out in four stages: Initially, requirements and specifications are gathered for the system, followed by the development of a model-based detection system. Subsequently, the development of a data-driven diagnosis system is performed in the third stage, and finally the system is integrated and tested in the last stage.

Results & Discussion

A state-of-the-art analysis (hybrid fault detection, observers, sensors and battery faults) has been carried out, which has enabled the adaptation of new elements according to the fault detection and diagnosis process, integrating hybrid approaches.

The battery equivalent circuit is identified using a pulse discharge current and a set of battery voltage measurements. A non-linear least squares identification method is adopted to obtain the parameters, and the simulation is developed under MATLAB. An equivalent circuit model (ECM) of a Battery Valence U1-12XP was obtained to have the equivalent of the math equations. Based on the battery (ECM), a linear observer was proposed. To implement the third stage, an analysis was conducted of the behavior of three machine learning algorithms for classification. The estimated results of voltage and SOC are obtained from the observer. The fault classification was performed with faults in the voltage sensor.

Conclusions

This paper presents a hybrid system consisting of a first part based on an observer which has good convergence and is stable. Real data were used to obtain the parameters based on the SOC-OCV (Open Circuit Voltage) curve and to be able to model the battery. A second

stage is integrated to improve the classification of the faults by testing with 3 algorithms. Finally, the system is tested by integrating uncertainties and good robustness to disturbances is observed by the model-based stage.

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SOUND OF SILENCE: FOSTERING INCLUSIVITY IN DUAL HIGHER EDUCATION FOR THE HEARING-IMPAIRED

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Keywords: hearing-impaired apprentices, engineering sign language vocabulary

Introduction

Professional education plays a crucial role in equipping individuals with the necessary skills to enter the workforce. However, hearing-impaired individuals often face significant barriers in accessing quality education, particularly in industries such as metal and woodwork. The lack of inclusive training programs, appropriate instructional materials, and specialized communication tools prevents them from fully participating in vocational education and employment.

This gap is most evident in dual and work-based learning models, where apprenticeships and internships play a critical role in skill development. While vocational schools exist for hearing-impaired children, higher education institutions struggle to integrate them into specialized training environments. The absence of a standardized sign language for technical and engineering terminology further limits their ability to acquire advanced skills. Additionally, the scarcity of mentors trained in inclusive teaching methods exacerbates these challenges. Addressing these issues is essential for ensuring equal access to education and employment opportunities for hearing-impaired individuals.

The Erasmus+ project InclusiVET: Bridging Skills and Accessibility in Vocational Training for the Hearing-Impaired seeks to close this gap by developing a comprehensive, accessible training program. By integrating modern technology such as virtual and augmented reality, along with standardized sign language for vocational training, InclusiVET aims to establish an inclusive and effective learning environment.

Needs assessment

To illustrate the challenges faced by hearing-impaired individuals in vocational education, we examine the case of a group of students aspiring to enter the metal and wood industries. Despite their enthusiasm and potential, these students struggle with accessing specialized knowledge due to the absence of sign language interpreters and adapted learning materials. Existing vocational programs lack the necessary resources to support their needs, making it difficult for them to complete apprenticeships or participate in hands-on training.

One key issue identified is the inadequacy of standard sign language in conveying complex technical concepts. Metal and wood industries require specialized terminology that is often absent in conventional sign language. As a result, hearing-impaired students find it challenging to understand technical instructions, operate machinery, or communicate effectively with trainers and employers. This leads to a higher dropout rate and limited employment opportunities.

Another major barrier is the lack of trained educators and mentors who can effectively communicate with hearing-impaired students. Many vocational trainers lack formal training in inclusive teaching strategies, making it difficult for them to provide adequate support. This results in a learning environment that is not conducive to the needs of hearing-impaired students, further widening the gap in professional education.

Results & Discussion

To address these challenges, the Erasmus+ InclusiVET project has implemented several innovative strategies. The project is developing a 24/7 accessible online learning platform that includes sign language interpretation and closed captions, ensuring that hearing-impaired individuals can access educational content at their own pace. This platform will provide a repository of instructional videos, technical tutorials, and interactive modules tailored to the specific needs of the metal and wood industries.

Another key initiative is the development of an industry-specific sign language that includes technical vocabulary relevant to these fields. By standardizing these terms across vocational education institutions, InclusiVET aims to improve communication between students, trainers, and employers. This will significantly enhance learning outcomes and increase employment opportunities for hearing-impaired individuals.

Welding The process of joining materials, typically metals, by melting them together.

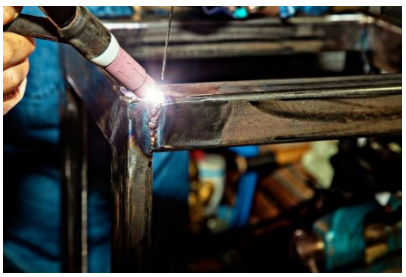

Figure 1. The example of specific industrial word.

Moreover, the integration of augmented and virtual reality (VR) technology is expected to revolutionize vocational training for the hearing-impaired. VR simulations will allow students to practice technical skills in a controlled, immersive environment, reducing the risks associated with hands-on training in hazardous industries. Augmented reality will further enhance learning by providing real-time visual guidance and interactive learning experiences.

Conclusions & Recommendations

The InclusiVET project represents a significant step toward bridging the educational gap for hearing-impaired individuals in the metal and wood industries. By addressing key barriers such as the lack of specialized sign language, inadequate instructional materials, and the scarcity of trained mentors, the project is setting a new standard for inclusive vocational training.

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LIQUID HYDROGEN AND INDUSTRY 5.0 FOR SUSTAINABLE AVIATION

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Keywords: Industry 5.0, Digital Twin, Liquid Hydrogen, Interactive Teaching, Human-centered Concept, Artificial Intelligence, ZeroESustainability, Aviation

Introduction

The Industry 5.0 migration requires sustainable, human-centered concepts for technology and employment [1]. A key aspect is the close collaboration between industry and academia to ensure the seamless integration of graduates into an evolving industrial landscape. Whereas the principle of Industry 4.0 was mainly focused on automation and the connection and communication between physical and digital systems, known as digitalization, and the concept of digital twins and intelligent manufacturing was introduced. However, with the proposal for Industry 5.0, the interaction and cooperation between humans and machines is brought to the fore to develop resilience and a more human-centric approach. With the transition to a new industry standard, a balance between technological growth and workforce well-being needs to be ensured, while the step toward greater sustainability must not be neglected. [2]

A key element of this transformation is the shift toward cleaner and more sustainable energy solutions in industrial applications. The aviation industry, as a major contributor to global carbon emissions, is seeking innovative propulsion alternatives to meet environmental goals. The adoption of liquid hydrogen (LH2) as a propulsion fuel represents a pivotal step toward achieving zero-emission (ZeroE) objectives. [3,4] However, to successfully integrate LH2 into aviation, substantial research is required to analyze the behavior of the system under cryogenic conditions and the implications for both operational safety and efficiency. This research focuses on the development of a cryogenic test rig and its corresponding digital twin to investigate these aspects.

Methodology

To contribute to this goal, a cryogenic test rig is being developed at the university to study phase transitions at varying temperatures and pressures while assessing the performance and reliability of control components such as pumps, valves, heat exchangers, and flow and thermal sensors under cryogenic conditions. This test rig is designed to resemble and simulate a fuel system for sustainable aircraft propulsion, enabling the investigation of cryogenic system feasibility. While liquid hydrogen is the intended propulsion fuel, liquid nitrogen will be used as a safe and cost-effective substitute during testing.

Additionally, to enhance experimental efficiency and reduce resource expenditure, a sophisticated digital twin of the cryogenic test rig is being developed. A rendering of the digital twin concept, including the planned sensor placement, can be seen in Figure 1. The test rig is designed to create a cycle with a return flow of the propulsion fuel, whereby a fraction of this is diverted to supply the engine with the required amount of fuel. The mass extraction from the tank remains constant, with the control depending only on the ratio of the returned fuel mass.

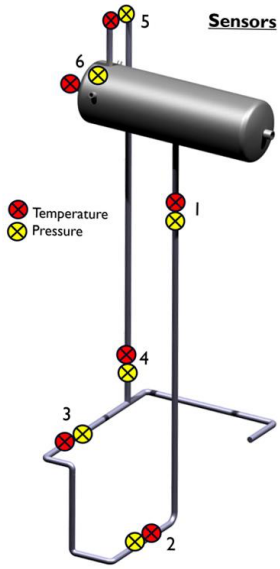

Figure 1. Concept of the test rig digital twin including sensor placement

Results & Discussion

For this project, students will be integrated and given specific tasks with various scopes to build the test rig, obtain and process results, and perform simulations, which will also be implemented into academia through interactive teaching modules. As academic courses often tend to provide structured and filtered data. However, in industry, data is rarely perfect

and often requires filtering, interpretation, and refinement, thus the integration of real-life and real-time data into courses plays a crucial role. By working with imperfect data, students gain a more realistic understanding of industry challenges and are better prepared for the complexities of data-driven decision-making in professional environments.

The digital twin will lead to enhanced experimental precision and will be used for various simulations, such as computational fluid dynamics and finite element simulations, to estimate and predict the behavior of the test rig. This information will be analyzed and utilized to enable early detection of potential system failures, allowing for preemptive modifications to experimental setups. This approach minimizes costs associated with material wastage and equipment wear while helping students gain valuable hands-on experience. By automating repetitive data processing tasks with machine learning and AI-driven tools, the workflow efficiency will improve, and the mental load on operators will be reduced, thus prioritizing human well-being and human-machine interaction. This reflects the core principles of Industry 5.0, where technology is used to support rather than replace human input [5].

Conclusion

By advancing hydrogen propulsion systems and integrating them into education and technological development, this research establishes a framework for sustainable industrial practices. It bridges innovation and social responsibility, fostering workplaces that balance productivity, inclusivity, and well-being, aligned with the vision of Industry 5.0. [6,7]

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STAR: AN AI-DRIVEN DISSERTATION SUPPORT SYSTEM

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Keywords: artificial Intelligence in education, dissertation support tool, personalized learning, VARK learning styles, future of work and teaching

Introduction

STAR, funded by Xjenza Malta through the Research Excellence Programme fund, aims to provide research students with an artificial intelligence (AI) dissertation support tutor that refers to appropriate resources as defined by their supervisors.

Case

STAR supports students based on their VARK learning style, with prompts optimized for visual learners, kinaesthetic, and read/write learners. STAR prototype performs multimodal language model queries, supplying images and diagrams to assist visual learners in understanding complex concepts while preparing for their dissertation submission. Research with 35 participants indicates that students engaged with the system, performed a significant number of queries, and provided their feedback on its functionality.

Discussion and results

The research highlights encouraging avenues of tailoring Large Language Models as interactive assistants for students, supporting students' specific learning requirements. It represents an advance in using AI to assist the educational process, contextualised to tertiary-level students and educators. By equipping students with AI-driven, personalized learning tools, STAR aligns with the evolving demands of the future of work, where proficiency in leveraging AI technologies is essential. For educators, STAR provides a glimpse into the future of teaching, where through the assistance of AI tools, they can focus on higher-level mentoring.

TRANSFORMING FROM I4.0 TO I5.0 IN PRODUCTION - A HOLISTIC METHODOLOGY

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Keywords: Industry 5.0, Change Management, Transformation, Methodology, Learning Factory

Introduction

After Industry 4.0 (I4.0), industry is about to face another important development. The crisis situations of recent years such as COVID-19, skills shortage and the climate crisis call for action in human- and ecology-centeredness and organizational resilience. The focus is on how I4.0 technology can positively influence these three areas. In this context, the European Commission introduced the term Industry 5.0 (I5.0) in 2021. The aim is not just on increasing efficiency, but rather on companies thinking long-term and contributing to social and environmental sustainability (European Commission, 2021; Leng et al., 2022; Xu et al., 2021). Thus, further transformation from I4.0 to I5.0 is required.

A current study shows that 7 out of 10 change processes fail. The main reasons are a lack of systematic transformation management and resistance from the workforce (Pustelniak et al., 2025). Manufacturing companies are faced with questions like which transformation elements are relevant or what needs to be considered for a sustainable successful change.

The Horizon 2020 project BRIDGES 5.0 addresses these questions and analyses which skills people in industry need to successfully master the outlined transformation. To make the results more tangible for companies, an existing I4.0 demo production facility - the Smart Production Lab - will be made I5.0 ready. The transformation process will be methodically accompanied and the findings prepared for manufacturing companies to use. This article presents the holistic methodological approach developed and provides an insight into the multi-stage research design.

Case presentation

As a 600m² industry-oriented learning and research factory the lab represents a fully (data) integrated production, whereby the industrial workplaces are supported by other relevant I4.0 technologies such as AGV or assistance technologies. Three blue collar (production and assembly) and three white collar workplaces (purchasing, production planning, IT) are displayed in the lab to show different I4.0 use cases. To transform the lab, a multi-stage research design was developed combining different methods mainly from Change Management, Organizational Development and Technology Acceptance. For a uniform understanding of I5.0, the BRIDGES 5.0 framework (Oeij et al., 2023) is used.

Results & Discussion

The scientific transformation methodology is as follows:

- **Step 1 – Technology status**
  A difference analysis based on a systematic literature review was used to detect the current technology status of the lab. The results of this analysis are currently being published in the paper “Bridging the Gap to Industry 5.0: Comparative Analysis of Technologies in Industry 4.0 and 5.0 and the evolutionary path of the lab”.
- **Step 2 – Vision and Strategy**
  The results of step 1 form the starting point for the strategy process. Using a combination of different methods such as transformation map, SWOT analysis or strategy map, first the vision of the desired I5.0 state and second the strategy for achieving this are derived.
- **Step 3 – Workplace analysis**
  In step 3, a holistic workplace analysis is carried out. For this purpose, classic methods of process analysis are further developed. In addition to the technology status, content-related I5.0 parameters such as skills and points of contact with human centricity, sustainability and resilience are documented.
- **Step 4 – Technology Acceptance**
  To effectively engage people in the implementation process, a key focus is on technology acceptance (Venkatesh & Davis, 2000). In the fourth step, an action plan is developed, including stakeholder management and participation planning.
- **Step 5 – Implementation and Training**
  Step 5 focuses on the implementation of measures and technologies to make selected workplaces I5.0-ready. Also a training plan is developed to familiarize individuals with the new concepts.
- **Step 6 – Evaluation and Recommendation**
  Finally, a guideline is developed to evaluate transformation initiatives and recommendations for action are formulated to better overcome challenges in the process.

By the end of the BRIDGES 5.0 project, all steps will have been implemented, documented, and made accessible for companies. To ensure a high research quality, all steps will be scientifically validated and, where possible, tested in practical applications.

Conclusions & Recommendations

The work on the transformation process so far has already highlighted the urgency of accompanying measures. The I5.0 concept is characterized by a multitude of interdependencies on both technological and social dimensions, resulting in a high degree of complexity. The BRIDGES 5.0 project contributes to providing guidance along this path and supports companies at various stages of the transformation.

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LEVERAGING MC CONCEPTS (EDC) TO FOSTER SCALABLE PATHWAYS FOR LIFELONG LEARNING AMONG H-VET PROVIDERS AND THE DUAL INDUSTRY IN EUROPE AND BEYOND

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Keywords: Micro-Credential (MC), Nano-Credential (NC), Microlearning, Higher Vocational Education and Training (H-VET), Clearing House, European Digital Credential (EDC), EUROPASS, lifelong learning (LLL), learner-centric up-and reskilling, agile learning pathways, LCAMP, MC Database, European Learning Model (ELM), future skills, systemic resilience, industry 5.0, competency-based education (CBE), European Skills, Competences, Qualifications and Occupations (ESCO), European Qualification Framework (EQF)

Introduction

Occupational and training standards define job-related skills and competencies, shaping recruitment and training programs. Frequent upskilling and reskilling are crucial for fostering an adaptable workforce that drives innovation and economic growth. Agile learning concepts aid policymakers in promoting inclusivity, reducing unemployment, and enhancing competitiveness. However, maintaining agility within canonical pathways amid evolving economic and societal demands remains challenging. Addressing global transformations, this Micro-Credential study focuses on Agile Occupational and Training Standards for Responsive Skills Policies (OECD, 2024) for a more resilient Industry 5.0 workforce. The microlearning concept and clearing house use case presented here aim to harmonize, digitize, and internationalize traditional learning achievements systematically.

Methodology & Use Case

This study tackles the conceptual challenge of developing a machine-readable credentialing backbone for dual education and training providers. The microlearning approach, designed for the LCAMP Center of Vocational Excellence (CoVEs), integrates competency-based education (CBE) concepts and aligns with skill-based digital credentialing principles (ESCO,

LinkedIn). The study follows Ehlers' (2021) conceptualization of competencies within the "Future Skills" framework (p. 359-72). Given that the appropriate size of credentialed microlearning remains contested (Zhang, 2019, p. 312;314, 2025), this study employs the smallest unifying educational and digital principles to unbundle canonical learning pathways across Europe and beyond. Using an unbundling and tagging methodology, a comparative analysis of transnational H-VET curricula, vocational profiles, and job advertisements — conducted in collaboration with the learner-centered training (LCT) working group of the LCAMP consortium — identified key interfaces for a Nano-Credential (NC) model. This model serves to bridge systemic and educational differences among H-VET providers. The developed credentialing approach records assessed learning achievements for advanced manufacturing in a machine-readable format. The approach shall foster agile learning pathways at the most granular level of dual, competencies. Accordingly, curricular competency data was analyzed with the support of the LCAMP consortium's VET providers and re-bundled into digitally aggregated ESCO skill datasets. A semi-automated tagging methodology was used to aggregate and harmonize institutions' I4.0 curricula with both the ELM metadata and specific framework data (EQF, proficiency level, I5.0 parameters relevant for the European Skills Agenda, and sector-specific skills gaps, when available), paving the way for further AI-driven EDC creation and advanced skills profiler systems.

Results & Discussion

This study presents a conceptual blueprint for a universal machine-readable CBE Nano-Credential, supported by the European Digital Credential (EDC) metadata standard. Referenced framework metadata ensures quality and interoperability, enabling agile pathways for learner-centric upskilling and reskilling. The fine-grained modeling of certifiable CBE learning achievements within the European Learning Model (ELM) facilitates transnational credit transfer and recognition. While the use case (Proof Of Concept) and its underlying metadata framework currently rely on manual tagging, this practical approach provides feasible solutions to the European harmonization challenge in H-VET alliances. The proposed granularization and digitalization strategy enhances seamless integration into canonical learning pathways and digital skills profiling systems. Furthermore, it supports recognition principles and scalability, catering to the up - and reskilling needs of the workforce.

Conclusions & Recommendations

Initial piloting at Baden-Württemberg Cooperative State University (DHBW) underscores the potential of the LCAMP Clearing House approach based on the NC concept. The micro-credential database offers a strategic framework for digitizing and streamlining public and corporate training programs. However, as recent meta-studies on micro-credentialing indicate, (trans-)national initiatives face significant challenges. Studies of the OECD (2023/24) and Hochschulrektorenkonferenz Modus (2023-25) highlight the complexity, lack of binding legislation, and unresolved recognition of quality parameters, which continue to hinder widespread micro-credential implementation. To maximize our Nano-Credential's potential for enhanced recognition and transferability, particularly in the absence of a binding ELM metadata legislation or Europe-wide conventions, the proposed EDC-based Nano-Credential concept currently requires "ad-hoc recognition via inter-institutional agreements" (Camilleri

et al., ETF, 2022, p. 38-46) as well as a critical revision, systematical restructuring and iterative updates of the ESCO framework database.

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A HOLISTIC APPROACH FOR DYNAMIC AND ERGONOMIC ADAPTATION OF ROBOT MOVEMENTS USING GEOMETRIC ALGEBRA

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Keywords: human robot collaboration, ergonomy, robotics, machine learning, conformal geometric algebra

Introduction

The rapid pace of development in Human-Robot-Collaboration is threatening to take the focus away from the well-being of the worker, especially in close cooperation or collaboration scenarios like handover of objects (see fig. 1). In particular, the increasing overlap between the workspaces of humans and robots, leads to particular challenges in terms of ergonomics, reliability and safety.

Figure 1. Human Robot Collaboration.

Humans contribute their cognitive abilities and high flexibility, thus facilitating faster changeover times on a production line.

In return, the aim of automation should be to free people from repetitive, monotonous, dangerous and/or particularly stressful tasks. However, this can only succeed if robots are also able to adapt to humans, so that humans do not necessarily have to adapt to the strictly periodic robot movements. It is important to achieve a balance between the highest possible adaptability and a fixed robot motion.

Case presentation

In the past, a database declaring comfort zones of workers was experimentally established by using a motion analysis system and a corresponding neural network was trained [1]. Conformal Geometric algebra is a higher dimensional algebra based on multivectors with maximum of 32 components. These multivectors directly can represent spheres, circles, points, planes and other geometrical objects. Several operators on these objects are defined e.g. to intersect them It has be shown, that the usage of conformal geometric algebra (CGA) can reduce the complexity of the description of the robot kinematics significantly [2]. Here Conformal Geometric Algebra allows very intuitive formulation and implementation of robotic algorithms, shown for DH-parameter extraction from given joint axes poses (see fig 2). In comparison with an implementation based on vector algebra the case distinctions between parallel, intersecting or skewed lines or even between lines crossing the origin or not can be overcome.

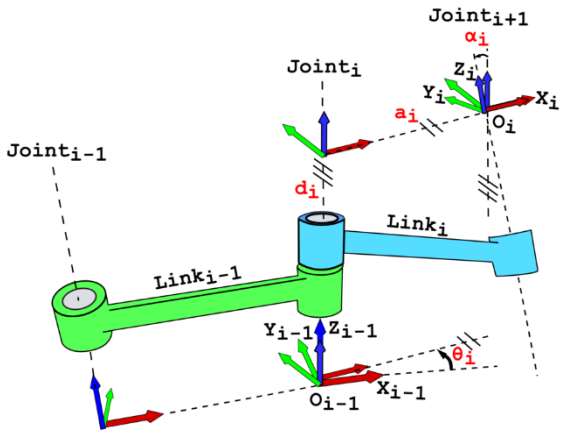

Figure 2. Denvit Hartenberg Parameters in Robotics.

Furthermore, for a holistic approach, we propose to use CGA in order to also simplify the workers kinematics, especially of the human arm, which can be observed by a camera based motion analysis system (see fig 3.)

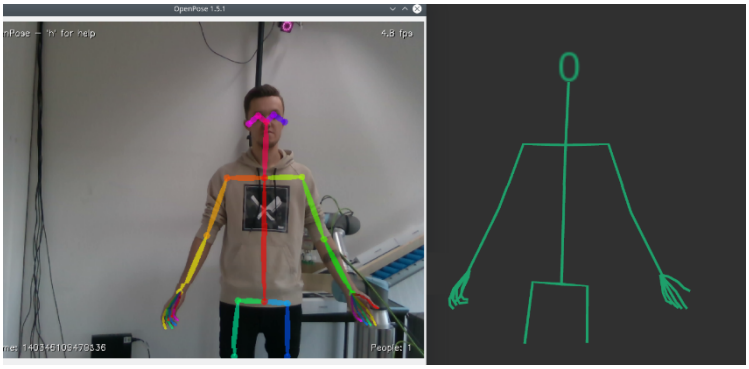

Figure 3. Skeleton Model observed by motion analysis system

Finally a generalized description of the human-robot-collaboration-system based on CGA is formulated in order to simplify and hence advance the efficient description of different cooperative or collaborative scenarios.

Results & Discussion

The CGA based methods allow the determination of all DH-parameters of robots without needing to respect case distinctions. This makes implementation easier and above all avoids jumps in the parameters during passing between different case distinctions. This happens in practice due to numerical reasons, if robot axes are nearly parallel or nearly have an intersection point. Similar results are expected in modelling human arms.

Conclusions & Recommendations

As a conclusion it can be stated that the usage of CGA in human robot collaboration is promising and will be investigated in more detail and different scenarios in the future.

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"RESEARCH DOES NOT HAPPEN IN A VACUUM": WORK-LIFE BALANCE OF EARLY-CAREER RESEARCHERS IN CROATIA

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Keywords: early-career researchers, well-being, mental health, work-life balance

Introduction

Recent research (Cilli et al., 2023; Friedrich et al., 2023; Nicholls et al., 2022) indicates worrying levels of mental health risks and a declining sense of well-being among researchers, particularly early-career researchers (ECR). The findings presented in this paper are part of the research project *Well-being and Mental Health of Early-Career Researchers in Croatia: a Longitudinal Study (ECR-WELL)*. The project aims to better understand well-being and mental health in the context of ECRs' work experiences. This paper presents results that focus on work-life balance.

Methodology

In the year 2024, the research team undertook the execution of twelve focus groups and two interviews involving 69 ECRs spanning various academic disciplines across all public universities within Croatia. The demographic distribution of the participants is delineated according to their respective career stages, comprising thirty PhD candidates with a mean age of thirty years, alongside thirty-nine senior assistants and postdoctoral researchers with a mean age of thirty-seven years. A predominant majority of the focus groups (N=9) were conducted in person (specifically, 3 in Zagreb, 2 in Split, 2 in Rijeka, 1 in Osijek, and 1 in Dubrovnik), with a lesser proportion (N=5) conducted via online platforms. The qualitative data from this research was analysed utilising NVivo 15 software, which facilitates the organisation, coding, and thematic examination of qualitative data (Allsop et al., 2022). The preliminary analysis of the qualitative data garnered from focus groups and interviews with mentors adhered to several established protocols of qualitative analysis (Bingham, 2023).

Specifically, the analysis employed the five-stage methodology delineated in Bingham (2023), which advocates for a systematic, transparent, and scrupulous approach to the processing of qualitative data. This methodology renders a structured and meticulous investigation of qualitative data, thereby elucidating salient themes, patterns, and significances that emerge from the experiences of the participants.

Results and Discussion

ECRs often find that high job demands intrude on their personal lives, leading to increased stress, frustration, and a sense of burden. This issue is pervasive in their professional experiences, marked by undefined working hours and insufficient institutional support. Achieving a work-life balance and ensuring the well-being of ECRs is both a personal challenge and an institutional necessity. To improve the situation, a shift in workplace culture is crucial, requiring better support for balancing work and personal responsibilities, clearer guidelines, and enhanced financial stability. The challenges of work-life balance and ECR well-being are pronounced in academia. Focus group participants reported that demanding jobs clash with their personal lives, raising stress levels. One noted, *"When they ask me how I combine work and leisure, the answer is: 'Bad.' I feel like I am always working, even when I want to do something else, the pressure is always there for my doctorate."* This issue spans their work experience, from vague working hours to institutional misunderstandings. A participant shared, *"Scientific work doesn't happen in a vacuum. Life goes on, and a PhD often requires weekend and late-night work, affecting everything from family time to personal space."* Challenges reflect both personal attitudes towards work and systemic institutional issues. While many value flexible schedules, work commitments frequently disrupt their work-life balance. Participants often feel overloaded, with many unpaid hours leading to little time for rest. This is especially true for parent participants who balance family responsibilities. One remarked, *"I was on maternity leave until January 2019, and only a few months later I started my doctorate and project... it's very challenging for a first-time mother."* Another noted, *"Constant stress from deadlines, coupled with private obligations that can't keep up, is overwhelming."* The feeling of isolation and inability to delegate tasks exacerbates stress. Financial insecurity, stemming from fixed-term contracts, complicates future planning and family formation, adding to their sense of insecurity. Participants frequently expressed feelings of loneliness, citing a lack of support from institutions and peers, which intensifies overwhelm and can lead to burnout. Furthermore, bureaucratic entanglements and unclear procedures exacerbate frustrations and dissatisfaction.

Conclusion

The concepts of work-life balance and the overall well-being of Early Career Researchers (ECRs) present challenges that extend beyond the individual level; they also constitute significant institutional hurdles. It is imperative that we implement meaningful changes in our work culture to enhance these conditions. Such changes might include the establishment of

robust support systems that promote work-life balance, alongside the development of clearer procedures and guidelines that can help streamline tasks and expectations. Additionally, ensuring greater financial security for ECRs is essential to alleviate stress and enable them to focus more on their research and professional growth. Moreover, fostering improved interpersonal communication and encouraging collaboration within the academic environment are crucial for cultivating a supportive atmosphere. Such an environment not only benefits ECRs but also contributes to a culture that values well-being and actively promotes the professional development of young scientists. By prioritizing these aspects, institutions can create a sustainable ecosystem that nurtures talent and innovation while addressing the pressing challenges faced by ECRs today.

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SHAPING EMPLOYMENT IN THE FUTURE WORKPLACE: SMART ORGANIZATIONS, FUTURE SKILLS, AND A SPATIAL MODEL FOR REGIONAL DEVELOPMENT

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Keywords: smart organizations, future skills, spatial model, regional development, labor market disparities

Introduction

The rapid development of digital technologies, automation, and artificial intelligence is profoundly reshaping employment structures and regional economies. While technological advancements present new opportunities, they also introduce significant challenges, particularly for peripheral regions struggling to adapt. Dynamic technological, demographic, and social changes necessitate innovative approaches to workplace organization and regional development. This study analyzes the potential of smart organizations in European Union regions and identifies key future skills required for the labor market. A spatial model is utilized, incorporating indicators grouped into five capitals: human, IT (digitization), innovation, relational, and scientific-research. Key metrics include tertiary education, lifelong learning, digital skills, ICT specialists, innovation activities, SME collaboration, and scientific outputs such as international co-publications and highly cited publications.

Methodology

The research employs a mixed-methods approach, integrating quantitative data analysis and qualitative case studies. Key sources include labor market statistics, industry reports, and policy frameworks related to digital transformation. A spatial model is developed to assess regional adaptation to technological changes, focusing on workforce reskilling and digital inclusion strategies. The study also utilizes the standardized sum method to identify employment trends across different regions. Cluster analysis identified four regional types:

1. Regions with moderate potential driven by human capital.
2. Regions with moderate potential led by innovation activities.
3. High-potential regions excelling across all capitals.
4. Low-potential regions lagging behind.

Results & Discussion

Findings indicate that while innovation and digitalization create job opportunities, they also exacerbate regional inequalities. By 2030, global employment trends suggest a net increase of 78 million jobs, with rapid growth in technology-driven sectors but significant job losses in traditional industries. The analysis highlights the need for continuous reskilling, as 40% of required skills will change, and 59% of workers will need retraining. Despite increasing investments in education and smart infrastructure, peripheral regions face substantial barriers to adapting to digital transitions. The spatial model underscores the importance of localized innovation policies and smart city initiatives in fostering inclusive economic growth. The results reveal substantial regional disparities and highlight the need for targeted interventions to promote development. High-potential regions demonstrate better adaptability to global challenges, fostering employee well-being, productivity, and balance between professional and personal life. Future competencies in technology, innovation, and social skills are essential for sustainable growth.

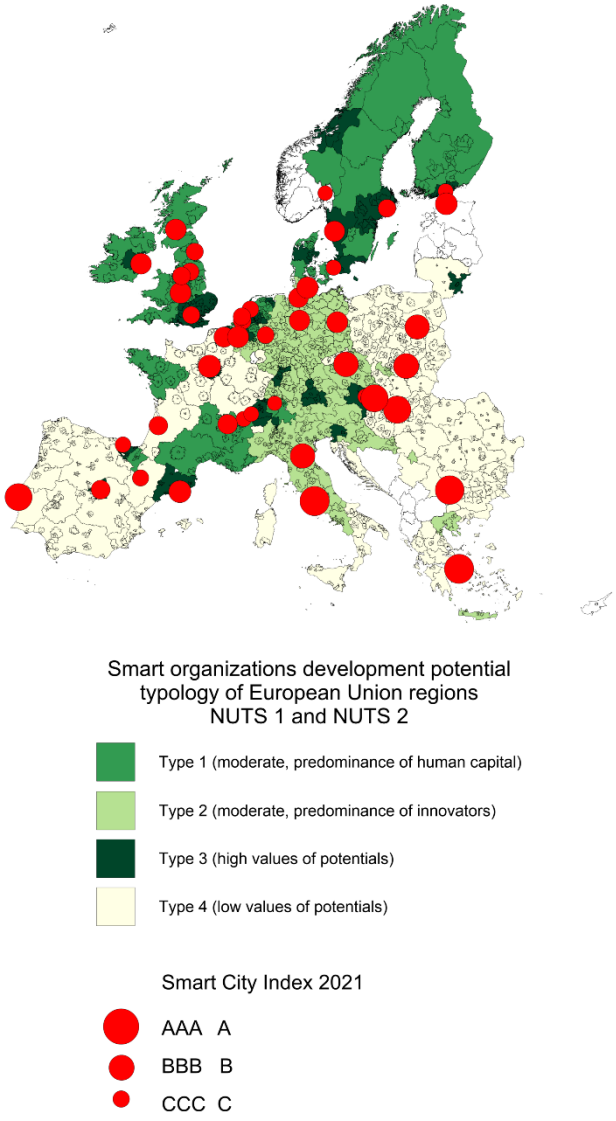

Figure 1. Smart organization development potential

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Conclusions

The future of employment hinges on a balanced integration of technological innovation and adaptive workforce strategies. Smart organizations play a crucial role in fostering digital skills development, while regional policies must address disparities in access to education and technology. The study underscores the importance of investing in education, innovation, and regional collaboration to build a resilient labor market and drive the development of

smart organizations as key enablers of regional competitiveness and societal well-being. Policymakers should prioritize investments in reskilling programs, support digital infrastructure in lagging regions, and develop targeted strategies to ensure labor market resilience. Addressing these challenges will be essential to shaping a sustainable, future-oriented workforce.

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THE FUTURE OF THE 4-DAY WORKING WEEK IN GERMANY A SYSTEMATIC REVIEW OF PILOT STUDIES AND SURVEYS CONDUCTED ON THIS TOPIC, AS WELL AS AN ANALYSIS OF HOW EMPLOYEES WOULD ORGANIZE AN ADDITIONAL DAY OFF.

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Keywords: 4-Day Working Week, Flexibility of Work, Work-Life-Balance, Business Indicators, Activities on a Day Off

Introduction

The study discusses the historical and ongoing interest in reducing working hours, specifically through a 4-day work week. Economist John Maynard Keynes envisioned reduced working hours in 1930, and the USA conducted pilot projects for a 4-day week in the 1940s and 1950s [1,2]. In 2023, the German Bundestag debated the 4-day week, but no decision was made despite employee interest [3]. This study aims to review existing pilot studies, analyze employee expectations, and explore differences in preferences across age groups and genders. Recent studies in Germany and other countries have examined productivity and business indicators under a 4-day week. Research shows that employees have specific ideas for their day off, with only 6.5% wanting to "do nothing." This article aims to fill gaps in social science research on the topic, presenting a systematic review and survey results from 2024. The study combines business, psychological, and social science perspectives to provide a comprehensive view of the 4-day work week.

Methodology and Research Questions

The article aims to summarize results and empirical data from existing studies and pilot projects on the introduction of a 4-day working week. It also presents employees' attitudes towards the topic and their planned activities for an additional day off. The research questions include how employees in Germany feel about a 4-day working week, the experiences of companies that have implemented it as a pilot project, how employees would like to organize the additional day off, and whether there are differences between age groups and genders regarding their preferences and planned activities. To answer these questions, the article conducts a systematic review, compiling and comparing knowledge and experiences from

studies and pilot projects in Germany and internationally. Additionally, it presents results from an online survey conducted in 2024, which gathered data on employees' attitudes towards the 4-day week and their planned activities for the additional day off, with a sample size of 628 participants in Germany.

Results and Discussion

Results of Systematic Review of Pilotstudies

The international pilot studies in Ireland, the UK, the USA, Australia, South Africa, and Brazil [4], as well as the study in Germany [5], indicate positive experiences among employees and improvements in key business metrics. However, the validity and objectivity of these projects are questioned, particularly because they mainly involved service sector organizations. Furthermore, the companies participated voluntarily with the strong focus on introducing the 4-day work week permanently. The effectiveness of a 4-day work week for manufacturing companies remains largely untested. Additionally, there is uncertainty about the specific working time model to be used, especially considering legal limits on daily working hours.

Results of Online Survey in 2024 in Germany

The 2024 online survey results align with previous studies [6,7], showing that most employees favor a 4-day work week with full pay compensation. Younger generations are more supportive of this change than older ones. Both the 2024 study and earlier research indicate that employees want to use the extra day off for hobbies, family time, sports, and volunteer work. Additionally, the 2024 survey reveals that employees are interested in using the day off for further education, errands, household chores, a second job, or starting a business. Only a small percentage (6.5%) plan to "do nothing," highlighting that employees intend to use the extra day productively. The biggest gender differences in planned activities for a day off are in errands, attending appointments, second jobs, and preparing for self-employment. Age group differences show that further education and starting a second job are more common among those under 40. Additionally, the age group 16-25 years mentions traveling more frequently than other German age groups.

Conclusions

The systematic review and online survey results indicate that no optimal solution has yet been found for introducing a 4-day working week that meets organizational, political, and legal requirements, as well as the needs of companies and employees. The 2024 survey shows that respondents desire an optimized work-life balance and more flexible working hours. Participants suggest measures for more efficient work, such as reducing distractions, optimizing processes, adjusting meeting culture, introducing focus times, and utilizing digitalization [8]. Additionally, the results of the 2024 online survey show that the younger generation does not want to put their feet up instead of working, but that work is important for

the younger age groups. However, the younger generation would like to work independently and flexibly [9].

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RETURN FROM HOME OFFICE TO FACE-TO-FACE WORK APPROACHES TO INCREASING THE ATTRACTIVENESS OF THE FACE-TO-FACE WORKPLACE IN GERMANY

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Keywords: Home office, advantages office work, business indicators, staff satisfaction, increase of office attractiveness

Introduction

The COVID-19 pandemic led to remote work to minimize health risks. In 2023, about 22% of German employees worked from home, similar to previous years, due to benefits like saving commuting time and accommodating more staff. A multitude of companies are currently trying to get staff back to the office through Return-to-Office policies [1]. However, for some employees, remote work is crucial in choosing an employer [2]. Despite concerns about loneliness, in-office work improves communication, coordination, and knowledge exchange. This article explores how to balance office and home-office time for mutual benefit.

Methodology and Research Questions

The research questions addressed in this article aim to find out the current expectations and wishes of employees regarding home office regulations. Furthermore, the question arises as to why employees prefer to work from home rather than in the office. What reasons and approaches do companies have for wanting employees to return to the office at least part-time? The methods used for data collection and evaluation include a literature review and a comparison of existing studies. Furthermore, this article includes an evaluation of an online survey in Germany—opinions and expectations of employees conducted in 2024 (n=205). Finally, a total of fifteen HR managers from various German companies were interviewed about their experiences and the topic of home office regulations, the reasons why companies want employees to return to the office at least part-time, and the incentives offered to motivate

employees to come to the office. Based on the data analysis, recommendations for action are presented.

Results

The literature review demonstrates that work in home offices provide several pros and cons

Table 1: Advantages and disadvantages of working from home [3]

Perspective from	Advantages	Disadvantages
Employees	**Employee satisfaction**	**Unclear boundaries work/private life**
	Flexibility	**Isolation and loneliness**
	Time saving (less commuting)	**Longer communication paths**
	Higher concentration	**Ergonomics at home**
Companies	**Fewer sick days**	**Insufficient control of employees**
	Increased company attractive.	**Extra office equipment (Ergonomics)**
	Optimization of office space	**Data protection**
		Difficulties onboarding new staff

The employee survey (n=205) revealed that only 10% of respondents want to work in the office five days a week, while 5% prefer to work from home full-time. Most employees (85%) favor a hybrid model, with 35% preferring two days of home office and three days in the office. The main reasons for using home offices are time savings (83%), flexibility (75%), and noise reduction (35%). To increase the attractiveness of office work, employees suggest more retreat areas (46%), improved food and drink options (36%), and sports facilities (36%). Respondents highlighted several factors that increase the attractiveness of office work, including good quality and affordable food options, modern and ergonomic workplace equipment, company sports facilities, flexible working hours, and enough retreat areas. Other factors mentioned were natural light, good company culture, company childcare, and having enough plants.

To present the companies' perspective on the topic, 15 HR managers were interviewed in 2024. According to their statements, most employees currently seem to accept the home office regulations — an average of 2 to 3 days of home office in job positions where home office is possible. Reasons for being present in the office include direct and short-line communication between employees and departments. Moreover, meetings in person increase team affiliation. However, there is no evidence that productivity is higher in the office compared to working from home [4]. Departments often organize special events on presence days. Some companies try to bring employees back to the office through initiatives like plant sponsorships, sports activities, covering commuting costs, or optimizing office design. However, since some companies reduced office spaces during the pandemic, they have to juggle with the desk spaces to ensure that not all employees are at the office at the same time.

Conclusions and Recommendations

The following recommendations for companies – based on the data analysis - can enhance the attractiveness of office work. Key suggestions include adopting a hybrid work model, flexible working hours, providing free snacks, improving food options, offering sports activities, covering commuting costs, creating retreat areas, updating workplace equipment, and optimizing office design and layout. These measures aim to balance the benefits of home office and office work, meeting employees' preferences and improving job satisfaction. Furthermore, acceptable return-to-office policies counteract loneliness in the home office and support social interaction, which is very important for the health of staff [5].

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PROACTIVE PERSONALITY, SELF-EFFICACY, TRANSFORMATIONAL LEADERSHIP AND HUMAN RESOURCE PRACTICES AS PREDICTORS OF BOUNDARYLESS CAREER ATTITUDES IN THE INDUSTRIAL SECTOR OF THE BASQUE COUNTRY

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Keywords: Proactive personality, self-efficacy, transformational leadership, HR practices, boundaryless career attitudes, Boundaryless career, Human Resources

Introduction

The Industry 5.0 [1] and the just transition paradigm [2] impact on careers, making them less predictable and irregular [3,4,5].Traditionally, careers followed a linear progression within an organization [6], but the current context requires more dynamic, flexible career models, increasing career transitions [7,3].

In this changing landscape, workers must actively seek opportunities to learn and adapt to labor market changes [6,8]. Owing to this, having a positive attitude toward professional change [9] and self-management of careers is crucial for maintaining employability [10].

Specifically, workers must adopt positive attitudes toward boundaryless careers to build successful career paths [11,12]. On the other hand, organizations, must develop HR and leadership strategies to foster autonomous career development [13,14]. Research on resilient careers and career transitions has grown [15], but studies on factors which influence boundaryless career attitudes in the Basque industrial sector are scarce [16,4].

This paper aims to identify how some individual and organizational factors positively impact on boundaryless career attitudes in Basque industrial workers, focusing on personality, leadership, HR practices, and self-efficacy. The hypotheses are:

- H1: HR practices influence boundaryless career attitudes.
- H2: Transformational leadership influences boundaryless career attitudes.
- H3: Proactive personality influences boundaryless career attitudes.
- H4: Self-efficacy influences boundaryless career attitudes.

Methodology

This research uses a quantitative approach to examine boundaryless career attitudes, in relation between variables mentioned previously [17]. The study use an experimental design to minimize bias and enhance internal validity and a representative sample is going to be selected, and analyzed the data with Structural Equation Modeling methods [17,18.19].

The sample will be drawn from companies in Gipuzkoa, a region where the industrial sector is crucial to the local economy, and which is focused on sustainable workplaces and lifelong learning [20].This research fills a gap in the literature by focusing on this underexplored sector.

The measurement will be done with a 5-point Likert scale survey that will measure career attitudes, self-efficacy, HR practices, and proactive personality [21, 22].

Results & Discussion

Since sufficient data for analysis is not yet available, based on the academic theories, the following results are expected:

- **Proactive Personality and Boundaryless Career Attitude**: Proactive individuals, characterized by initiative and seeking opportunities, are likely to lean toward boundaryless careers, especially with high psychological mobility [21].
- **HR Practices and Boundaryless Career Attitude**: Organizations that promote development and autonomy through HR practices will likely see employees focus on internal career growth, enhancing psychological mobility and reducing physical mobility.
- **Self-Efficacy and Boundaryless Career Attitude**: Individuals with high self-efficacy, who are more confident in taking risks, are more likely to pursue career changes and embrace physical mobility.
- **Transformational Leadership and Boundaryless Career Attitude**: Transformational leadership, which fosters professional development, is expected to encourage psychological mobility and reduce external career opportunities (physical mobility).

Conclusions

Industry 5.0 and the just transition have reshaped career paths, highlighting the importance of both physical and psychological mobility [23]. A boundaryless career attitude is crucial for managing employability [24]. This study will explore the influence of self-efficacy, proactive personality, HR practices, and leadership on boundaryless career attitudes in the industrial sector, an underexplored area, and will offers practical insights for organizations, stressing the need for HR initiatives that promote.

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TANGIBLE INTERACTION FOR THE MECHANICS OF MATERIALS: STUDY OF COGNITIVE SUBSTRATES

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Introduction

Ubiquitous computing represents a key evolution for Industry 5.0, by seamlessly integrating technology into the everyday environment to enhance efficiency, human-machine collaboration, and user experience. Industry 5.0 complements the existing Industry 4.0 paradigm by highlighting research and innovation as drivers for a transition to a sustainable, human-centric and resilient European industry. It moves focus from shareholder to stakeholder value, with benefits for all concerned. Industry 5.0 attempts to capture the value of new technologies, providing prosperity beyond jobs and growth, while respecting planetary boundaries, and placing the wellbeing of the industry worker at the center of the production process [3]. This paper explore how to bridge the gap between technological advancement and human welfare. A key aspect in manufacturing is understanding material mechanics. While simulation software is essential, its virtualization can limit workers' grasp of mechanical properties. By providing new kinds of human-machine interfaces, such as tangible user interfaces (TUI) [6], it is possible to exploit together and better, the cognitive substrate (we use this term to refer to all the underlying structures and processes that enable cognition, i.e. the ability to perceive, understand, learn and reason) and the kinesthesis capacities of the workers. TUI link digital data, processed by computers, to physical elements that users can manipulate [5].

A study was carried out using strength-calculating software, where participants manipulated a virtual beam. Results showed that multisensory TUI enhance immersion and understanding compared to traditional graphical user interface (GUI). The multimodal

characteristics allow for better cognitive resource distribution, leading to improved performance and reduced mental fatigue. Harnessing human-machine collaboration through TUI fosters confidence, deeper understanding, and overall well-being for Industry 5.0 workers.

Case presentation

Our case study is centered around the comparative analysis of two types of human machine interfaces: a traditional GUI and a TUI, in the specific context of learning and understanding material mechanics [8]. This study examines the use of TUI to enhance understanding of material mechanics while traditional simulation software's can hinder comprehension. A within-subjects experiment was conducted using RDM6 software, with participants manipulating a virtual beam via both GUI and TUI. RDM6 is a software for teaching structural design using the finite element method [4]. The main objective is then to evaluate whether a TUI improves the acquisition of knowledge and the understanding of mechanical concepts, performance compared to a GUI.

We did 2 hypotheses: (H1) Subjects manipulate the virtual beam more easily with the TUI and complete easily exercises with the TUI than with the GUI; (H2) The use of a TUI improves understanding of the task as opposed to formal learning.

There were 20 volunteers divided in two groups, as many men as women, with no prior experience in material mechanics, aged 22–26, all right-handed.

Participants performed four basic exercises, which were all designed in the same way, on the material resistance software RDM6, using both the GUI and the TUI. The first group started with the GUI, while the second started with the TUI. The exercises consisted of beam deformation tasks. A questionnaire was administered at the end of the test to collect the subjects' impressions.

Quantitative, qualitative and physiological measures are collected:

- time required to perform each exercise and number of errors (quantitative),
- types of errors and subjective impressions via a questionnaire (qualitative),
- heart rate and electrodermal response (physiological).

The TUI is composed of a ShapeTape (Measurand product) [2] that captures physical deformations of the ribbon and transmits the movements to the computer (see figure 1). An envelope to the ShapeTape, composed of a flexible boiler tube and a tensioning system, allows adjusting the physical (elastic) characteristics of the beam according to its size,

section, and weight. The GUI is the classical window of RDM6 (see figure 2). Electrodermal response was measured with ProComp Infiniti model SA7500 and heart rate with Geonaute. The subjects were filmed and all the data was synchronised with The Observer software. The aim of these last measurements is to assess the stress levels of the individuals.

Figure 1: The TUI is a ShapeTape, a flexible that measures shape, position static and dynamic orientation [2].

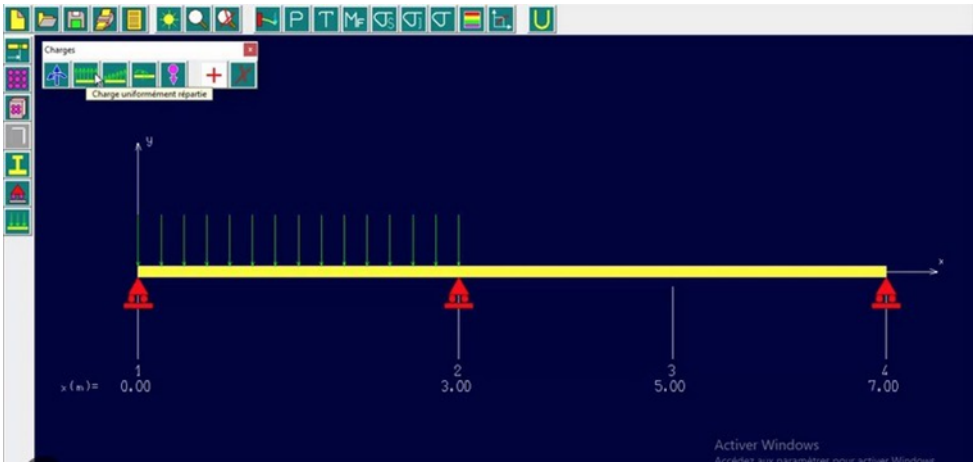

Figure 2: The GUI is the RDM6 window [2].

Results & Discussion

Our analysis of the two interfaces (TUI and GUI) considered four parameters: the time to complete the exercises, the accuracy of the results, the gender of the subjects, cognitive fatigue, and stress. Subjects completed the exercises more quickly with the TUI than with the mouse-keyboard interface, averaging 90 seconds less with the TUI, see table 1. The TUI allows non-expert users to better evaluate the value of forces exerted on the beam. This

difference in time is important for reducing the mental fatigue of the subject during longer and more complex tasks. With the TUI, subjects answered 71% of the questions correctly, while with the GUI, they answered only 62% correctly, see table 2. The TUI promotes a better understanding of the mechanical properties of the beam based on the forces and physical properties present.

Time	Q1	Q2	Q3	Q4	Average
GUI	345	87	101	322	213,75
TUI	176	102	101	146	131,25

Table 1: Analysis of exercise time: validation oh hypothesis 1 concerning ease of use.

Qualitatively, the subjects preferred to work with the tangible. 90% of the subjects think that these interfaces are useful for learning mechanics and therefore very useful for carrying out mechanical deformation exercises for non-expert subjects. 51% found the TUI pleasant to use, and 61% preferred using the TUI compared to the GUI. The subjects were more aware of the forces at work with the TUI. This qualitatively corroborates the validation of hypotheses 1 and 2.

Time	Q1	Q2	Q3	Average
GUI	100,00%	14,00%	71,00%	61,67%
TUI	86,00%	43,00%	86,00%	71,67%

Table 2: Performance comparison with the analysis of the quality of answers: validation of hypothesis 2 concerning understanding of the task.

The TUI enhance immersion and understanding compared to traditional GUI. Moreover, the multimodal characteristics allow for better cognitive resource distribution, leading to improved performance and reduced mental fatigue. Despite these very positive conclusions, our study revealed several limitations that could be overcome in future research. First, the tensioner that adjusts the elasticity of our" beam" was experienced differently depending on the individual. Only 46% of subjects found the use of the tensioner useful in its current state. It could be a problem of maturity of the prototype. Second, there were synchronization problems between the ShapeTape and the RDM6 software, which regularly caused bugs. The RDM6 software is static; subjects indicated that it would be more pleasant and easier to use if the twisting of the beam occurred simultaneously on the software and on the tangible part. Third, the recorded physiological measurements (electrodermal response and heart rate) did not show significant differences between the two interfaces. This may be because the exercises are too easy to generate stress and that the interface does not optimize working memory. In the second stage, we will perform more complex exercises. Fourth, subjects did not feel the elastic limit of the beam before it passed into the plastic

domain. This TUI offers purely passive haptic feedback. We could design and fabric a new prototype with a dynamic haptic feedback system.

Conclusions & Recommendations

We have conducted a within-subjects experiment to find that TUI are more suitable for mechanics of materials tasks compared to classic GUI. Participants (N = 20) performed beam deformation tasks in RDM6, using GUI and TUI. The TUI aimed to improve mechanical property understanding. Time, accuracy, and subjective feedback were recorded. Order was counterbalanced to mitigate learning effects. Physiological measures (heart rate, electrodermal response) were collected. TUI significantly reduced task completion time (90s faster, $p < 0.05$). With the TUI, the subjects answered 71% of the questions correctly, whereas with the GUI they only answered 62% correctly. Subjective feedback favored TUI for learning mechanics (61% preference). In conclusion, TUIs offer promising advantages for learning material mechanics, particularly for novices, by reducing task time and improving comprehension.

In perspective, addressing the issues with the tensioner mechanism to ensure a more consistent and user-friendly experience across different strength levels and to incorporate active haptic feedback seems to be relevant. Indeed, enhancing the TUI with active haptic feedback would allow users to feel the elastic limit of the material and the transition into the plastic domain. This could involve integrating devices like the Phantom (from 3D Systems company) or going towards shape-changing TUI [1] inspired by line-based interfaces such as [7]. For Industry 5.0 future work, the integration of TUI to exploit workers' cognitive and kinaesthesis abilities holds great promise to bridging the gap between technological advancement and human well-being.

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THE IMPACT OF AI AND DEFI ON WORKFORCE DYNAMICS

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Introduction

The rapid advancements in digital technologies, particularly artificial intelligence (AI) and decentralized finance (DeFi), are reshaping the global labor market, presenting both opportunities and challenges for job quality and employment. As economies transition toward digitization, understanding the interplay between these technologies and workforce dynamics becomes crucial for ensuring equitable growth, fair working conditions, and sustainable employment opportunities.

This paper explores how AI and DeFi influence job quality, reshape industries, and redefine the future of work. AI is driving automation, data-driven decision-making, and productivity enhancements, while DeFi is decentralizing financial services and creating new employment opportunities. However, both technologies raise concerns about job displacement, skills gaps, regulatory uncertainties, and socio-economic inequalities.

Case Presentation

Artificial Intelligence (AI) and Employment

AI integration across industries is transforming the nature of work by automating routine tasks, increasing efficiency, and enabling advanced decision-making. AI-driven tools have the potential to create high-quality jobs, particularly in fields related to AI development, data science, and machine learning (Jansen & Li, 2021).

However, automation also threatens traditional roles, particularly in sectors such as manufacturing, retail, and logistics (Xu & Zhang, 2023). Workers in these industries face challenges transitioning to AI-driven roles due to skill mismatches and a lack of digital training (Harrison, 2020). Additionally, AI contributes to the rise of the gig economy, where automation and digital platforms facilitate short-term, project-based employment. While

this provides flexibility, it raises concerns about job security, fair wages, and social protections (Brown & Miller, 2023).

Decentralized Finance (DeFi) and Employment

The decentralization of financial services through blockchain technology is reshaping traditional banking, lending, and investment sectors. DeFi eliminates intermediaries, reducing costs and increasing financial accessibility (Miller & Roberts, 2021). As a result, new job opportunities are emerging in blockchain development, smart contract programming, and cryptocurrency markets (Alvarez et al., 2022).

However, DeFi also presents significant risks. The lack of regulatory oversight can lead to security vulnerabilities, scams, and financial instability (Feng, 2022). Additionally, as DeFi automates many financial processes, traditional banking roles such as loan officers, financial advisors, and compliance analysts may decline in demand, requiring workforce reskilling initiatives (Tran & Patel, 2024).

Results & Discussion

Positive Impacts on Job Quality

- **New Employment Opportunities:** AI and DeFi are creating high-value job roles in data analytics, blockchain development, and AI-driven decision-making (Baker & Walters, 2022).
- **Improved Work-Life Balance:** AI-driven automation reduces the burden of repetitive tasks, allowing employees to focus on creative and strategic activities, leading to higher job satisfaction (Giles & Patel, 2021).
- **Financial Inclusion:** DeFi expands access to financial services, particularly in underbanked regions, enabling new economic opportunities for freelancers and entrepreneurs (Nguyen & Zhao, 2021).

Challenges and Risks

- **Job Displacement:** Automation may disproportionately impact low-skill workers, leading to job losses and increased income inequality (Lee & Menzies, 2022).
- **Skill Gaps and Reskilling Needs:** The rapid adoption of AI and blockchain requires significant investment in education and workforce training (Kumar et al., 2023).
- **Regulatory and Ethical Concerns:** The absence of clear regulations in DeFi and AI-based hiring raises concerns about fairness, security, and wealth concentration (Sharma & Gupta, 2024).

Conclusions & Recommendations

Key Findings

AI and DeFi are reshaping the labour market by introducing automation, new job categories, and decentralized financial structures. While these technologies create employment opportunities, they also present risks such as job displacement, skill mismatches, and regulatory uncertainties.

Recommendations

To maximize the benefits of AI and DeFi while minimizing risks, the following strategies are proposed:

1. **Investment in Reskilling and Upskilling:** Governments and private sectors should develop digital training programs to equip workers with AI and blockchain skills (Roberts, 2022).

2. **Regulatory Frameworks for DeFi and AI:** Policymakers must establish regulations that promote financial stability, data security, and fair labour practices in AI-driven workplaces (Thomas et al., 2024).

3. **Ethical AI Deployment:** Organizations should implement ethical guidelines to prevent bias in AI-driven hiring and workplace automation (Hussain & Patel, 2021).

4. **Inclusive Workforce Strategies:** Digital literacy programs should be expanded to underserved communities to reduce digital inequality and enhance job accessibility (Patel & Shaw, 2023).

By implementing these recommendations, AI and DeFi can drive innovation while ensuring fair and sustainable employment opportunities in the digital era.

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HUMAN-CENTERED INDUSTRY 5.0: BALANCING TECHNOLOGICAL INNOVATION AND ETHICAL INCLUSIVITY

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Introduction

Industry 5.0 represents the next stage in industrial evolution, building upon the digital advancements of Industry 4.0. While Industry 4.0 focused on automation, data-driven decision-making, and interconnected systems, Industry 5.0 shifts the emphasis toward a human-centric approach. This paradigm prioritizes user experience, inclusivity, and ethical considerations, ensuring that technological innovations serve societal needs rather than solely enhancing efficiency and productivity [1,2].

A key challenge of Industry 5.0 is balancing rapid technological progress with ethical and human-centered design. The introduction of artificial intelligence (AI), robotics, and automation must be guided by principles that prioritize human well-being [3]. This paper explores these aspects and introduces the Human-Centered Industry (HCI) Index, a metric designed to measure how well industrial practices align with human-centric principles [4]. The EARASHI project, a European initiative dedicated to advancing human-centered and ethical industrial practices, provides a comprehensive approach to implementing these principles in real-world scenarios [5].

Case Presentation

In this case study, we examine several projects granted under the EARASHI initiative, each exemplifying ethical technology adoption, workforce well-being, and sustainable industrial practices. Notably, all these projects have implemented the (HCI) Index as their assessment framework, ensuring a comprehensive evaluation across multiple dimensions of human-centered industry. The assessment framework used in this study explores multiple dimensions of human-centered industry, structured into five core sections (see table 1).

Table 1. HCI Index and core sections.

Section	Description
1. Descriptive Industry Overview	The initial stage focuses on gathering contextual information about the organization, including general industrial characteristics and operational insights.
2. Human-Centered Industry Perspectives	This section evaluates user experience, technology acceptance, and human factors, providing a comprehensive understanding of how employees and stakeholders interact with emerging industrial technologies.
3. Inclusiveness and Ethical Considerations	A critical component examines diversity, equity, and ethical governance within industrial settings, ensuring that companies align their technological advancements with socially responsible values.
4. Adoption of Emerging Technologies	The integration of new technologies is analyzed to understand industry readiness and implementation challenges.
5. Strategic Expectations and Industry Needs	The final section captures industry expectations, organizational goals, and the perceived impact of human-centered approaches on future industrial transformation.

Each area is assessed through structured evaluation criteria, facilitating a holistic understanding of the industry's alignment with human-centered principles. This structured approach provides insights into key challenges and opportunities for advancing Industry 5.0 objectives. The HCI Index has been systematically applied across all these projects, facilitating a holistic understanding of each initiative's alignment with human-centered principles. This structured approach provides insights into key challenges and opportunities for advancing Industry 5.0 objectives.

Results & Discussion

An in-depth analysis of industry perspectives highlights several critical themes. Organizations with structured user experience strategies and well-defined technology adoption plans transition more smoothly into Industry 5.0, whereas companies lacking clear implementation frameworks often encounter resistance and lower adoption rates. While many industries recognize the transformative potential of cybersecurity, mixed reality, and AI-driven automation, their widespread adoption is often constrained by financial limitations,

integration complexities, and a shortage of specialized expertise. Additionally, organizations increasingly seek structured methodologies to align technological advancements with human-centered objectives, driving a growing demand for frameworks that ensure innovation remains ethical, sustainable, and conducive to workforce development.

Despite the evident benefits, several barriers continue to hinder the full-scale implementation of human-centered industrial transformation. Investing in human-centered strategies requires significant financial and resource commitments, which can be particularly challenging for smaller organizations. Additionally, shifting from efficiency-driven models to human-centric approaches demands cultural transformation, often met with skepticism and resistance. Furthermore, while organizations recognize the value of human-centered industry practices, the lack of standardized metrics complicates impact measurement and makes cross-sector comparisons difficult.

Conclusions & Recommendations

Industry 5.0 marks a shift towards human-centric industrial transformation. The implementation of the HCI Index provides a structured framework for assessing organizations' alignment with these principles, offering valuable insights into industry readiness and best practices. However, addressing cost constraints and resistance to change is necessary for full adoption. Future research should refine the HCI Index, develop industry-wide benchmarks, and assess economic impacts. Policymakers should enforce ethical compliance and support workforce reskilling initiatives.

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TECHNOLOGY TRANSITION – A KEY QUALIFICATION FOR INDUSTRIAL ENGINEERS AND MANAGERS

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Keywords: transhumanism, Kondratiev wave, logit model, IOOI logic, Kuznets curve

Introduction

Technology is in transition, causing new challenges in engineering as well as in management. Neither the engineering alone, nor pure management, is enough for a successful transition, but a well-aligned coaction of both. A “transition engineer” must know about the options to provide energy and matter by means of alternative technologies. And a “transition manager” must know about economic mechanisms of market change.

Industrial poll

In 2019 we undertook an investigation among our dual partners in industry about the relevant topics for our students in industrial engineering and management. It turned out that transition topics – like projects, changes and innovations – were higher ranked than maintaining topics – like supply chain, quality, controlling or marketing.

The logics of theory and practice

Gottfried Wilhelm Leibniz (1646-1716) can be assigned as an early technologist at the onset of modernity, who combines deep insights in sciences – like the differential calculus, the binary number system, or “monads” for quantum mechanics – with pioneering technologies – like a mechanical computer, a steam engine prototype, water pumps and windmills, hydraulic presses, lamps, submarines or clocks. In 1705 he stated a difference in the logics between theoretical conclusions and practical conclusions, namely: A practical conclusion is only true, if proofed by facts, whereas a theoretical conclusion is already true, if not contradicted by facts. [i] In consequence, there are always more theoretical conclusions possible, than given in practice. And therefore, the world is not condemned to stay as it has always been but may be – theoretically – conceived in alternative ways, as well as –

practically – thereupon accomplished. This may be considered as the initial spark for any technological transition.

Transition engineering

Regarding the theory of long economic cycles, which relates global economy with predominant technologies, we are approaching the end of the fifth Kondratiev wave. [ii] After the technological transitions due to the mechanization by steam engines first, to propulsion second, to electrification third, to automation fourth and to digitalization fifth, we are nowadays facing a transition, which is sometimes labelled as transhumanism.

“Transhuman” technologies are meant to decouple the subjection of humanity to natural restrictions and natural resources. Thus, it comprises transition in consumption as well as transition of the human existence itself. Less consumptive technologies are meant to be sustainable by decarbonization, by renewable energies and by circular economy, like recycling, cogeneration, recuperation, heat pipes and heat pumps, pyrolysis, ORC, or KERS. Human technologies are meant to be enhancing by cyber-physical systems CPS, by human-computer interactions HCI, by an internet of things IoT or by artificial intelligence AI, like brain interfaces, augmented and virtual reality, genome hacking, smart grids, cybernetics, wearables, autonomous driving, neuroenhancement, bionics, or prosthetics. Apparently, there seems to be no lack of transition ideas in transhuman engineering.

Transition management

One fundamental observation of transition dynamics is a specific hysteresis during the diffusion of new technologies, known as the “S-curve”. With respect to a dominant design effect [iii], a new technology must pass retarding periods, where its diffusion stays always behind the technical progress and related investments: from an early precursor to a pace making phase. However, once a technology has gained economic advantages, a merit order effect propels a quick turnaround, where the old economy is substituted by a more profitable one: from a key phase to a basis technology. Meanwhile it turned out that the dynamics of transition can be mathematically matched by the logit model of a logistic regression. [iv] However, the dangers of a hype cycle must be considered [v], as well as the observation that transition has accelerated during the past centenary. [vi]

Other management theories concern the emergence of technologies, since they are not just satisfying a need, but creating their own market. The emerging effects attain another level than expectable by the mere artefacts and related technical competences. For instance, food technology is not only meant for nourishment but extensively for gourmet purposes, and transport is more than mere displacement but to a greater extend tourism and pleasure cruise, even computation does rarely mean calculation but mainly entertainment, as well as medicine does not only serve health but self-optimization, too. Later on, the emerged market has always become much bigger than has been the original demand.

For the analysis of emergence, a process of subsequent steps or levels can be applied, generally based on the “analogy of the divided line” by Plato. It describes the progressive abstraction from reliable facts to supposable considerations by a multi-tier architecture, where – based on an input – an output is generated “by fact”, however, emerges to an overall outcome and results finally in an impact “by effects”. This IOOI method may be paraphrased in a multitude of expressions, like the DPSIR interaction, where an input demand D of the society causes an output pressure P on the environment, emerging to an outcome state S and resulting in an environmental impact I – which finally permits appropriate responses R. Whatever the words are, transition is significantly more than just change, but another level of evolution.

A further feature of transition management is the imparity of adoption. This can be examined by the Lorenz curve and represented by a Gini coefficient. According to a progressive adoption and habituation, the Kuznets curve prospects a parabola of decreasing imparity over time, however, until a new technology transition begins. [vii]

Conclusions & Recommendations

Technology transition is not a fate anymore, but an important event which requires engineering as well as management skills. The particular mechanisms are meanwhile well understood and furnished with suitable methods. Especially for the dual concept of “theories for practice” it becomes an issue to teach, to train and to instruct students in the respective sciences.

TECH QUIZ MARATHON: A GAMIFIED PLATFORM REVOLUTIONIZING SKILL ASSESSMENT FOR INDUSTRY 5.0

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Keywords: Soft skills, Evaluation platform, Gamified assessment, Academia-industry collaboration

Introduction

The findings of the Tech Quizz Marathon highlight the growing need to align students' competencies with the demands of an increasingly complex and technology-driven industrial landscape. As we transition towards Industry 5.0, which integrates human-centric, sustainable, and resilient approaches with advanced digitalization and automation, the necessity for a balanced skillset—combining technical expertise with strong soft skills—becomes even more evident. [1] This necessity is emphasized in several strategic documents at both national and European levels, which focus on aligning education with market needs in key technological and economic sectors [2].

Recognizing this shift, the Faculty of Engineering and Information Technology at George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures has implemented a pilot students' skills evaluation method in collaboration with the business sector. This new approach evaluates students' technical and soft skills through an applied digital program called Tech Quizz Marathon. The objective is to identify the key competencies expected by industrial employers and analyze how well students' skills align with these expectations.

Case presentation

The Tech Quizz Marathon, conducted in March 2024, involved 16 industrial companies evaluating 106 students from the Faculty of Engineering Information Technology. Employers were asked to assess the students' technical and soft skills based on predefined criteria

aligned with ESCO competencies under the major group 2 COR, 2141 - Engineering and Production Technologies [3].

The results highlighted a set of key competencies required by industrial partners. Among the technical competencies, the most valued skills were programming, which is crucial for software development and automation; data analysis and visualization, which supports informed decision-making; and quality management, which ensures efficiency and compliance with industry standards. Regarding soft skills, the new evaluation approach found that employers prioritize communication, as it facilitates information exchange in both technical and non-technical contexts; a proactive learning attitude, essential for continuous professional development and adaptability; and teamwork, which plays a fundamental role in modern engineering projects.

Results & discussion

The statistical analysis of responses obtained through the Tech Quizz Marathon examined the distribution of scores for soft skills (S) and technical skills (T). A One-Way ANOVA test applied to the collected data revealed that the average score for soft skills ($M = 3.55$, $SD = 9.51$) was slightly higher than the score for technical skills ($M = 2.61$, $SD = 5.82$). However, the difference was not statistically significant ($p = 0.079$) at the $\alpha = 0.05$ level, indicating that although a trend favoring soft skills is noticeable, it cannot be confirmed as meaningful beyond chance variation. The results suggest that both skill sets remain critical for industry, and future research should further explore their relative impact on employability. Additionally, an analysis of student performance based on gender and year of study revealed that while female students were underrepresented in the sample, their average scores did not significantly differ from those of male students. Interestingly, female participants scored higher in soft skill domains, particularly in communication and teamwork-related assessments, reinforcing the importance of interdisciplinary and collaborative competencies in modern engineering education.

Conclusions & recommendations

The results emphasize the rising demand for engineers who not only possess strong technical skills—such as programming, data analysis, and quality management—but also excel in soft skills like communication, teamwork, adaptability, and continuous learning. In the context of Industry 5.0, where human intelligence and collaboration with advanced technologies like AI, IoT, and robotics will play a crucial role, these competencies will be essential. Furthermore, national and European strategies, including the Digital Agenda for Europe and the European Green Deal, highlight the increasing need for interdisciplinary expertise, reinforcing the importance of integrating digitalization, automation, and sustainability into engineering education [4].

To address these evolving requirements, we propose several key recommendations. First, updating academic curricula to align with Industry 5.0 principles is crucial, ensuring that students develop both advanced technical capabilities and the necessary soft skills, including communication, teamwork, and adaptability. Additionally, universities should prioritize experiential learning, incorporating hands-on projects, case studies, and dual-

education programs that provide students with direct industry exposure. Strengthening partnerships between academia and businesses will facilitate this real-world learning approach, helping students bridge the gap between theoretical knowledge and industrial application. Lastly, fostering a culture of continuous learning and digital fluency will be critical, ensuring that graduates remain agile and capable of adapting to the dynamic shifts in the future workforce.

By implementing these measures, universities can enhance graduates' employability and enable them to thrive in Industry 5.0, where technological advancement and human creativity must go hand in hand.

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ELECTRIC MOBILITY AND RENEWABLE ENERGY: STRATEGIC FORMATION AND UNIVERSITY-INDUSTRY CONNECTION IN AUTOMOTIVE INDUSTRY 5.0 THE IMPACT AND SUCCESS OF THE MOVER, WEG, AND UNISENAI PROGRAM

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Keywords - Electric Mobility - Renewable Energies - Innovative Higher Education - University-Industry Connection - Sustainability.

Introduction

Brazil, an emerging industrial power, has been making significant progress through robust state policies and strategic efforts in the productive sectors, aiming to consolidate its position in the global landscape of technological innovation and sustainable development. Within this context, the National Service for Industrial Learning (SENAI) has stood out as a reference institution in technical education and innovation, playing a crucial role in training highly qualified professionals capable of meeting the demands of an ever-evolving market. Specifically, UniSENAI Santa Catarina excels in offering innovative courses driven by an integrated network of technology, research, and innovation, fostering an academic environment that promotes synergy between theoretical knowledge and practical application.

1Case Presentation

Amidst this transformative scenario, the lato sensu postgraduate program structured in a co-creation format emerges as an innovative and differentiated initiative. This curriculum development model enables one or more companies to actively participate in the design of courses, working in direct collaboration with UniSENAI's educational team. A notable example of this approach is the Master Business Innovation (MBI) in Electric Mobility and Renewable Energy, developed in partnership with WEG, a globally recognized manufacturer of electromechanical equipment. This program aims to prepare professionals to lead the energy transition and drive the adoption of sustainable technologies in Brazil.

Since its inception, the MBI in Electric Mobility and Renewable Energy has yielded remarkable results, having trained 82 students and directly supported 40 companies in the productive sector. Currently, the third cohort includes 90 students from 64 companies within

the automotive sector and its supply chain, reflecting the increasing demand for qualifications in strategic industrial fields. The course structure is distinguished by its practical and immersive training approach, fostering professional networking, startup development, and innovative formats that strengthen university-industry relations, significantly enhancing knowledge and technology transfer.

Results and Discussion

The key differentiator of this third edition of the program is the expansion of institutional partnerships, now supported by the MOVER project, a Federal Government initiative in collaboration with the National Department of SENAI. This strategic alliance represents a substantial advancement in Brazil's commitment to modernizing its energy matrix and developing clean technologies, aligning with the United Nations' Sustainable Development Goals (SDGs).

Parallel to the MBI program, UniSENAI, in line with its commitment to social responsibility and knowledge democratization, offers self-instructional extension courses focusing on foundational training in electric mobility. These academic extensions have reached a broad audience, surpassing 2,600 participants through three open community courses: "Renewable Energy Sources," "Introduction to Electric Traction," and "Vehicle Embedded Systems." These initiatives strengthen Brazil's technological knowledge base, preparing a new generation of professionals attuned to the needs of sustainability and technological innovation.

The intrinsic connection between decarbonization, smart cities, and artificial intelligence (AI) lies at the core of the training programs offered by UniSENAI, transcending traditional disciplinary approaches. The institution implements innovative educational models, recognized by the labor market, that emphasize the creation and application of advanced technological solutions. This commitment is materialized through effective actions such as the MOBICIT – National Integrated Congress on Electric Mobility and Smart Cities, established in 2023. Now in its third consecutive edition, the congress has solidified itself as a convergence space for academia, industry, and government, fostering high-level discussions on the future of sustainable mobility and the integration of technologies for more human-centered cities.

These initiatives reflect UniSENAI and WEG's dedication to transforming Brazil's energy landscape, driving technological innovation, sustainability, and skill development aligned with global demands. Strengthening partnerships between academia, the productive sector, and government through programs such as the MBI in Electric Mobility and Renewable Energy and the MOVER project positions Brazil at the forefront of discussions on electric mobility and renewable energy, paving the way for a greener future.

Conclusions and Recommendations

The co-creation model employed in the MBI in Electric Mobility and Renewable Energy at UniSENAI Santa Catarina demonstrates a highly effective approach to aligning academic training with industry needs. The direct collaboration between educational institutions and

leading companies ensures that professionals receive up-to-date, market-driven education, reinforcing their role in Brazil's energy transition.

Furthermore, expanding strategic partnerships, such as the integration with the MOVER project, highlights the importance of multi-sector collaboration in advancing technological and sustainable innovations. The continuous development of extension courses and initiatives like MOBICIT further underscores the need for accessible and inclusive knowledge dissemination.

For future initiatives, it is recommended that similar models of co-created education be adopted in other sectors with strategic relevance for Brazil's industrial and environmental agenda. Additionally, further investment in interdisciplinary programs that connect AI, smart cities, and energy efficiency can enhance the country's technological and sustainable development. These actions will contribute significantly to positioning Brazil as a global leader in renewable energy and sustainable mobility.

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LIQUID HYDROGEN AND INDUSTRY 5.0 FOR SUSTAINABLE AVIATION

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Keywords: Industry 5.0, Digital Twin, Liquid Hydrogen, Interactive Teaching, Human-centered Concept, Artificial Intelligence, ZeroE, Sustainability, Aviation

Introduction

The Industry 5.0 migration requires sustainable, human-centered concepts for technology and employment [1]. A key aspect is the close collaboration between industry and academia to ensure the seamless integration of graduates into an evolving industrial landscape. Whereas the principle of Industry 4.0 was mainly focused on automation and the connection and communication between physical and digital systems, known as digitalization, and the concept of digital twins and intelligent manufacturing was introduced. However, with the proposal for Industry 5.0, the interaction and cooperation between humans and machines is brought to the fore to develop resilience and a more human-centric approach. With the transition to a new industry standard, a balance between technological growth and workforce well-being needs to be ensured, while the step toward greater sustainability must not be neglected. [2]

A key element of this transformation is the shift toward cleaner and more sustainable energy solutions in industrial applications. The aviation industry, as a major contributor to global carbon emissions, is seeking innovative propulsion alternatives to meet environmental goals. The adoption of liquid hydrogen (LH2) as a propulsion fuel represents a pivotal step toward achieving zero-emission (ZeroE) objectives. [3,4] However, to successfully integrate LH2 into aviation, substantial research is required to analyze the behavior of the system under cryogenic conditions and the implications for both operational safety and efficiency. This research focuses on the development of a cryogenic test rig and its corresponding digital twin to investigate these aspects.

Methodology

To contribute to this goal, a cryogenic test rig is being developed at the university to study phase transitions at varying temperatures and pressures while assessing the performance and reliability of control components such as pumps, valves, heat exchangers, and flow and thermal sensors under cryogenic conditions. This test rig is designed to resemble and simulate a fuel system for sustainable aircraft propulsion, enabling the investigation of cryogenic system feasibility. While liquid hydrogen is the intended propulsion fuel, liquid nitrogen will be used as a safe and cost-effective substitute during testing.

Additionally, to enhance experimental efficiency and reduce resource expenditure, a sophisticated digital twin of the cryogenic test rig is being developed. A rendering of the digital twin concept, including the planned sensor placement, can be seen in Figure 1. The test rig is designed to create a cycle with a return flow of the propulsion fuel, whereby a fraction of this is diverted to supply the engine with the required amount of fuel. The mass extraction from the tank remains constant, with the control depending only on the ratio of the returned fuel mass.

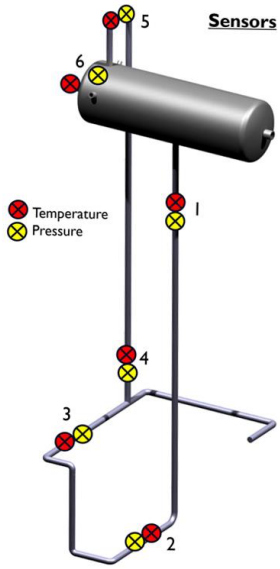

Figure 1. Concept of the test rig digital twin including sensor placement

Results & Discussion

For this project, students will be integrated and given specific tasks with various scopes to build the test rig, obtain and process results, and perform simulations, which will also be implemented into academia through interactive teaching modules. As academic courses

often tend to provide structured and filtered data. However, in industry, data is rarely perfect and often requires filtering, interpretation, and refinement, thus the integration of real-life and real-time data into courses plays a crucial role. By working with imperfect data, students gain a more realistic understanding of industry challenges and are better prepared for the complexities of data-driven decision-making in professional environments.

The digital twin will lead to enhanced experimental precision and will be used for various simulations, such as computational fluid dynamics and finite element simulations, to estimate and predict the behavior of the test rig. This information will be analyzed and utilized to enable early detection of potential system failures, allowing for preemptive modifications to experimental setups. This approach minimizes costs associated with material wastage and equipment wear while helping students gain valuable hands-on experience. By automating repetitive data processing tasks with machine learning and AI-driven tools, the workflow efficiency will improve, and the mental load on operators will be reduced, thus prioritizing human well-being and human-machine interaction. This reflects the core principles of Industry 5.0, where technology is used to support rather than replace human input [5].

Conclusion

By advancing hydrogen propulsion systems and integrating them into education and technological development, this research establishes a framework for sustainable industrial practices. It bridges innovation and social responsibility, fostering workplaces that balance productivity, inclusivity, and well-being, aligned with the vision of Industry 5.0. [6,7]

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ON THE DEVELOPMENT OF A FINITE ELEMENT MODEL DESIGNED TO OPTIMIZE THE ELECTRON CYCLOTRON RESONANCE PROCESS IN BATCH PLASMA SYSTEMS.

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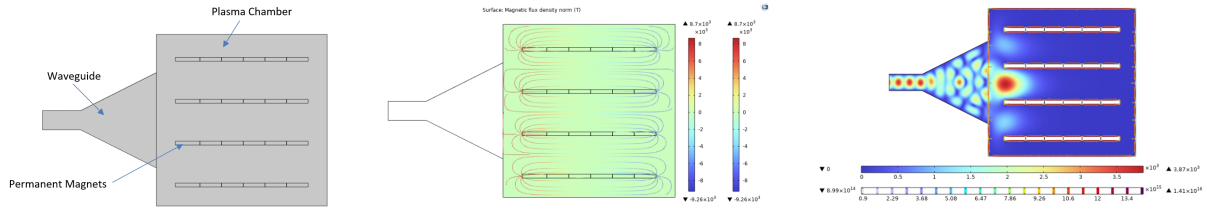
Keywords: Plasma; Semiconductor Manufacturing; Lead frames; Electron Cyclotron Resonance;

Introduction

The production yield in semiconductor manufacturing is vital for industry sustainability and product quality. To prevent yield losses during processes like molding and wire bonding, plasmas are employed to clean lead frames from contaminants such as oxides and carbon deposits (Amri, Norhisyam, Harun, A.F.Kadmin, & M.F.Basar, 2019) (Pulutan, Fernandez, & Estolano, 2022). In Industry 4.0/5.0, where robotic handling dominates, batch plasma systems are essential, enabling simultaneous processing of multiple components. Some of these systems generate plasma through the interaction of microwave radiation with electrons which are under the influence of a static magnetic field. Electrons spiral along the magnetic field lines and efficiently absorb electromagnetic radiation when the microwave frequency aligns with the electron cyclotron frequency, a phenomenon known as Electron Cyclotron Resonance (ECR), (Hupert, 1975) (Inan & Golkowski, 2011) (Fridman & Kennedy, 2011).

Methodology

This paper presents a Finite Element Model (FEM) developed using COMSOL Multiphysics to optimize ECR systems for hydrogen-based plasmas. The model integrated three key modules: Electromagnetic Wave Physics, Plasma Physics, and Static Magnetic Field Physics, while also incorporating two coupling modules namely Plasma Conductivity and Electron Heat Source. The geometry of the plasma chamber being modelled is shown in Figure 1 (a).



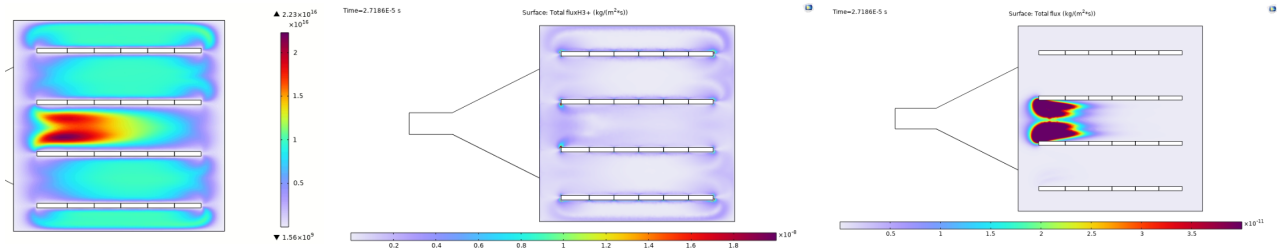
a b c

Figure 1 ~ Views of the FEM showing (a) the geometry of the plasma system with the waveguide to the left and the plasma chamber to the right, (b) the Magnetic Flux Density developed by the permanent magnets and (c) the Electric Field plot showing the microwaves travelling through the waveguide and into the chamber.

The first stage of the model's operation involved running a stationary study of the magnetic fields through which the Magnetic Flux Density was computed as shown in Figure 1 (b).

Results & Discussion

The next stage of the process was the conduct of a frequency – transient study through which the microwave ingress into the chamber was simulated as shown in Figure 1 (c). The FEM successfully linked the interaction of the electrons with the static magnetic field and the incident microwave radiation. This was achieved by setting the properties of electron transport into functions of the static magnetic flux density. In this case plasma conductivity was set as a highly nonlinear function of the static magnetic field's magnetic flux density. Figure 2 (a) shows the electron density within the chamber.



a b c

Figure 2 ~ FEM results showing (a) the electron density inside the chamber with (b)showing trihydrogen cation concentration and (c) showing the concentration of hydrogen atoms having their lone electron excited to the third energy level (n=3). All at time 2.7x10^{-5}s after onset of excitation.

Next the FEM simulated the interaction of the electrons with the hydrogen gas particles. This case was quite complex with eight different species being involved including electrons, molecular hydrogen, atomic hydrogen, protons, hydrogen with electron excited to energy levels 2 and 3, hydrogen molecular ions and trihydrogen cations. Figure 2 presents FEM results showing (b) the trihydrogen cation and (c) excited atom concentration. These are among the species which are crucial for effective cleaning as they react with the oxides and carbon deposits present on the lead frames, forming gaseous products that are extracted from the chamber. The process cleans the substrates thereby improving the surface contact angle.

Conclusions

The Finite Element Model presented in this paper is an important tool which allows engineers to optimize plasma parameters thus visualizing the process better and achieving ideal parameters and equipment design. The actual results achieved through the operation of the model will be reported in subsequent literature to be published.

Acknowledgements

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MANAGING MULTIDISCIPLINARY TEAMS FOR INNOVATION IN THE AGE OF INDUSTRY 5.0: INSIGHTS FROM TECHSCALE

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Keywords: Industry 5.0, multidisciplinary teams, inclusive workplaces, nanotechnology, innovation management

Introduction

The advent of Industry 5.0 represents a paradigm shift, emphasizing the integration of human intelligence and automation to foster innovation and address societal challenges. Unlike Industry 4.0, which primarily focused on automation and digitization, Industry 5.0 prioritizes human-centric solutions, sustainability, and resilience. Managing multidisciplinary teams within this framework presents unique challenges, especially in high-tech fields like nanotechnology, where expertise from diverse domains must be effectively integrated.

The TECHSCALE project ("Technologies Beyond the Nanoscale") serves as a case study on managing multidisciplinary collaboration for innovation. This study explores structured frameworks for fostering inclusivity, leveraging digital communication platforms, and implementing cross-disciplinary training. By analyzing TECHSCALE's strategies, we provide actionable insights into enhancing team effectiveness in complex, technology-driven environments.

Case Presentation

Overview of the TECHSCALE Project

TECHSCALE is a research initiative dedicated to expanding nanotechnology beyond its conventional limits. The project aims to drive fundamental discoveries with real-world applications in energy storage, chemical catalysis for the pharmaceutical and chemical industries, disease diagnosis and treatment, and antimicrobial therapy—particularly in addressing bacterial resistance to antibiotics. Beyond scientific advancements, TECHSCALE also evaluates the societal impact and public acceptance of emerging

technologies. Bringing together experts from physics, chemistry, materials science, engineering, and social sciences, the initiative fosters multidisciplinary collaboration to transform theoretical breakthroughs into practical solutions.

Challenges in managing multidisciplinary teams

Despite the advantages of diverse expertise, multidisciplinary teams face several challenges, including:

- **Communication barriers:** Differences in terminology and methodologies between disciplines can hinder effective collaboration.
- **Coordination complexity:** Managing tasks and workflows across multiple domains require structured frameworks.
- **Inclusivity and integration:** Ensuring that all disciplines have an equal voice in decision-making is crucial for innovation.

Strategies for effective team management

To address these challenges, TECHSCALE implemented the following key strategies:

- **Structured collaboration frameworks:** Establishing clear roles, responsibilities, and workflows to ensure efficient teamwork.
- **Digital platform for communication:** Using centralized project management tools to streamline interactions and document progress.
- **Cross-disciplinary training:** Conducting workshops to foster mutual understanding among team members from different backgrounds.
- **Stakeholder engagement:** Integrating feedback from industry partners, policymakers, and end-users to align research outcomes with societal needs.

Results & Discussion

Impact of management strategies

The adoption of structured collaboration frameworks and digital platforms significantly improved coordination and reduced communication gaps. Regular training sessions enhanced interdisciplinary understanding, leading to more cohesive teamwork. Additionally, stakeholder engagement contributed to the development of socially relevant innovations.

Lessons learned

- **Clear communication is key:** Defining common terminology and ensuring transparency in discussions can mitigate misunderstandings.
- **Flexibility enhances innovation:** Allowing adaptive workflows fosters creativity and accommodates the evolving nature of research.

- **Inclusivity drives performance:** Diverse perspectives lead to more comprehensive problem-solving approaches and innovative outcomes.

4. Conclusions & Recommendations

The TECHSCALE case study highlights the importance of advanced management techniques in shaping effective multidisciplinary teams. To optimize innovation in Industry 5.0 environments, organizations should:

- Implement structured frameworks to streamline collaboration.
- Leverage digital tools for seamless communication and project tracking.
- Foster a culture of inclusivity through cross-disciplinary training.
- Engage stakeholders to ensure societal alignment of technological advancements.

By adopting these strategies, organizations can create dynamic workplaces that harmonize human ingenuity with technological progress, paving the way for sustainable and impactful innovation.

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MINISTRY OF EDUCATION, YOUTH AND SPORTS

MACHINE COLLABORATION IN SUSTAINABLE AIRCRAFT PROPULSION: ADVANCING TECHNOLOGIES FOR INDUSTRY 5.0

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Keywords: Industry 5.0, Human-Machine, Sustainable Aviation, Combustion-Testing CFD Simulations, Sustainable Aircraft Fuels, Dual Higher Education

Introduction

The transition to Industry 5.0 emphasizes human-centered, sustainable, and adaptable industrial practices, requiring shifts in education and workforce development. Early educational initiatives are important in equipping professionals with the skills needed for advanced manufacturing and the digital economy [1]. In aviation, sustainable aircraft propulsion systems demand human expertise and human-machine collaboration to develop cleaner, more efficient technologies. Numerical simulations are vital in modern research, helping analyze complex aerothermal interactions. A challenge in system development is that different software tools are needed for specific simulation aspects.

For example, in liquid hydrogen propulsion systems, simplified models optimize the entire system over a mission, but detailed phenomena like liquid sloshing require Smoothed Particle Hydrodynamics (SPH) simulations. SPH is unsuitable for multiphase flows with phase transitions, where Reynolds-Averaged Navier-Stokes (RANS) simulations with a Volume of Fluid (VoF) approach are better. Specialized combustion software provides more accurate results. Engineers must effectively integrate these tools into a coherent simulation environment, enabling data exchange through well-defined interfaces.

This study explores human-machine collaboration in sustainable aircraft propulsion system development within aviation degree programs, preparing students for the challenges of Industry 5.0.

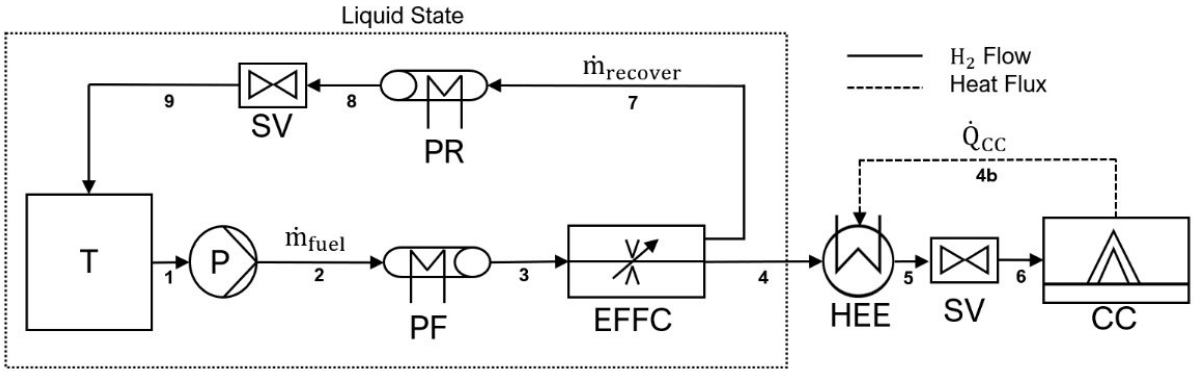

Figure 1. Cryogenic hydrogen fuel simulation model scheme (Main components: Tank (T), Booster Pump (P), Pipes (PF & PR), Engine Fuel Flow Controller (EFFC), Heat Exchanger Engine (HEE), Safety Valves (SV) and Combustion Chamber (CC)), cf. [2].

Methodology

As the T&T Aircraft Propulsion Systems research group at the Institute of Aviation of the University of Applied Sciences FH JOANNEUM, we actively involve students in ongoing research through bachelor's and master's theses and projects. This hands-on engagement enables them to contribute directly to real-world projects, gaining practical experience in the development of sustainable aircraft propulsion systems.

Aligned with Industry 5.0 principles, which emphasize human-machine collaboration and sustainability [3], our research group utilizes collaborative digital tools to enhance efficiency and knowledge transfer. Microsoft SharePoint and Microsoft Teams serve as key platforms for structured communication and coordination across both research and student projects.

A central Knowledge Base connects different disciplines by mapping interactions between simulation tools, modeling approaches, and experimental methods. It provides a framework where students and researchers access project results, technical expertise, and validated methodologies. By linking simulations with experimental investigations, it ensures theoretical predictions align with real-world behavior.

This collaboration-driven approach to develop Aircraft Propulsion Systems enhances students' project management skills, fosters interdisciplinary research, and ensures continuous knowledge transfer, as illustrated in Figure 2.

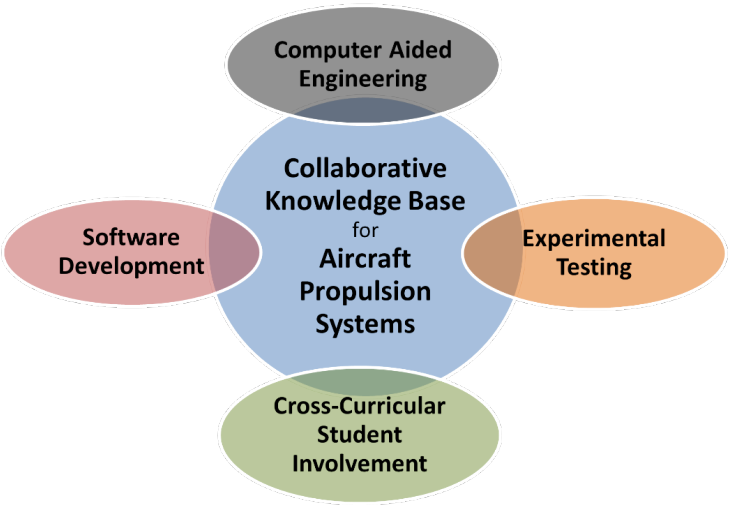

Figure 2. The key pillars of T&T Aircraft Propulsion Systems research team, illustrating the interdisciplinary and knowledge-driven approach.

Results & Discussion

The evaluation of this initiative highlights the importance of educational transformation alongside technical innovation. By fostering competencies in both technical and soft skills - such as critical thinking, collaboration, and environmental responsibility - students are better equipped to develop sustainable and safety-oriented aviation technologies.

This combination of human expertise with machine capabilities exemplifies Industry 5.0's human-centric ethos, driving technological progress, workforce preparedness, and sustainable innovation through digital collaboration [3][4].

Key Performance Indicators (KPIs) since the launch of the T&T Aircraft Propulsion System Team (August 2023):

- Number of people with access to the collaborative space: 297
- Number of completed student projects: 109
- Number of deployed web apps: 12
- Number of documented case studies: 105

Key Outcomes:

- **Sustainable Propulsion Technologies** – Enhancing low-emission propulsion systems through experimental and computational research.
- **Educational Transformation** – Creating interdisciplinary learning environments to equip students for future aviation challenges.

- **Knowledge Management** – Building a centralized knowledge repository to drive innovation in sustainable aircraft propulsion.
- **Human-Machine Integration** – Connecting diverse tools within a human-centric collaborative framework.

Conclusion

By integrating Industry 5.0 principles, this research pushes technological innovation while preparing future engineers through hands-on education and interdisciplinary collaboration.

The structured use of simulation tools, experimental validation, and digital collaboration platforms creates a knowledge-driven environment, equipping students with key skills in numerical modeling, system optimization, and project management. This bridges the gap between academia and industry, ensuring efficient propulsion system development while supporting decarbonization efforts in aviation with actual product development.

By leveraging advanced simulation techniques and digital tools, we enhance system prediction, decision-making, and safety - particularly in high-risk testing scenarios involving flammable fuels [5][6]. Simulation and approximation tools further mitigate risks, enabling resource-efficient designs and safer testing [7].

This approach not only accelerates sustainable innovation but also strengthens the reliability and efficiency of next-generation propulsion systems. Additionally, it ensures that students gain practical experience and actively contribute to the development of sustainable aircraft propulsion concepts, consolidating the understanding of the interdependence of individual subsystems

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THE EFFECT OF INSTITUTIONS ON THE PERFORMANCE OF THE LOGISITCS SECTOR IN THE EU4DUAL COUNTRIES

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Keywords: EU4DUAL countries, quality of institutions, quality of governance, economic performance, logistics sector

INTRODUCTION

Today, as a consequence of the global economic order being transformed and the apparent increased role of logistics services in this process, the business practices of multinational corporations (MNCs) have motivated developed countries to increase the efficiency of supply chains as a result. [1]

In addition, given that most logistics activities and services are now run by multinational corporations (MNCs), the concept of logistics management has gained a great deal of importance. It became important to managers why some companies thrive in uncertain, chaotic environments while others falter. According to *Collins–Hansen* the main driving factors are [2]:

- the importance of unwavering consistency in goals, values, and methods, even in the face of turbulent circumstances,
- leaders in companies actively plan for worst-case scenarios and build financial and operational buffers to endure unforeseen challenges,
- a set of well-defined operating principles that guide decision-making and actions, ensuring adaptability without losing focus
- the authors critique reliance on luck, proposing instead that great companies make the most of their opportunities by combining preparation and execution
- in sum a balanced, evidence-driven approach to leadership, emphasizing resilience, discipline, and adaptability as key drivers of sustained success in a volatile world.

The hypothesis is as follows:

- In those EU4DUAL countries in which the quality of governance, the HDI and the level of property rights are higher, the performance of the logistics sector is higher.

METHODOLOGY AND ANALYSIS

In this section of the article first the methodology used, then the compared variables are introduced.

The main methodology is comparative analysis, which approach puts institutions into its focus.

The results of the comparative analysis are tested with correlation analysis as well.

Table 1. The statistical data of the 4 clusters on institutions and the logistics sector performance (own editing)

Country	Country Code	HDI (UNDP) 2022	WGI Government effectiveness (World Bank) 2022	IPR 2022	Logistics Performance Index 2023
Western European Countries	WCE	0,93	90,57	7,45	3,90
Eastern European Countries	EEC	0,86	69,73	5,72	3,35
Meditteranian European Countries	MEC	0,89	73,98	5,76	3,53
Skandinavian European Countries	SEC	0,95	96,70	7,86	4,10

Table 2. Correlation Analysis of the examined Indices (own calculations)

	HDI (UNDP) 2022	WGI Government effectiveness (World Bank) 2022	IPR 2022	Logistics Performance Index 2023
HDI (UNDP) 2022	1			
WGI Government effectiveness (World Bank) 2022	0,973094437	1		
IPR 2022	0,938806644	0,991693095	1	
Logistics Performance Index 2023	0,986066409	0,995280727	0,975	1

If we focus only on the EU4DUAL countries (Austria, Croatia, Finland, France, Germany, Hungary, Malta, Poland, Spain,) then the following findings can be summarized (Table 2).

Table 3. The statistical data of EU4DUAL countries on institutions and the logistics sector (own editing)

Country	Country Code	HDI (UNDP) 2022	WGI Government effectiveness (World Bank) 2022	IPR 2022	Logistics Performance Index 2023
Western European Countries	**WCE**	**0,92**	**87,58**	**7,34**	**4,00**
Austria	AT	0,916	91,51	7,77	4
France	FR	0,903	83,02	6,78	3,9
Germany	DE	0,942	88,21	7,47	4,1
Eastern European Countries	**EEC**	**0,86**	**66,98**	**5,25**	**3,37**
Croatia	HR	0,858	70,28	4,92	3,3
Hungary	HU	0,846	68,87	5,42	3,2
Poland	PL	0,876	61,79	5,41	3,6
Meditteranian European Countries	**MEC**	**0,91**	**77,36**	**6,01**	**3,60**
Malta	MT	0,918	76,89	5,78	3,3
Spain	ES	0,905	77,83	6,25	3,9
Skandinavian European Countries	**SEC**	**0,94**	**96,70**	**8,17**	**4,20**
Finland	FI	0,940	96,70	8,173	4,2

CONCLUSIONS

In this article we aimed to test whether the quality of institutions as a macro-economic driver has influence on the performance of the logistics sector among the EU27 member states. In the first chapter of the article, we reviewed all those literatures, which demonstrate the importance of institutions for the development of the economy. An overview of the methodology used in this article and the indices that were examined is presented in the second section. In the main chapter we created clusters, then compared the data of the countries and the clusters. The main findings of the research are:

- All the indices examined in the analysis show very strong correlation. the weakest correlation is even 94% between the IPR and HDI indices.
- HDI and WGI are correlated at a 97% level, so as the IPR and LPI indices.
- LPI and HDI are correlated at a 98,6% level,
- WGI and IPR are correlated at a 99,1% level, which reflects and supports the results of other analyses in the literature.
- The HDI index, followed by IPR and Government Effectiveness have the strongest 99,5% correlation on 1% significance level on the logistics performance index 2023.
- Finland has the highest scores for HDI, WGI, IPR and LPI indices. As a contrast Hungary has the lowest scores in all 4 indices.
- The HDI, WGI and IPR are the second highest in Austria, the LPI of Austria is ranked 3rd. Germany is almost as good as Austria, as the LPI is the 2nd highest and the HDI, WGI and IPR are the 3rd among the examined countries.
- France's data are slightly below the German ones and slightly above Spain and Malta.
- Among the Post-socialist Eastern European countries, the HDI and LPI are the highest in Poland, but even with these results it lags behind the Scandinavian, Western and Mediterranean countries (Malta has a bit lower LPI score, but it is an island with special constraints).

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ADVANCING THE CIRCULAR ECONOMY: THE ROLE OF THE EUROPEAN DIGITAL PRODUCT PASSPORT IN DATA GOBERNANCE AND SUSTAINABILITY

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Keywords: Circular Economy, Digital product passport, European Unión, Legislation, Digitisation.

Introduction

The linear economic model ("take, make, dispose") is unsustainable due to resource depletion, climate change, and rising waste levels [1,2,6,11,12]. The Circular Economy (CE) promotes recycling, reconditioning, and renewable energy to maximize efficiency [2,7], but faces regulatory, infrastructural, and technological challenges [6,11].

The Digital Product Passport (DPP) is a strategic tool enhancing product traceability and sustainability. Introduced in the European Green Deal [4] and developed through the Ecodesign Regulation [5], the DPP provides data on product life cycles, material composition, and

recyclability. With mandatory implementation for batteries by 2027 [6], it sets a precedent for broader applications.

Methodology

A systematic literature review followed the PRISMA approach [16] and PRISMA-S extension [7]. Searches in SCOPUS and Web of Science (01/03/2025) were supplemented with gray literature and snowballing techniques [18].

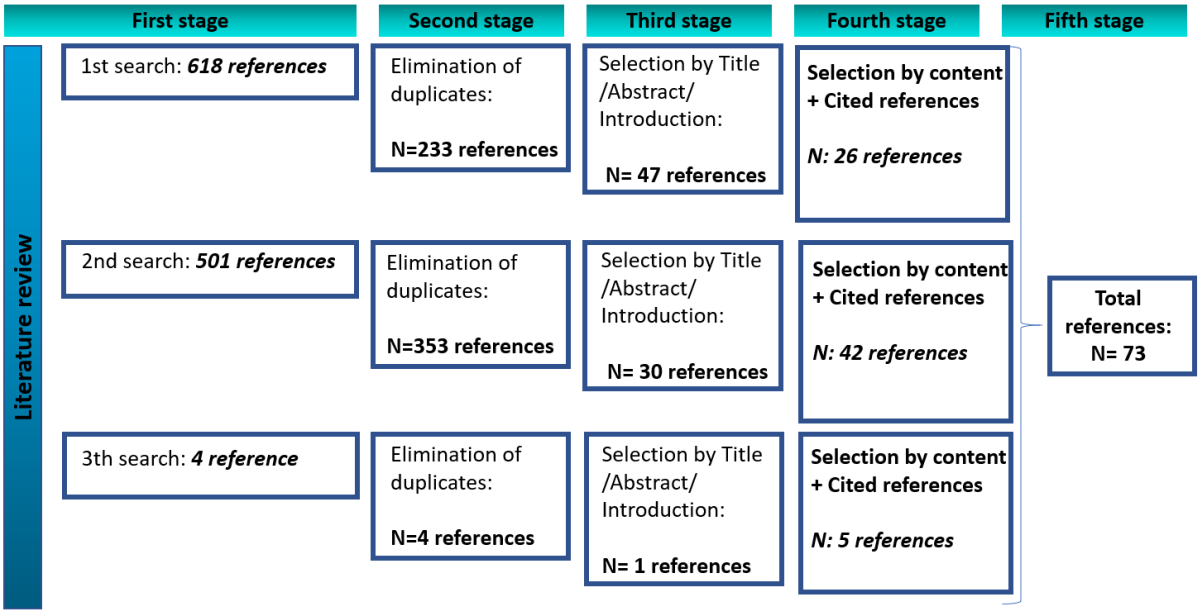

Figure 1. Search flow diagram Source: Own elaboration.

Results

The **DPP enhances data governance and sustainability** by improving **traceability and decision-making** throughout a product's lifecycle [12,17]. **The Ecodesign Regulation [5]** mandates **open, interoperable data** [11], but privacy concerns necessitate **anonymization and encryption.**

To address these, governance models include:

- **Data trusts and cooperatives** [9,10].
- **Blockchain-based systems**, ensuring **secure, transparent data management**.

These models support interoperable data spaces while preserving data ownership [8]. Integrating DPP with digital technologies strengthens sustainable value chains and enables a data-driven Circular Economy.

Conclusions

The **DPP is essential for sustainability and resource optimization** but requires **clear governance frameworks** to define **roles and responsibilities**. Balancing **data accessibility, security, and privacy** is crucial, with **blockchain and data cooperatives** emerging as key solutions.

For successful implementation, three factors are critical:

1. **Robust digital infrastructure**.
2. **Clear regulatory frameworks**.
3. **Collaboration among stakeholders**.

Addressing these challenges will **unlock the DPP's full potential**, advancing **a more sustainable Circular Economy**.

Green economy

ADDITIVE MANUFACTURING AS AN ENABLER FOR THE TRANSITION FROM A LOCALISED TO A MORE SUSTAINABLE DISTRIBUTED MANUFACTURING SYSTEM

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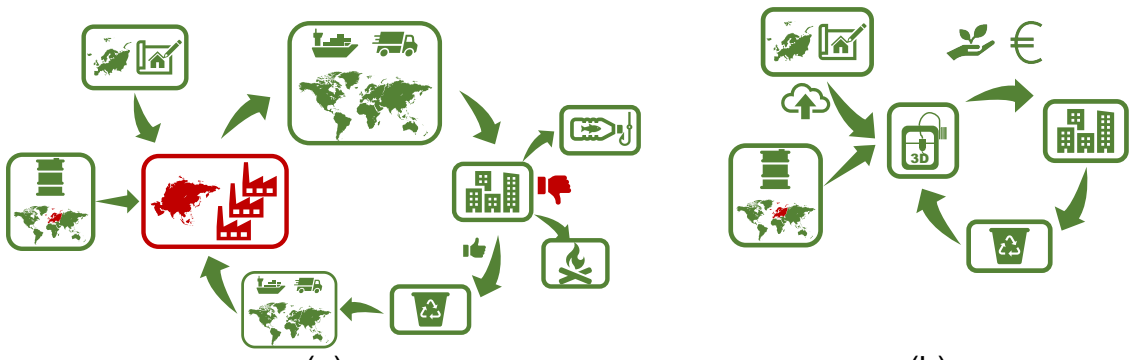
Keywords: Additive Manufacturing, Sustainable manufacturing, Distributed Manufacturing

Introduction

The current centralized manufacturing approach is based on mass production factories and complex distribution chains, with a high environmental impact. Additive manufacturing can change this paradigm by allowing products to be manufactured on demand and close to the customer, known as distributed manufacturing [1], resulting in a drastic reduction in emissions and inventory costs. Furthermore, depending on the technological sophistication of the product, the customer can 3D print the product at home or at a hub, becoming a prosumer, which creates a stronger user-product relationship and extends the life of the product (waste reduction).



(a) (b)

Figure 1. Value chain of a centralized (a) and distributed manufacturing system (b).

The sports equipment market has evolved due to rising living standards, customization trends, and Circular Economy principles. Customizing cycling footwear to individual anthropometry and pathological conditions is highly complex due to their organic shapes. However, several authors have identified additive manufacturing as a promising technology to address this challenge [2].

Methodology

The product has been designed using topology optimization for a complex plantar pressure distribution and with the stiffness of a commercial cycling shoe as target. A Mark Two® 3D printer from Markforged® has been employed for manufacturing the prototypes. The bending stiffness at the hallux and the heel have been characterized and compared with those of the commercial shoe.

Results & Discussion

From a performance perspective, the specific stiffness of the 3D-printed sole can be increased by at least 60%. The design flexibility allows for local stiffness adjustments to match the pressure at the hallux, toes, forefoot, midfoot, and heel zones. In terms of lead time, once the cyclist's plantar pressure and foot scan are received, it takes less than 8 hours to complete the detailed design and about a day and a half to manufacture each sole.

Conclusions

The key contribution of this paper is the first-time implementation of a customized 3D-printed cycling sole design (Figure 2). Topology optimization has proven effective in creating rough designs tailored to individual plantar pressure. However, refining the local geometry was necessary, incorporating design criteria for additive manufacturing with continuous carbon fiber-reinforced polyamide composites.

Figure 2. Fully 3D printed and customized cycling shoe sola.

Acknowledgements

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EDUCATION AND INNOVATION FOR SUSTAINABLE AGRICULTURE

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Keywords: Sustainable agriculture, Education, SAFA, CAPTIVATE, CAP

Introduction

The agricultural sector, which is responsible for 10-14% of global anthropogenic greenhouse gas (GHG) emissions, plays a crucial role in the implementation of the EU Green Deal (Scuderi et al., 2021; Jantke et al., 2020). However, we are often faced with the fact that key actors in the process (farmers, advisors, agricultural professionals) lack the necessary theoretical knowledge and motivation to develop sustainable food systems (Jantke et al., 2020).

The implementation of sustainable agricultural production is not possible without proper training and education of key actors. This requires the development of innovative tools that allow theoretical knowledge to be transferred in an effective and easy to learn format. In addition to transferring knowledge these tools should promote engagement in sustainable agriculture by increasing the motivation of stakeholders through awareness and understanding.

Case presentation

Between 2022 and 2024, five institutions in four countries have developed a multilingual, user-friendly, complex training platform for farmers and advisors on sustainable agriculture and related EU policies, followed by various exercises and quizzes to test their knowledge. The CAPTIVATE system also includes a user-friendly Eco-Farm Assessment and Decision Tool (EAD) and a collection of good eco-farming practices linked to the EAD tool (Mihálka

et al., 2024). The EAD tool is structured from ecological themes and sub-themes based on the SAFA guidelines (FAO, 2014). The participants were IZPI (formerly known as Agroinstitut Nitra) (Slovakia), FiBL Austria, IPS Konzalting (Croatia) and two Hungarian institutions: the Research Institute for Organic Agriculture (ÖMKI) and the Faculty of Horticulture and Rural Development of John von Neumann University. The Erasmus+ project was completed in October 2024. The interface is available at the following link: https://cap-tivate.eu/.

The original aim of developing CAPTIVATE was to help farmers and advisers to better understand the new CAP and how to implement the requirements of each programme correctly. The system, developed by experts from the five institutions, will not only provide users with knowledge about sustainable agriculture and CAP, but will also use the EAD tool to identify areas where they can improve their farms to make them more sustainable, and will provide them with practical recommendations in the form of good farming practices. The complex system thus developed can not only be used to help farmers successfully apply for subsidies and comply with various regulations but is also expected to have a comprehensive impact on shaping their attitudes.

Results and Discussion

In addition to testing with farmers and advisors, the system was piloted in two courses at the Faculty of Horticulture and Rural Development of John von Neumann University in the autumn semester of the academic year 2024/25. Completion of the CAPTIVATE course material was not mandatory for students, but they received extra points upon completion. In the **Rural Development Engineering** BSc program within the *Rural Policy* course all 19 full time students and 27 out of the 31 part time students earned the certificate, which is generated automatically by the system upon mastering the material and successfully completing the required tests and assignments (Figure 1.).

Figure 1. CAPTIVATE certificate of completion.

As part of the *Natural Resources* course **Rural Development Engineering** and **Horticultural Engineering BSc** students tested the CAPTIVATE platform. Among the 67 part time students, 38 while 28 out of the 33 full time students obtained the certificate.

Conclusions & Recommendations

The results are encouraging, with an average of 75 % of students taking the e-learning course on their own initiative. Positive feedback has been received from students who have completed the course, and it is expected that it will be developed into a micro-credential course in the future. Through such complex innovative systems, current and future stakeholders in agriculture can see for themselves how they can contribute to the sustainable management of agriculture. By using the system, both their theoretical knowledge, their understanding of the context and their motivation can be increased, which is key to achieving sustainable agricultural production. In the future, it would be worthwhile to carry out a study to examine the extent to which the use of CAPTIVATE increases users' commitment to sustainable agriculture.

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UNIVERSAL HEALTH COVERAGE (UHC) IN PHYSIOTHERAPY SERVICES, GLOBAL PERSPECTIVE

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Keywords: Universal Health Coverage, physiotherapy services coverage, Out-of-pocket expenses

Introduction

UHC in physiotherapy services aims to ensure that everyone has access to necessary rehabilitation services, without facing accessibility or financial hardship [1,2]. Achieving UHC is part of the United Nations' Sustainable Development Goals (SDG), specifically Goal 3, which aims to ensure healthy lives and promote well-being for all at all ages [3]. There are no data on how UHC have been achieved in physiotherapy services. The purpose of this research was to describe the view of UHC in physiotherapy services globally.

Methodology

A scoping review literature retrieval [3] was conducted across multiple databases including PubMed and CINAHL Ultimate, covering publications from 2015 to 2025. Articles were included based on inclusion and exclusion criteria according to the research questions. Data was analyzed with theory-driven content analysis utilizing three dimensions of UHC [1,2].

Results

Altogether, number of eligible articles were 58. Preliminary results showed that availability of services in rural areas was challenging. Out-of-pocket (OOP) expenses raised when employers transfer part of the health care cost burden to consumers, especially in low-income countries.

Conclusions

There is still work to be done in implementing UCH in physiotherapy services. In low-income countries, developing the health care systems should be promoted. Remote physiotherapy services and direct access might solve some UHC issues.

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CRAFTING A DIGITAL FASHION HERITAGE: WEAVING NARRATIVES AND EXPLORING DIGITAL TECHNOLOGIES IN FASHION HERITAGE PRESERVATION

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Keywords: digital fashion heritage, technologies, textile preservation, cultural heritage, craft.

Introduction

The intersection of digital technology and fashion heritage preservation has become an emerging area of research, offering new possibilities for documenting, revitalizing, and disseminating traditional textile craft techniques. While digital platforms enable broader accessibility and engagement, concerns regarding authenticity, inclusivity, and sustainability remain critical. This study explores how the digitization of textile crafts contributes to preserving and evolving tangible cultural expressions in fashion heritage. Using an autobiographical narrative inquiry and thematic narrative analysis, the research delves into personal experiences, expert insights, and theoretical frameworks to examine the impact of digital interventions on heritage conservation.

The study follows a three-phase research design, beginning with a critical literature review, followed by an autobiographical narrative inquiry, and concluding with narrative interviews with experts in digital technology, cultural heritage, and sustainable fashion. These multiple perspectives provide a holistic understanding of how digital tools influence fashion heritage preservation and evolution.

Methodology

A qualitative, narrative-based approach is employed to investigate the intersection of digital technologies and textile heritage preservation. The study is structured into the following stages:

2.1 Critical Literature Review: Examining existing research on digital fashion heritage, textile craft preservation, and narrative methodologies to establish a theoretical foundation.

2.2 Autobiographical Narrative Inquiry: Reflecting on personal experiences and connections with textile heritage, exploring the relationship between tradition, innovation, and cultural identity.

2.3 Narrative Interviews with Experts: Conducting in-depth interviews with three professionals from digital technology, cultural heritage, and sustainable fashion to capture lived experiences and professional perspectives on the digitization of fashion heritage.

This methodology allows for an exploratory and interdisciplinary analysis, integrating theoretical insights, lived experiences, and industry expertise to examine how digital technologies influence authenticity, accessibility, and sustainable cultural practices.

Results & Discussion

Findings reveal both opportunities and challenges in the digitization of textile craft techniques:

3.1 Preservation and Evolution: Digital platforms archive traditional techniques, ensuring their longevity and accessibility while enabling innovation in design and material representation [2].

3.2 Authenticity Concerns: While VR, AI, and digital archives allow for detailed reconstructions, scholars argue that digital representations lack material authenticity, raising concerns about the commodification of cultural heritage [1].

Inclusivity and Artisan Participation: Digital tools offer artisans new opportunities to engage with global markets but many lack digital literacy or face barriers in accessing these technologies [4].

3.3 Sustainability: While digital technologies reduce the need for physical prototypes, their high energy consumption and digital waste raise environmental concerns, necessitating eco-conscious preservation strategies [3].

These findings highlight a crucial gap in research—the need for ethical and inclusive digital frameworks that ensure artisans are active participants rather than passive subjects in fashion heritage digitization.

Conclusions

This study contributes to the growing discourse on digital fashion heritage, emphasizing the complex interplay between preservation, innovation, and cultural integrity. By examining authenticity, inclusivity, and sustainability, the research underscores the importance of:

- Hybrid models that balance digital engagement with material authenticity.
- Collaborative digitization frameworks ensuring artisans are active contributors in preserving their cultural heritage.
- Sustainable digital strategies that minimize environmental impact while maintaining accessibility and cultural integrity.

Future research should explore multisensory digital heritage tools, ethical co-creation models, and consumer perceptions of digital authenticity to ensure fashion heritage remains vibrant, ethical, and accessible for future generations.

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ALIGNING SMALL BUSINESSES WITH THE CIRCULAR ECONOMY: THE CASE OF A SMALL ISLAND STATE

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Keywords: circular economy, circular business models, owner-managers, small businesses, small island states

Introduction

This research focuses on the adoption of circular business models (CBM) by Maltese small enterprises. Circular economy (CE) is currently receiving attention as a contribution to how nations, including small nations such as Malta, can improve their economies sustainably [1]. However, the circular transition may be challenging for small island states whose economies depend on small and micro businesses. Small enterprises employ between 10 to 49 full-time workers, while micro firms employ less than 10 employees [2]. For this study, small enterprises include both small and micro-businesses as per EU definition.

In Malta, not only 98% of the local businesses are small enterprises, but 95.1% of them are micro-businesses [3]. Small enterprises lack the required resources and skills to cope with changes brought about by the CE transition, in which they play a significant part. The CE concept becomes more complicated in small states like Malta [4].

Current literature identifies diverse enablers and barriers to the adoption of CBM in SMEs but research on small enterprises is missing. In addition, studies about contextual factors which shape the environment of these organisations are scarce [5, 6, 7]. Few studies have

delved into an in-depth understanding of the factors influencing owner-managers of small firms in small island states aligning CBM to their strategies. This study, therefore, aims to answer the research question:

"How are Maltese small enterprises aligning their strategies with circular economy business models (CBM)?"

This research closes a gap in literature and develops recommendations for businesses and policymakers in the CE shift. The emergent conceptual framework could be tested for applicability to other small EU states, potentially assisting their circular transition.

Methodology

Grounded theory, with a constructivist approach was adopted for this research [8, 9]. Because of the study's specific nature, grounded theory is a suitable methodological stance [10]. Data was gathered through qualitative in-depth interviews with 39 owner-managers of small enterprises operating in Malta. Open coding and constant comparison analysis was used to create an abstract conceptual framework [8, 10]. Both purposeful and theoretical sampling were utilised. The data was analysed using the software package MAXQDA2024.

Results & Discussions

The hierarchical structure in Figure 1 follows the coding paradigm of the *Conditional and Consequential Matrix* [8], which is used to interrelate the macro and micro conditions affecting CBM-strategy alignment and, hence, identifying the conceptual categories of the framework.

As indicated in Figure 1 'owner-manager's interest in circularity' and 'managing circular activities', significantly aid understanding of the CBM-strategy alignment process. They affect the firm's involvement in research and innovation as well as sectoral collaboration.

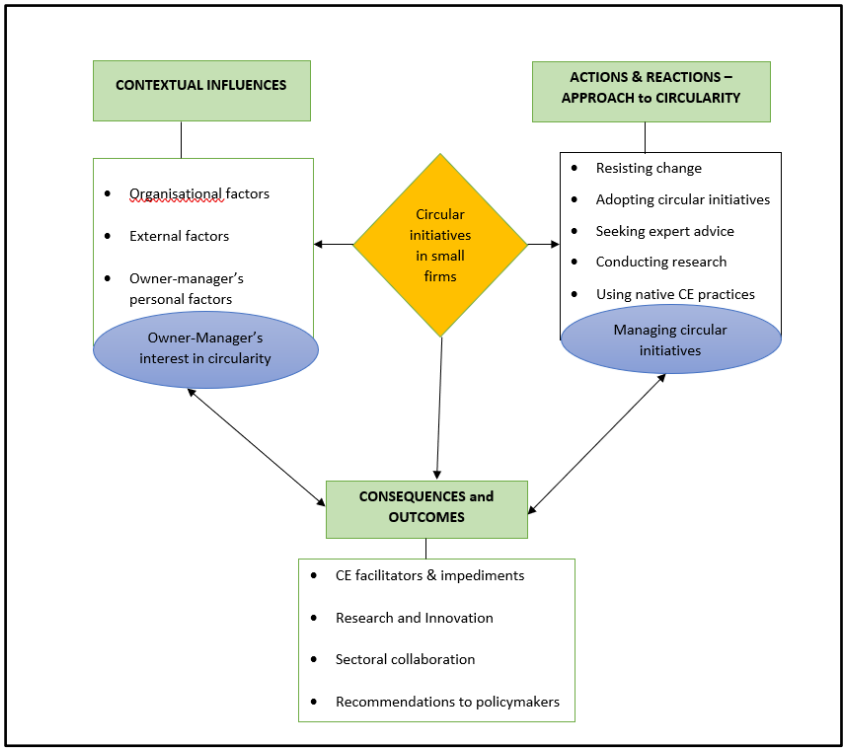

Figure 1: A Framework for CBM Adoption in Small Firms

The owner-manager's interest in circularity is influenced by diverse contextual conditions (Figure 1). These are grouped into external factors, organisational factors and owner-manager's personal factors. They create facilitators and impediments to CBM-alignment in these firms, shown in Figure 2. Significant are those deriving from owner-manager's personal factors because of the strong relationship there is between these factors and organisational factors. In these firms the owner has a dominant influence [11]. Attempts at resource maximisation, legal compliance and attitudes towards circularity determine the owner's adoption of circular activities.

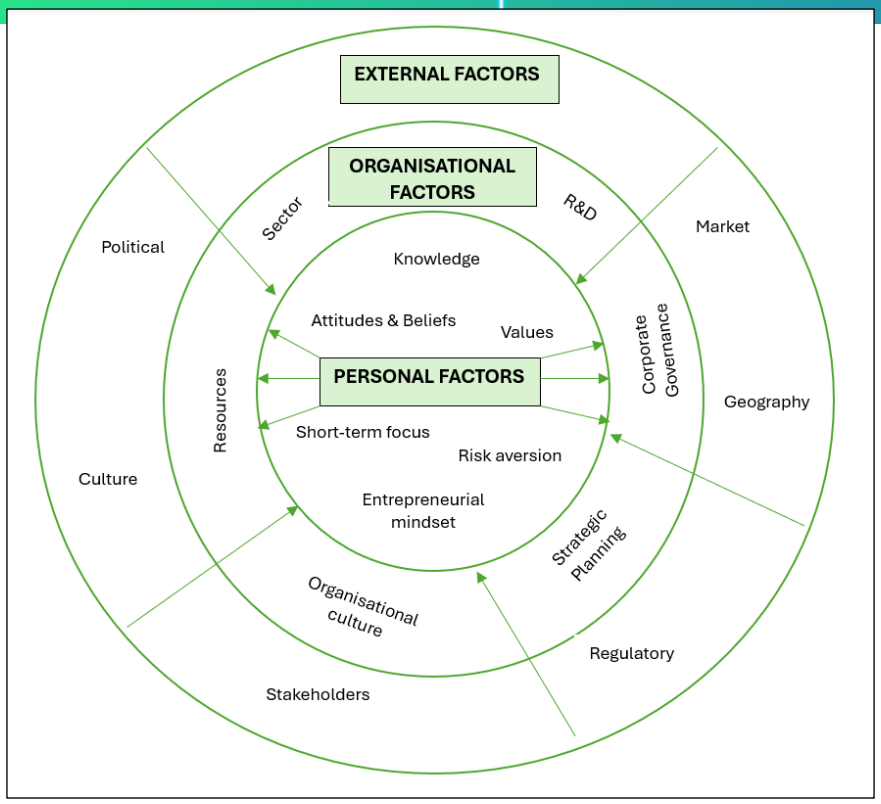

Figure 2: Facilitators & Impediments to CBM-Alignment in Small Firms

Following the thorough analysis of emerging constructs, and how they relate to circular behaviours of the participating businesses, five different types of CBM-strategy alignment patterns have been identified - Eco-entrepreneurs, Greens, Opportunists, Traditionalists, and Reluctant Adopters (Figure 3). These represent the different forms of CBM-strategy alignment that small firms could possibly implement over time.

The typology classifies the participating firms in terms of two main variables - owner-manager's interest in circularity and management of circular initiatives. The size of the circle in the map reflects the number of firms in the respective category. Owner-manager's interest in CE mirrors their attitude towards circular initiatives, formed from factors, such as knowledge about CE, perception of CBM, drive for innovation, risk aversion, need for change, approach to strategic planning, and the belief about ability to adopt CBM. This interest influences the adoption of CE practices.

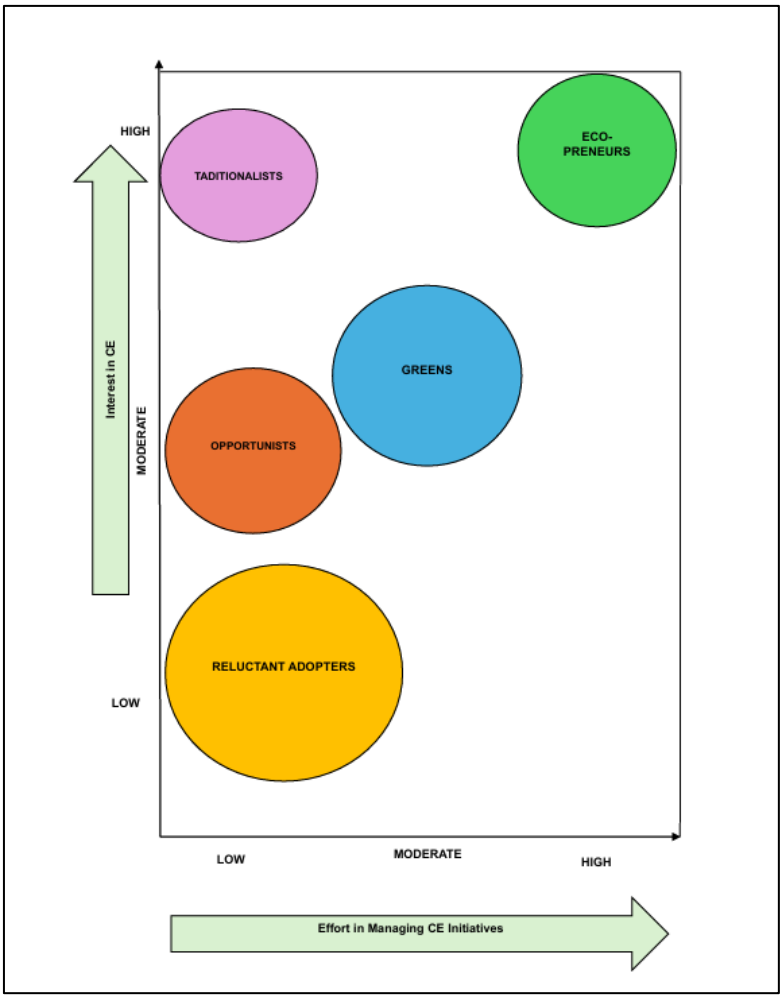

Figure 3: The CBM-Alignment Map

Conclusions

The legislative pressure on industry for more environmentally-responsible practices increased policy makers' interest in the CE transition of small enterprises [12, 13]. Policy makers would be able to provide relevant support to such businesses only if they understand their challenges in the transition. This study assists policy-makers in developing educational programmes, resources, and legal frameworks to aid this transition.

In addition, this research aids owner-managers to benefit from economic opportunities of circularity. The study recommends actions directed towards increasing awareness and education of owners-managers and their employees about circularity and thus contributing to the development of eco-preneurship in Malta. Due to its geographic position and its lack

of natural resources, eco-preneurship is an important concept in growing Malta's economy sustainably.

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INCREASING THE SHARE OF (ORGANIC) REGIONALLY PRODUCED FRUIT AND VEGETABLES IN COMMUNITY CATERING (CC) THROUGH FRESH CUTS WITH THE HELP OF A DIGITAL PLATFORM – STATUS QUO, NEEDS, AND BARRIERS.

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Keywords: Fresh Cuts, community catering, (bio-)regional production, digital networking, communication

Introduction

Regional food supply, organic farming, and more sustainable food consumption are three key strategies to reduce the environmental impact of agriculture. Various European and national initiatives, such as the European *From Farm to Fork Strategy* as part of the broader European Green deal, aim to increase the use of products from organic-regional cultivation. It promotes sustainable development along the entire value chain by ensuring sustainable food production and supporting environmentally friendly processing methods, including in community catering, sustainability in food consumption and prevention of food losses and waste [1], [2].

The EIP-Agri-funded research project *Conception of a Fresh-Cut Cluster* builds on these objectives with the specific goal of establishing regional processing and marketing structures for fresh-cut products made from (organic-)regional fruits and vegetables for the out-of-home catering sector. Fresh-cut products refer to fresh fruit or vegetables, or a combination thereof, that have been physically altered from their original form. These physical modifications include washing, sorting, peeling, cutting, or chopping, without compromising their "fresh quality"[3], [4]. The use of these pre-processed products simplifies workflows in community catering while requiring less personnel. Within the project “regional” was defined as produced in the state of Baden-Württemberg an “organic” referred to fruits and vegetables that are grown at least in accordance with the requirements of the EU regulation on organic farming.

As one of two the scientific partners within the project, DHBW Heilbronn was responsible for characterizing the consumer side, specifically the community catering sector. The primary

focus is on the current and future use of (organic) regional fresh-cut products, the barriers to their adoption and the acceptance of a digital networking platform.

Methodology

A two-stage mixed methods approach was used. First, guideline-based expert interviews identified key aspects of Fresh-Cut use, potential, and barriers. Second, a quantitative online survey (via Unipark) validated and expanded these findings. The survey included open and closed questions (e.g., Likert scales, filter questions) and reached 171 businesses through a contact database, networks, and a press release. Conducted from February to March 2024, the data was analyzed using SPSS with descriptive and statistical methods to assess the use and acceptance of (organic) regional fresh-cut products in community catering.

Results & Discussion

65% of the 171 participating community catering companies already use fresh-cut products, of which 82% are sourced from conventional farming (Figure 1). 46% of fresh-cuts source from regional farming, but only 8% originate from organic-regional farming (Figure 1). The main types of vegetables used are potatoes, carrots, lettuce, and onions.

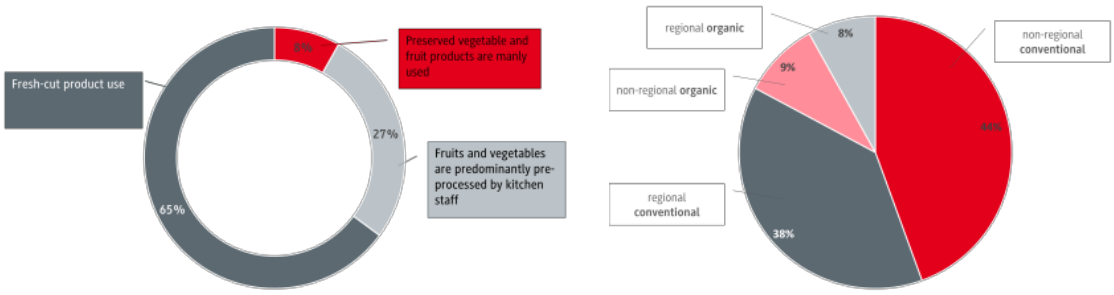

Figure 1. Current use of fresh-cut products (left) and their origin (right).

If participants could decide freely, 37% of participants expressed interest in increasing the use of regional fresh-cuts in the future, while 33% would like to incorporate organic-regional fresh-cut products. The willingness to use (organic) regional fresh-cut products in the future is significantly higher ($p < 0.001$) among community catering companies that already use fresh-cut products.

The main barriers to using (organic-) regional fresh cuts are seasonality, perceived higher prices, assumed limited availability, and lack of awareness about the offerings.

To connect the players of the value chain a digital networking platform was considered useful by 79%, and 72% would likely use the digital platform to connect with other players. To

disseminate the project results and facilitate contact and purchasing opportunities, a communication campaign was developed and shared with the relevant stakeholders along the value chain.

Conclusion

There is significant interest in (organic-)regional fresh-cut products within community catering. However, the lack of information and seasonality currently hinder their use. Digital networking among stakeholders could provide a solution and is desired by the majority of respondents. Expanding (organic-)regional offerings and implementing strategic communication to raise awareness and support seasonal planning could further assist community catering operations.

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The project is funded within the framework of the European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI). The funding measure is part of the Action and Development Plan for Rural Areas in Baden-Württemberg 2014-2020 (MEPL III). The project is financed by the state of Baden-Württemberg and through the European Agricultural Fund for Rural Development (EAFRD).

MOTIVATORS FOR DECISION-MAKERS IN HOTELS IN MALTA TO ADOPT ENERGY-EFFICIENT AND RENEWABLE ENERGY INITIATIVES.

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Keywords: energy efficient, renewable energy, tourism, sustainability, small economies, Malta

Introduction

The hospitality industry in Malta is a key economic driver but faces challenges in adopting energy-efficient (EE) and renewable energy (RE) initiatives. As global sustainability demands grow, hotels must align with EU directives, including the European Agenda for Tourism 2030 and “Fit for 55”, to enhance EE and reduce carbon emissions. However, despite regulatory frameworks promoting green investments, hotels encounter financial, operational, and perceptual barriers such as misconceptions about eco-tourism, that hinder sustainability adoption. This study examines the intrinsic and extrinsic motivations of hotel decision-makers, the role of financial and regulatory support, and the impact of market trends in driving sustainability efforts. By understanding these factors, policymakers and industry stakeholders can develop targeted strategies to overcome barriers, encourage investment, and integrate sustainability as a competitive advantage in the Maltese hospitality sector.

Case Presentation

This preliminary research employs a qualitative methodology, focusing on four in-depth interviews with hotel decision-makers across various ownership types and classifications in Malta. A purposive sampling approach ensures diverse representation from the decision makers having relevant expertise in EE and RE investments, capturing perspectives from luxury, mid-range, and budget hotels, as well as independently owned and chain-operated establishments. The study follows Charmaz’s constructivist grounded theory, allowing an iterative and flexible data analysis process to identify patterns, themes, and evolving insights from participant experiences. The study investigates the role of financial incentives, government policies, competitive pressures, and consumer demand in shaping sustainability adoption. It also explores how hotels perceive and measure sustainability outcomes, addressing challenges related to data collection, impact assessment, and communication with stakeholders. Additionally, the research assesses the effectiveness of external support mechanisms, including government grants, consultancy services, and industry certification programs, in encouraging sustainable investments.

Results and Discussion

This study reveals that hotel decision-makers encounter a complex interplay of motivations, barriers, and external influences when considering EE and RE investments. Financial incentives, including grants, subsidies, and tax breaks, play a crucial role in facilitating the adoption of EE and RE initiatives, particularly for small and independently owned hotels that often face significant financial constraints associated with upfront investment costs. Sustainability certifications, such as the transition from the Malta Tourism Authority (MTA) Eco-label to the Global Sustainable Tourism Council (GSTC) certification, further enhance the credibility of hotels by aligning them with internationally recognised environmental standards. This transition not only strengthens their competitive positioning but also increases their appeal to eco-conscious travellers. Additionally, the growing market demand for sustainability has shifted consumer preferences, with an increasing number of guests actively seeking environmentally responsible accommodation. Hotels that successfully integrate sustainable practices into their operations can enhance their brand reputation and foster long-term customer loyalty. Furthermore, improvements in operational efficiency, including reductions in energy costs and optimised resource management, contribute to long-term profitability, reinforcing the economic viability of sustainability investments within the hospitality sector.

Financial constraints represent a significant barrier to the adoption of EE and RE initiatives, particularly for smaller hotels that often lack access to the necessary capital despite the availability of government incentives and subsidies. Additionally, challenges in measuring the impact of sustainability efforts hinder hotels from effectively assessing the benefits of their investments. Larger hotels frequently rely on approximate waste disposal calculations, while smaller establishments struggle with the absence of standardised methodologies for tracking sustainability progress. Misconceptions surrounding eco-tourism persist due to a lack of awareness and education among hotel managers, with some maintaining the belief that sustainability exerts minimal influence on consumer choices, despite growing evidence indicating a shift in traveller preferences towards environmentally responsible accommodations. Furthermore, regulatory uncertainty and the complexity of administrative procedures act as deterrents, discouraging hotel managers from engaging with sustainability certification schemes and navigating the processes required to secure financial support for green investments. While government initiatives and EU directives provide a framework for promoting sustainability, their effectiveness depends on clearer implementation guidelines, accessible financial support, and better stakeholder engagement. Hotels require improved communication and education on the long-term benefits of green investments, to ensure informed decision-making.

Conclusions and Recommendations

This study highlights the importance of financial support, regulatory clarity, and strategic communication in advancing sustainability in Malta's hospitality sector. Several key recommendations are proposed to facilitate the widespread adoption of EE and RE solutions. Strengthening financial incentives through targeted subsidies for small hotels and streamlined access to government and EU funding would help alleviate financial barriers and encourage investment in sustainable initiatives. Enhancing measurement and reporting mechanisms by implementing digital tools, smart meters, and standardised reporting frameworks would enable hotels to track energy savings, waste management, and carbon

reduction more effectively. Increasing stakeholder engagement through industry workshops and improved communication of sustainability outcomes would further raise awareness among guests, investors, and policymakers, fostering greater support for sustainable practices. Additionally, facilitating policy implementation and certification by providing clear regulatory guidelines and financial incentives for Global Sustainable Tourism Council (GSTC) certification would encourage more hotels to integrate sustainability into their operations. Strengthening cross-sector collaboration through partnerships between hotels, government agencies, and industry experts would further promote knowledge-sharing and the exchange of best practices. Future research should focus on examining the economic impacts of energy-efficient and renewable energy investments and assessing the role of artificial intelligence-driven energy management systems in optimising sustainability efforts within the hospitality sector.

SUSTAINABILITY REPORTING FOR A EUROPEAN UNIVERSITY ALLIANCE

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Keywords: Sustainability reporting, European Sustainability Reporting Standards (ESRS), Triple bottom line, European university alliance, Virtual network organization

Introduction

Through the Green Deal, the European Union is transitioning to a sustainable economy, with the European Commission driving various initiatives to promote sustainability in businesses. Among these initiatives, the European Sustainability Reporting Standards (ESRS) [1] represent one of the most comprehensive frameworks for ensuring transparency in sustainability reporting. In the coming years, stakeholders and the public will likely increase pressure on organizations to transparently disclose their sustainability efforts. While many companies and individual universities already publish sustainability reports, this is not yet the case for European university alliances. EU4Dual has made sustainability a core commitment, emphasizing it since its inception and integrating it into its future organizational development. This commitment included the creation of a sustainability report [2] covering the first project year, released at the end of 2023. With strong links to the business sector, the alliance takes a proactive stance on sustainability reporting, aiming to align with ESRS and set a notable example for others to follow.

Case presentation

EU4Dual is committed to the principles of the triple bottom line reporting by publishing a comprehensive report, covering profitability, social responsibility, and environmental sustainability [3]. Our goal is to demonstrate that even a university alliance as a virtual network organization can implement effective and professional sustainability reporting. The development of the sustainability report is a key component of the work package “Quality management and impact monitoring”, which is led by FH JOANNEUM. In autumn 2023, a

project team with representatives from all partner universities was formed to develop the report.

The process began with a training session for the project team to deepen their understanding of the reporting standards. Building on this, the value chain for the university alliance was developed, using the “student journey” to map key interactions between universities, industry partners, and students. This visualization helped to identify both positive and negative impacts across education, society, and the economy, with a particular focus on the alliance’s core themes: the future of work, the green economy, and healthy living. Following this, a double materiality analysis was conducted to determine the most relevant sustainability topics, assessing impacts, risks, and opportunities in relation to EU4Dual’s strategy and business model. A preliminary list of material topics, derived from the ESRS, was then evaluated for its relevance to EU4Dual. Finally, stakeholders were engaged through an online survey to gather feedback and refine the analysis. The resulting list of material topics guided the systematic data collection and disclosure requirements, capturing essential information about the

sustainability performance and impacts of the university alliance. Based on the insights from the materiality analysis and the data collected, we developed a comprehensive sustainability strategy. This strategy outlines objectives and measures for continuous improvement and integrates the aspects of the strategy with the Sustainable Development Goals (SDGs). The process culminated in the drafting of a sustainability report.

Results & Discussion

The EU4Dual project's value chain highlights the collaboration between universities, industry partners, and students, emphasizing its impact on the environment, society, and education. The visualization reflects the project's vision of students as contributors who bring their competencies back to society and the economy.

The list of material topics guided the systematic data collection and disclosure requirements. Data was sourced from partner universities and presented in sustainability statements. For the first year of the EU4Dual project, greenhouse gas emissions were determined based on business trips related to the initiative. As mobility is a crucial element of the international university alliance, implementing best practices for international exchange is essential for the consortium's long-term sustainability. The sustainability strategy sets objectives for ecological and social sustainability, governance, and finance. It also outlines prioritized actions and specific goals for the project year 2025.

Our initial efforts focus on establishing a foundational structure and understanding the specific requirements and implications of the ESRS standards. Each partner in the university alliance has a different starting point, so it's essential to consider these individual circumstances when developing the EU4Dual sustainability report. Participation in the reporting process also offers an opportunity to enhance and advance the sustainability practices of all partners. Several partner universities within the alliance have already taken proactive steps to align their reporting practices.

Conclusion & Recommendations

The EU4Dual sustainability report represents a significant milestone in addressing sustainability within higher education organizations. As a pioneer among European university alliances, EU4Dual demonstrates that ESRS-aligned reporting is feasible for network organizations. This commitment extends beyond teaching to embedding sustainability in our structure and projects. By integrating sustainability from the outset, we have laid the foundation for long-term practices and continue to enhance monitoring and reporting for greater compliance and impact.

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A PRAGMATIC EPISTEMOLOGY FRAMEWORK IN SUPPORT OF DESIGN FOR SUSTAINABILITY PRACTICES: THE RADICAL CONSTRUCTIVISM APPROACH

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Key Words: design for sustainability, eco-innovation, epistemology, systems theory, radical constructivism

Introduction

In the face of rising environmental challenges and the urgent need to address climate change, design for sustainability has emerged as a key focus in various fields, including industrial engineering, and product development. Design for sustainability goes beyond mere compliance with environmental regulations; it seeks to create systems and products that minimize negative environmental and social impacts, utilize resources efficiently, and enhance overall quality of life. This paper explores the critical importance of integrating sustainable principles into the design process and highlights the need for eco-innovative approaches.

Case Presentation

To illustrate the practical application of design for sustainability, this paper presents a case study of a recent energy project that successfully integrated sustainable design principles. The project includes territorial development and energy democracy aspects by the development of renewable energy sources. By examining the design process, material selection, and stakeholder involvement, this case study demonstrates how sustainable design can be effectively implemented in real-world scenarios.

Discussion

The discussion delves into the theoretical underpinnings of design for sustainability, drawing on constructivist epistemology and systems theory. It examines different research paradigms and methodologies that can be employed to study and advance sustainable design practices. The paper also addresses the challenges and barriers to implementing sustainable design, such as economic constraints, lack of awareness, and resistance to change. By analysing these factors, the discussion provides insights into how these obstacles can be overcome to promote wider adoption of sustainable design practices.

Conclusion

In conclusion, this paper underscores the necessity of integrating design for sustainability into various fields to address the pressing environmental challenges of our time. By presenting an epistemological framework for integrating sustainable design and eco-innovation processes, the research offers a comprehensive understanding of how these practices can drive positive environmental change. The findings highlight the potential of sustainable design to foster a more resilient and sustainable future, emphasizing the need for continued research and innovation in this area.

BATTERY SENSOR FAULT DIAGNOSIS SYSTEM DEDICATED TO BUILDING MICROGRIDS

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Keywords: Fault diagnosis, Sensor fault, Early fault detection, Model-Based, Hybrid Method, Battery, Building Microgrids.

Introduction

Energy and sustainability are two of the biggest challenges facing the world today. The tool for reducing greenhouse gas emissions is energy transition. As part of the energy transition, microgrids in buildings have a key role in addressing energy use challenges to improve sustainability and maintain resilience. The BBSS (Battery-Based Storage System) plays a key role in microgrids, and the real-time early diagnosis of battery sensor faults is mandatory to ensure the safety and reliability of the storage[1]. Considering that prevention is the core objective of human security, this paper presents a fault diagnosis solution proposed for an energy storage system based on lithium batteries. The battery sensor faults can appear due to external or internal causes [2]. The risks associated with battery faults, such as overcharging, over-discharging, overheating, thermal runaway, fire and incorrect control commands due to incorrect currents, can cause catastrophic problems affecting human safety. Due to the faults in the battery sensors, the battery management system does not receive the correct operating status (temperature and SOC), this can lead to further cascading faults, accelerating battery degradation [3],[4],[5]. Different methods have been proposed to fault diagnosis task, 3 large groups of methods can be mentioned: Data-drive, Model-Based and Knowledge-based [5]. Each method has its advantages and disadvantages, the combinations of the two strategies Model Based and Data driven to

improve fault diagnosis [6]. Hybrid methods aim to enhance diagnostic results by leveraging the advantages and avoiding the limitations of their consisting techniques. This research aims to develop a hybrid (model-based-data-driven) fault diagnosis and isolation (FDI) system to detect, isolate and identify BBSS sensor faults in a building microgrid.

This paper presents the methodology in section 2, the results and discussion in section 3 and ends with a brief conclusion of the research that has been carried out.

Methodology

The methodological approach adopted in this study is a mixed methodology based on the fault diagnosis process, which mainly integrates model-based and data-based strategies that complement each other. Through this strategy it is possible to overcome the difficulty of developing more accurate models and at the same time work in a complementary way, retaining the intuitiveness of a model but explaining the observed data [7]. The methodology is carried out in four stages: Initially, requirements and specifications are gathered for the system, followed by the development of a model-based detection system. Subsequently, the development of a data-driven diagnosis system is performed in the third stage, and finally the system is integrated and tested in the last stage.

Results & Discussion

A state-of-the-art analysis (hybrid fault detection, observers, sensors and battery faults) has been carried out, which has enabled the adaptation of new elements according to the fault detection and diagnosis process, integrating hybrid approaches.

The battery equivalent circuit is identified using a pulse discharge current and a set of battery voltage measurements. A non-linear least squares identification method is adopted to obtain the parameters, and the simulation is developed under MATLAB. An equivalent circuit model (ECM) of a Battery Valence U1-12XP was obtained to have the equivalent of the math equations. Based on the battery (ECM), a linear observer was proposed. To implement the third stage, an analysis was conducted of the behavior of three machine learning algorithms for classification. The estimated results of voltage and SOC are obtained from the observer. The fault classification was performed with faults in the voltage sensor.

Conclusions

This paper presents a hybrid system consisting of a first part based on an observer which has good convergence and is stable. Real data were used to obtain the parameters based on the SOC-OCV (Open Circuit Voltage) curve and to be able to model the battery. A second

stage is integrated to improve the classification of the faults by testing with 3 algorithms. Finally, the system is tested by integrating uncertainties and good robustness to disturbances is observed by the model-based stage.

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A SYSTEMATIC APPROACH TO SDG INTEGRATION IN DUAL TRAINING: INSIGHTS FROM A PILOT EXPERIENCE

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Keywords: DUAL high education, Engineering, Sustainable Development Goals, systematic approach

Introduction

The dual education model, which combines academic learning at a university with practical training in a professional environment is a topic of growing interest, even though specific research on this model at university level is relatively recent [1] [2] [3]. Similarly, the implementation of the SDGs in Higher Education Institutions (HEIs) has been reviewed in recent years, resulting in multiple approaches to the integration of the SDGs by HEIs and with diverse outcomes [4] [5]. However, less attention has been paid to studying the integration of the work of the SDGs into dual practices.

With the exception of cases such as the INEBB1 project of the German Federal Institute for Vocational and Technical Education and Training [6], where since 2021-year 326 dual training professions are implementing a sustainability training programme, research contributions to integrate the SDGs into dual training are limited.

Case presentation

This article presents a novel pilot experience carried out in the Computer Engineering degree at Mondragon University during the academic year 2023-2024. In this experience, a previously applied SDG work methodology in the field of engineering projects has been extended to the academic monitoring of students' dual experience in the company.

The PBL-SDG methodology has allowed the Computer Engineering degree to integrate the systematic study of the SDGs in the semester projects based on the Problem-Based Learning (PBL) methodology [7]. The PBL-SDG methodology incorporates new activities into the university's PBL methodology, including an initial training on SDGs and the assessment of the project's impact on the SDGs. The SDG training is carried out as classroom training pills. And for the evaluation of the impact of projects on the SDGs, an assessment checklist that measures the students' ability to analyse the impact of projects

carried out in a PBA context on the SDGs [8]. The checklist developed allows students to design and develop the impact analysis of the project and allows teachers to evaluate the students' analysis. The checklist tasks enable students to learn a methodology for assessing the impact of the project on the SDGs and to progressively deepen their understanding of both the SDG goals and targets. In addition to the checklist that serves as a guide for students, the use of the SDG Impact Assessment Tool has been adopted. This tool, developed by Gothenburg Center for Sustainable Development in collaboration with Chalmers University of Technology allows impact to be systematically and regularly reported in all academic work.

In this experience, the PBL-SDG working methodology previously used in the field of engineering projects has been extended to the academic monitoring of the students' dual practices in the company. The extension of the methodology encompasses two dimensions. In the training section, students have already received the instruction provided through the training pills during the academic term. However, it has been necessary to supplement this training with an additional pill to help students learn how to analyse the corporate sustainability policies of the companies where they undertake their dual practices. In the evaluation dimension, the tools used in the PBL-SDG methodology have been adopted, both the evaluation checklist and the use of the SGD Impact Assessment Tool, since both are already known by the students and enable the analysis of the SDGs in the dual practices. The lecturers have also adopted the use of a checklist to carry out the evaluation.

Results & Discussion

During the 2023-2024 academic year, a total of 58 students of the Computer Engineering degree completed dual experiences in companies. Each student completed a progress report and a final report in each semester of the course. In each of the reports, the students incorporated the study of the impact of their work on the SDGs carried out with the SDG Impact Assessment Tool as well as an analysis of the corporate policies in relation to the SDGs of their company site.

The result consisted of a systematic approach to how students should handle the study of the SDGs in the working environment of the company where they carry out their dual experience. Students have found it easy to incorporate this analysis into their dual reports, given their prior experience in the tasks they were required to perform. Sometimes students show little interest in completing the task. However, the lecturers' perspective is that awareness-raising and dissemination work must be constant in order to prepare future professionals in a committed manner.

Conclusions & Recommendations

In conclusion, it can be said that students are more aware of the SDGs at both the organizational and individual level. This approach provides students with the possibility to further explore the company's initiatives and their impact on the SDGs. This pilot experience shows the feasibility and benefits of integrating the SDGs into dual training, promoting greater responsibility and social awareness among future engineers.

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GREEN ENTREPRENEURSHIP AS A MECHANISM FOR POST-CONFLICT RECONSTRUCTION: REBUILDING WAR-TORN ECONOMIES THROUGH SUSTAINABILITY

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Keywords: green entrepreneurship, post-conflict reconstruction, sustainable development, circular economy, economic resilience

Abstract

As the world grapples with the devastating impacts of war, post-conflict reconstruction must go beyond traditional economic recovery models. In conflict-affected regions, green entrepreneurship has proven to be an effective tool for rebuilding economies, restoring ecosystems and fostering long-term stability. Countries that have successfully implemented sustainable business models – through sustainable agriculture, eco-tourism and circular economy initiatives – offer valuable lessons for nations currently in crisis. This research explores how green entrepreneurship has revitalized war-torn economies, emphasizing past successes in post-conflict regions and their relevance as a framework for recovery in Ukraine and Gaza. Given Ukraine's potential in renewable energy and climate-smart agriculture, alongside Gaza's urgent need for solar power and circular waste management, green entrepreneurship emerges as a viable long-term solution for fostering sustainable and self-sufficient economies in both regions. Despite challenges such as political instability, financial constraints and damaged infrastructure, it provides a scalable and sustainable alternative to aid-dependent recovery efforts. By highlighting successful initiatives, this study serves as a call to action for policymakers, investors and international organizations to prioritize sustainability-driven post-war recovery strategies. The findings emphasize the need for proactive policies, investment in green industries, as well as the cross-sector collaboration to rebuild war-torn regions into resilient and self-sufficient economies.

Introduction

The destructive impacts of armed conflict extend beyond casualties and physical damage, creating economic hardships that traditional recovery approaches struggle to resolve. While conventional reconstruction focuses on rapid rebuilding, it often overlooks environmental concerns. Green entrepreneurship offers a better alternative by combining sustainable practices with economic development. These businesses address immediate rebuilding needs while creating lasting, environmentally-friendly economic growth. By putting sustainability at the center of recovery, conflict-affected regions can build healthier economies that avoid the environmental mistakes of the past and create more stable societies. This research examines how green entrepreneurship initiatives have successfully contributed to holistic post-conflict recovery across diverse regions, and how these experiences can inform reconstruction efforts in current conflict zones like Ukraine and Gaza. It also evaluates both established models in post-conflict settings and emerging opportunities in regions currently experiencing or recovering from conflict.

Case presentation

The study analyzes six post-conflict regions that have successfully implemented green entrepreneurship models. Rwanda's remarkable recovery from genocide through eco-tourism development demonstrates how environmental conservation can align with reconciliation (Nielsen & Spenceley, 2011), while Colombia's sustainable agriculture programs create new farming jobs for people affected by the conflict and simultaneously protect natural habitats (Castro-Nunez et al., 2017). Similarly, Bosnia and Herzegovina's eco-tourism development has revitalized rural economies while fostering intercultural dialogue between formerly divided communities (Efendić & Hadžiahmetović, 2019). Nepal's community forest program shows how decentralized resource management empowers local communities while reversing deforestation (Ojha et al., 2009), whereas Sierra Leone has implemented reforms to transform its mining sector – once a contributor to civil war – into a more sustainable industry through improved governance (Bottazzi et al., 2016). Last but not least, Timor-Leste has established locally managed marine areas that combine traditional practices with modern conservation techniques to rebuild depleted fish stocks (Alonso-Población et al., 2018).

Ukraine's rebuilding efforts offer major opportunities for renewable energy and sustainable farming that could reduce reliance on imported energy while creating new jobs (Ahamer, 2021). Despite damaged infrastructure, Ukraine has significant potential for wind, solar and bioenergy that could transform its energy future. Gaza faces severe energy and water shortages that could be addressed through small-scale solar power systems and water recycling projects (Juaidi et al., 2016). Reusing and recycling materials could help solve Gaza's waste problems while creating jobs, even with import restrictions and limited space.

Results & Discussion

Cross-case analysis identifies five critical success factors: community ownership of initiatives, integration of traditional knowledge with modern sustainable practices, diversified funding models, supportive policy frameworks and comprehensive capacity building programs. These elements transcend geographic and cultural differences, suggesting widely applicable principles for sustainable post-conflict recovery. Despite these promising approaches, green entrepreneurship in post-conflict settings faces significant obstacles including governance gaps, financial constraints, market access difficulties and technical capacity limitations (Brück et al., 2013). These challenges require targeted interventions and realistic timeframes for implementation, particularly in regions like Ukraine and Gaza where ongoing instability complicates long-term planning (Enshassi et al., 2014).

Conclusions & Recommendations

This research shows that green entrepreneurship can effectively rebuild war-torn regions while addressing economic needs, environmental restoration and social healing together. To make this approach work, governments should create policies that reward sustainable businesses, donor organizations should require environmental standards in their funding, while investors should recognize both financial and social benefits from green businesses in recovering areas. Future research needs to develop better ways to measure these combined impacts and study how successful small projects can grow to benefit entire regions.

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PERFORMANCE OF ESG FUNDS IN POLAND - IMPACT OF MARKET FLUCTUATIONS AND SUSTAINABLE INVESTMENT TRENDS

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Keywords: green investing, sustainable finance, funds performance, ESG funds

Introduction

The extent to which investors integrate sustainable development factors into their investment activities remains relatively low, and the lack of transparency among financial service providers has hindered the development of the market. This situation has changed in recent years with the introduction of the Sustainable Finance Disclosure Regulation (SFDR) by the European Parliament and the Council of the European Union [1]. These regulations prevent asset management companies from promoting funds as "responsible" or "green" when they are not.

Existing research on both the US and European markets remains inconclusive. Some studies show that ESG funds outperform their conventional counterparts [2,3]. Conversely, O. Klinkowska and Y. Zhao [4] conclude from their analysis that funds with ESG ratings perform similarly to traditional funds. However, when funds with similar characteristics are not managed by the same investment companies, they can outperform their conventional peers. Other studies suggest that ESG funds tend to be more effective in times of crisis, but underperform in other periods [5-7]. Further research suggests that ESG funds do not necessarily generate better returns than other funds [8] or that there is no statistically significant difference in fund performance with respect to ESG ratings [9,10]. Meanwhile, Wee, K. W. et al. found that higher ESG ratings in funds either lead to higher risk-adjusted returns or show no statistically significant difference in performance with respect to ESG ratings [11].

The aim of the study was to assess the performance of ESG funds in Poland in the context of financial market fluctuations in recent years.

Case presentation

The sample consisted of 22 ESG equity funds and 100 conventional equity funds in Poland. Historical values of fund shares and market index quotes were obtained from the Stooq.pl

portal and the official websites of individual investment funds. The study covers the period from January 2019 to June 2024. This period includes two significant events from the perspective of both the Polish and global economies: the COVID-19 pandemic and the outbreak of armed conflict in Ukraine. Common risk-adjusted measures such as Sharpe Ratio, Treynor Ratio, M2 and Jensen's Alpha were used to assess performance.

Results & Discussion

Table 1 shows the performance results, based on selected efficiency measures, for the average equity fund and the average ESG equity fund in Poland in 2019-2024.

Table 1. Performance results of average equity fund and average ESG equity fund in Poland from 2019 to 2024.

Average equity fund					
Year	Sharpe Ratio	Treynor Ratio	M2	Jensen's Alpha	Rate of return
2019	13,74	0,13	0,18	0,02	0,12
2020	1,75	0,12	0,13	0,06	0,11
2021	19,55	0,17	0,25	0,00	0,13
2022	-9,60	-0,38	-0,42	-0,06	-0,20
2023	11,47	0,19	0,27	0,02	0,21
2024	6,93	0,04	0,10	-0,02	0,09
2019-2024	1,79	0,05	0,09	0,00	0,08
Average ESG equity fund					
2019	12,85	0,14	0,11	0,03	0,19
2020	1,77	0,66	0,29	0,18	0,11
2021	23,14	0,21	0,30	0,00	0,13
2022	-10,10	-0,38	-0,39	-0,09	-0,19
2023	7,10	0,13	0,17	-0,03	0,14
2024	16,25	0,37	0,75	0,08	0,11
2019-2024	2,17	0,08	0,14	0,08	0,08

Source: own study.

The results obtained show that in the period covered by the study (2019-2024), the average ESG fund outperformed the average equity fund in terms of performance. However, in 2022-2023, the average equity fund generated better investment results. This trend is also observed in the 2019-2021 period when looking at individual performance measures. These results suggest that no definitive conclusions can be drawn regarding the superior management skills of ESG equity fund managers compared to traditional equity funds.

Furthermore, no clear correlation was found during periods of significant market volatility, namely in 2020 and 2022. In 2020, the average ESG fund showed higher efficiency, while in 2022 the average equity fund outperformed. This suggests that ESG funds may not always be immune to broader market fluctuations and crises. This is a different conclusion from some previous studies [5-7]. Furthermore, it is worth noting that both fund types performed relatively well throughout the period 2019-2024. Despite the performance fluctuations, both ESG and traditional equity funds showed relative efficiency compared to their respective benchmarks (where applicable), indicating that both types of funds are able to generate returns above the market average. This suggests that there is no clear distinction between the performance of ESG and non-ESG funds, which is consistent with the conclusions of S. El Ghoul and A. Karoui [8].

Conclusions & Recommendations

ESG fund performance research is relatively rare in Polish literature, with studies particularly challenging due to the relatively underdeveloped market. The obtained results are inconclusive, with the assessment of fund performance varying depending on the period studied and the performance measure used. Given the different performance of fund types during, it may be beneficial for investors to adjust their strategies during periods of significant market upheaval. ESG funds may offer better protection in some crises, while traditional equity funds may outperform in others.

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COST CALCULATION AND ACCOUNTING METHOD FOR BATTERY ELECTRIC BUS OPERATION

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Keywords: Accounting method, Battery electric bus, Energy consumption, Energy management, Line characteristics, Public transport, Operation cost optimisation, Vehicle dynamics

Introduction

Public transport systems play a crucial role in urban mobility and are largely funded by the community. Efficient operation is essential to minimize the gap between revenue and costs. The transition to battery electric buses introduces substantial investment costs and requires a reassessment of cost structures. Unlike diesel buses, electric buses involve costs related to battery procurement, charging infrastructure, and energy consumption, which vary significantly based on operational conditions. Key factors influencing energy consumption include topography, stop distance, passenger load, ambient temperature, traffic delays, and auxiliary systems. A precise cost calculation method is essential for sustainable operation, ensuring that operational costs reflect actual energy use.

Methodology

The total cost (TC) of operating battery electric buses is determined by both fixed costs (FC) and variable costs (VC). The fixed costs include vehicle procurement cost (VPC), service and maintenance cost (SC), and personnel cost (PC). These costs are relatively stable and depend on factors such as purchase price, maintenance schedule and expenses, and salaries of operational staff. In contrast, variable costs consist primarily of energy cost (EC), which fluctuates based on electricity prices, route characteristics, passenger load, and environmental conditions.

The relationship between these costs is expressed as Eq. (1):

$$TC = FC + VC = VPC + SC + PC + EC \quad (1)$$

The vehicle procurement cost (VPC) represents the amortized expense of purchasing the bus, spread over its operational lifespan.
Service and maintenance cost (SC) includes regular upkeep, repairs, and parts replacement to ensure continuous and safe operation.
Personnel cost (PC) covers salaries, training, and benefits for drivers and maintenance staff.
Energy cost (EC) is influenced by factors such as route length, stop frequency, ambient temperature, and the efficiency of the power supply system. The energy cost per section (ECi) can be calculated using the Equation (2):

$$EC_i = \frac{E_{ALL,i} \cdot c_{electric}}{\eta_{supply}} \quad (2)$$

where $E_{ALL,i}$ represents the total energy (drivetrain consumption and auxiliary consumption) consumed per section, $c_{electric}$ is the cost of electricity, and η_{supply} denotes the efficiency of the power supply system.

Topography, stop distances, and passenger load significantly influence energy consumption. [2] Routes with frequent stops and hilly terrains require more energy due to repeated acceleration and elevation gain, while higher passenger loads increase the energy needed for propulsion. Ambient temperature impacts energy use primarily through HVAC systems, especially in extreme conditions. Traffic conditions also affect consumption by causing delays, which lead to longer operational times and increased energy use.

Results and Discussion

The analysis revealed that urban routes exhibit up to 30% higher energy consumption compared to suburban routes due to frequent stops and lower average speeds [3]. Ambient temperature significantly influences energy costs, with HVAC systems increasing energy consumption by up to 25% in extreme cold or hot conditions. [4] Traffic delays were found to elevate energy costs by approximately 15%, indicating the importance of integrating traffic conditions into the cost calculation model. Passenger load was also a critical factor, with full-capacity operations consuming substantially more energy than low-occupancy trips.

The sensitivity analysis confirmed that ambient temperature and passenger load are the most impactful variables affecting energy consumption. The implementation of real-time adjustments in energy norms based on these factors can improve accuracy in cost calculations and support more efficient energy management.

Conclusion

The comprehensive cost calculation model effectively integrates fixed and variable costs, providing a detailed understanding of the factors influencing energy consumption for battery electric buses. By accounting for topography, stop frequency, passenger load, ambient temperature, and traffic conditions, the model offers a robust framework for optimizing operational costs. Public transport operators can leverage this model to enhance cost-efficiency and energy management practices. Future research should expand on this model by incorporating real-time data analytics and exploring the effects of energy price volatility.

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DIRECTED ENERGY DEPOSITION PROCESSES, TOWARDS SUSTAINABLE MANUFACTURING PERFORMANCE?

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Keywords: Metal additive manufacturing, sustainable performance, environmental impact, parameters characterization, decision support

Introduction

Despite their promises, the Directed Energy Deposition (DED) Metallic Additive Manufacturing (MAM) processes are still not widespread in industry as their integration does not guarantee performance for manufacturing companies. This performance traditionally refers to cost, productivity, quality, flexibility and delivery (Roth & Miller, 1992). Nowadays, the performance is extended by the concept of sustainability defined in the Tripple Bottom Line (TBL), proposed by Elkington in the 1990s (Elkington, 2008). According to the TBL, sustainable performance must take into account three dimensions: economic, social and environmental. To contribute to the industrial integration of DED processes, it is imperative to master mechanical and sustainable industrial performances, which are sometimes antagonistic (Peng et al., 2018). A lack of model and studies able to predict the performance based on manufacturing parameters has been highlighted in literature (Bernard et al., 2023). This is partly due to the complexity of developing a performance model in light of the large number of DED process and the heterogeneity of the parameters from one process to another (Dass & Moridi, 2019). Thus, this contribution addresses the choice of the manufacturing process parameters for DED considering both mechanical and sustainable criteria.

Methodology

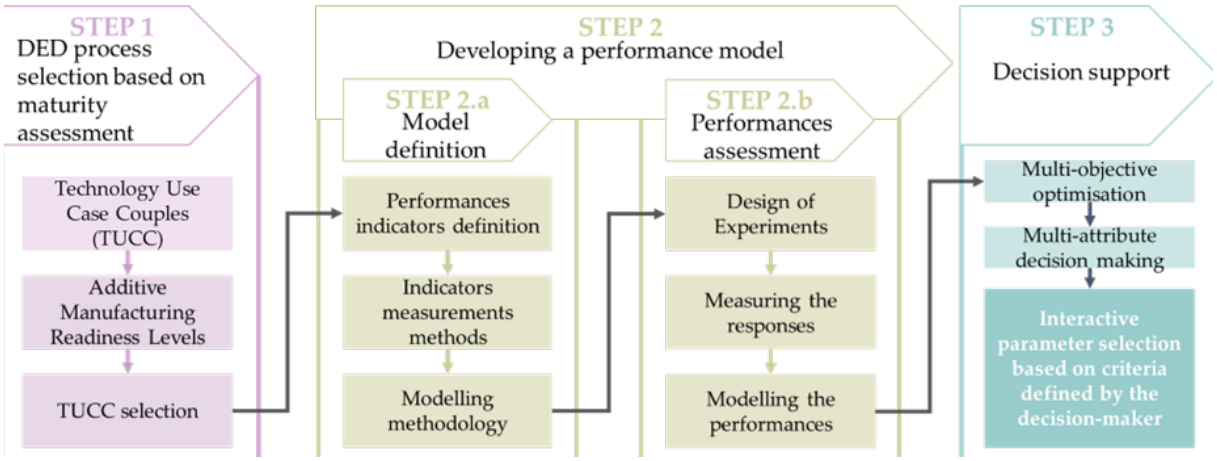

Figure 1. Methodological framework to assist the selection of DED process parameters considering both mechanical and sustainable performance.

To answer the problematic, a multidisciplinary approach ranging from mechanics to industrial engineering is proposed which leads to the development of a decision support model, which aims to guide the choice of manufacturing parameters to achieve the targeted performance for the production of DED parts in a given industrial context. To this end, three stages have been defined, as illustrated in Figure 1. In this contribution stages 2 and 3 are presented.

Results and Discussion

Performance model

A performance model featuring two input parameters of the manufacturing process (the wire feed speed, WFS and the torch speed, TS) and five output performance indicators (dimensional accuracy, load bearing force, manufacturing time, cost and environmental impact) has been defined. Using surface response methodology, based on experiments (using WAAM-CMT to build thick walls in 316L stainless steel), the model allows to predict the indicators based on the selected manufacturing parameters (Terrenoir et al., 2023). Based on the results, five equations were developed to predict the value of these indicators as a function of WFS and TS, which are ultimately the developed performance model. From these equations, the difficulty of choosing the parameters according to the performance indicators was highlighted: in fact, the optimum values of the mechanical and sustainable industrial performance indicators are achieved for divergent values of WFS and TS. It shows that selecting a single combination of parameters does not enable the simultaneous promotion of all indicators, which calls for the development of a decision support model.

Decision support model

The decision problem considered is a multi-criteria decision problem. The number of alternatives is a combinatorial function of the number of variables and parameters considered. After reviewing the state of the art, we propose a two-stage hybrid model to solve the problem. The developed decision support system (DSS) articulates Multi Objective Decision Making (MODM) and Multi Attribute Decision Making (MADM) techniques. The MODM algorithm selected is the non-sorting genetic algorithm - NSGA II, which finds the pareto-optimal solutions among all alternatives (Deb et al., 2002). Then, the MADM algorithm TAMARIN (Laguna Salvadó et al., 2022), allows the decision maker to hierarchize his priorities between the considered performance indicators. TAMARIN, interactively and in real-time, displays the ranking of the remaining pareto optimal alternatives to assist the decision according to the preferences selected. The model has been tested and validated on scenarios by manufacturers. This DSS ensures to find quickly a solution that is overall optimized in regard of all criteria, and also in regard of the decision maker's preferences. This model has been designed to be scalable to broader performance models.

Conclusion and Perspectives

The work presented herein provides some answers to the difficulties of industrialising DED MAM processes. For the selected use case, the developed performance model is able to predict the mechanical and sustainable performances, which can be optimised through the decision support model proposed. To surmount some of the limitations that have been identified in the results of the study, the following prospects are highlighted. In the short term, for the performance model, the study and inclusion of indicators relating to the social dimension is mandatory to be able to really defend sustainable performance. In the medium term, the proposed models should be consolidated with real and diversified industrial cases, with the aim of creating a complete predictive model for DED. Finally, in the long term, the integration of all stages of the product life cycle must be considered. Finally, this work emphasises the promotion of multidisciplinary approaches, which engender a holistic understanding, imperative for addressing the inherent complexities in the industrial integration of DED processes.

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ECONOMIC INTEGRATION AND POLLUTION DISPARITIES: HOW EFFICIENT ARE ENVIRONMENTAL POLICIES?

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Keywords: environmental policy, foreign investment, maritime connectivity, pollution disparities, trade, gravity analysis, econometrics

Introduction

Despite global efforts as well as political and social events slowing down the global economy, CO2 emissions keep going up even though at a slower pace and with high disparities between countries, with developing countries taking the lead (Crippa et al., 2022). Our econometric analysis under a gravity setting is trying to disentangle the effects of economic integration on these trends, especially on the gap between countries in terms of CO2 emissions. Firstly, we are interested in how different measures of economic integration (through trade, foreign direct investment (FDI), transportation infrastructure) may impact the disparities between countries and their economic partners, in terms of CO2 emissions. We measure these disparities through the CO2 emissions gap between partner countries. Secondly, we are interested in how environmental policies interact with the different measures of economic integration, in driving CO2 emission disparities between partner countries.

Data and methodology

We conduct our empirical study on a heterogeneous panel of countries, in a standard gravity setting. Due to data availability, we focus on the 2008-2012 period (data for all countries available). Our dependent variable is defined as the pollution ratio between two partner countries (partners in terms of trade or FDIs). Then, based on previous works, we define our independent variables in order to take into account different measures of economic integration as well as the economic development, the economic structure and the environmental policies of partner countries. Regarding economic integration, we proceed to several robustness checks and consider different proxies, such as bilateral outward FDI of origin countries, inward FDIs in origin and destination countries, the market access of origin and destination countries as well as bilateral exports and imports. Then, we consider UNCTAD's bilateral index for liner shipping connectivity (LSCI), as a proxy for the international

maritime infrastructure, which supports over 80% of international trade and thus, economic integration. As a proxy for environmental policies (EP), we choose the environmental policy stringency (EPS) index developed by the OECD, but as robustness checks, we also run estimations by replacing the EPS with the number of climate change laws and policies, environment related taxes or climate change related taxes. Finally, we also consider the renewable energy (RE) use and the industrial output (IND) of origin and destination countries. Consequently, the baseline equation to be estimated is written as:

$$Pollgap_{ijt} = LSCI_{ijt} + InFDI_{it} + InFDI_{jt} + Exports_{ijt} + Imports_{ijt} + EP_{it} + EP_{jt} + RE_{it} + RE_{jt} + IND_{it} + IND_{jt}$$

where: i = the origin country; j = the destination country; t = year

Given the summary statistics and variance analysis of our dataset, we use the recommended maximum likelihood estimators (Poisson, Gamma, PGLM), for robustness checks, in line with Head and Mayer (2014) and Basu (2005).

Preliminary results and discussion

Most of our results are robust regardless of the estimators or the proxies we use. We find that the bilateral LSCI has mostly a negative and statistically significant impact on the pollution gap between origin and destination countries: strong maritime connections encourage pollution transfer abroad, in partner countries. We also find that the pollution gap between origin and destination countries tends to increase with inward FDI stocks and the industrial output of origin countries, but also when destination countries apply more stringent environmental policies and use more renewable energy. On the other hand, the pollution gap tends to decrease with inward FDI stocks in and imports from the destination countries, as well as when origin countries apply more stringent environmental policies and use more renewable energy. As expected, the pollution gap increases with the market access of origin countries but decreases with the market access of destination countries. We deepen our analysis by testing for interaction effects. We find that more stringent environmental policies in destination countries allow mitigating the negative impact of maritime connectivity. Through interaction effects tests between environmental policies in origin and destination countries, we also find evidence for some kind of learning effect or good practices diffusion effect. The positive impact of environmental policies in destination countries is enhanced by stringent environmental policies in origin countries: destination countries become more efficient in reducing their relative pollution levels when their economic partners apply more stringent environmental policies

Conclusions

This work in progress is analyzing the determinants of the pollution gap between partner countries. We find that increasing economic activity in a partner country (higher FDIs, higher exports, higher market access) leads to pollution transfer towards that country. We also find a significant impact for bilateral maritime connectivity: stronger maritime connections lead to pollution transfer abroad, in partner countries. Differences in environmental policies also make the pollution balance tip towards the countries with weaker environmental policies. However, when testing for interaction effects, we find that stronger environmental policies in host countries may help mitigating the impact of maritime connectivity: applying higher environmental norms in host countries reduces and may even offset the positive effect that maritime connectivity may have on transferring pollution towards those countries. Finally, we find evidence for some kind of learning effect or good practices diffusion in terms of environmental policies: environmental policies in hosts countries are more efficient in reducing the pollution level relative to the origin countries when environmental policies are stronger in the latter.

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NANOTECHNOLOGIES AS PART OF THE CIRCULAR ECONOMY - HOW ARE THEY ACCEPTED BY SOCIETY? A CASE STUDY FROM THE CZECH REPUBLIC.

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Keywords: circular economy, nanotechnologies, socio-economic aspects, acceptance, Czech Republic

Introduction

The circular economy concept is based on an economic model of efficient use of primary resources, waste reduction, closing material flows and innovative product design. New materials based on nanotechnology greatly contribute to the realization of such a concept and the reduction of material intensity. However, such materials should be evaluated for their socio-economic and environmental aspects (Purker et al., 2023). Various methodological approaches can be used concerning the impact of nanomaterials, such as risk assessment, life cycle assessment, and socio-economic analysis. Further, willingness to pay (WTP) for products containing nanotechnologies/nanomaterials is investigated. For example, Zhou and Hu (2018) and Liu et al. (2022) conducted WTP for nanotechnologies at the national level, focusing on various types of products.

The main objective of our research is to discuss the socio-economic aspects of nanotechnologies in the context of the SDGs. A sub-objective is to present the results of a pilot cross-sectional study conducted in the Czech Republic.

Methodology

The pilot research was conducted in the Czech Republic between September 1, 2024, and January 30, 2025. The questionnaire was sent to various institutions in the Czech Republic and shared on the social network LinkedIn. The number of respondents in the pilot cross-sectional study is 326.

Firstly, respondents commented on nanotechnologies/nanomaterials in general, then on consumer behaviour concerning two groups of products: 1) products containing nanotechnology, identical to conventional products, and 2) products containing nanotechnology with improved properties and/or design. Based on the research design inspired by Liu et al. (2022), WTP was investigated.

Results & Discussion

Table 1 shows the results of the pilot survey for questions related to the purchase of products containing nanomaterials, namely consumer goods, cosmetics, food and medicines.

Table 1. Purchase of a product containing nanomaterials.

Type	Yes	No	I don't know
Consumer goods	69.9 %	2.5 %	27.6 %
Cosmetics	36.5 %	27.9 %	35.6 %
Food	20.6 %	37.1 %	42.3 %
Medicines	52.8 %	10.4 %	36.8 %

Some respondents would definitely not buy a product containing nanotechnology and/or nanomaterials, especially in the case of cosmetic products (27.9%) and food (37.1%). Most respondents would buy consumer products containing nanotechnology. Overall, we also observe a large number of "don't know" responses, which may indicate a lack of awareness of nanomaterials and low knowledge of the characteristics of nanomaterials, especially in the context of food. Table 1 shows the average values for all respondents; there are differences in the subgroups of respondents by age, education, income and gender.

Table 2. Purchase of a product containing nanomaterials, improved properties and/or design.

Respondents with selected socio-economic characteristics	Same price	Higher price +25 %	Higher price +50%	Higher price +100%
Secondary education	53 %	22 %	13 %	13 %
Higher education	86 %	64 %	30 %	15 %
Low income	65 %	33 %	17 %	7 %
Above average income	86 %	67 %	45 %	26 %

Table 2 shows WTP for product containing nanomaterials with improved properties and/or design in comparison with conventional products. Results are presented only for certain groups of respondents, according to selected socio-economic characteristics. With higher education and income, WTP for products with better characteristics increases.

Conclusions

The results show that people are interested in the presence of nanomaterials in products. The findings also reveal that people's acceptance of nanotechnology varies, largely depending on their knowledge of nanomaterials, education, age, and income. Importantly, respondents showed a higher support for products with nanotech- enhanced performance or design. Understanding how the public perceives nanotechnologies is crucial, as it can significantly influence the development of regulations, shape economy policies, and guide decisions for academic research and industrial innovation.

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SPEAK OUT PROJECT

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Keywords: Motor Disability, Artificial Intelligence, Interactive Machine Learning, Multimodal Data, Non-Verbal Behavior, Emotion Detection, Facial Expressions, Gestures

Introduction

The inability of some individuals with motor disabilities to produce intelligible communication confines them to extremely limited interactions, often restricted to basic needs such as hygiene, comfort, or nutrition. Yet, they possess rich and complex inner lives. This gap between their internal richness and limited expressive capacity can lead to psychological issues, including intense sadness or depression. According to the WHO [1], people with disabilities are twice as likely to experience depression compared to the general population. This situation also causes frustration among caregivers, who feel inadequate in fulfilling their support roles.

Case presentation

The SPEAK OUT project aims to design, test, and deploy an AI-based solution to enhance the communication abilities of individuals with motor disabilities who are unable to speak intelligibly. This solution will function as an instant translator, inferring and conveying intentions and emotions through multimodal analysis of non-verbal signals [2], such as gestures [3], facial expressions [4], and physiological indicators [5].

The integration of a wide range of non-verbal signals is based on the observation that each person with a disability has specific motor abilities. These non-verbal signals will be collected using non-intrusive sensors, such as a camera (e.g., a webcam) and a connected bracelet.

The goal is to design a discreet, non-intrusive, and non-stigmatizing device. Therefore, all or part of the signals can be interpreted depending on the expressive modalities unique to each user. An innovative aspect of this approach lies in leveraging correlations between multiple non-verbal multimodal signals to accurately identify the message that the person with a disability wishes to convey. In addition, the identification of emotional signals will enable a more accurate interpretation of messages [6]. For example, rapid and erratic movements could be associated with a state of frustration, while slow and deliberate movements could be interpreted as a sign of sadness.

The use of artificial intelligence, particularly interactive machine learning [7], will enable the design of a solution capable of "learning" the communication patterns specific to each individual. As a result, the system will adapt to the needs and abilities of each user, rather than imposing a predefined solution that requires the user to learn and master a new language.

Results & Discussion

The **Speak Out project**, have been awarded in 2024 as part of Universcience's call for innovative projects on the theme "Artificial Intelligence at Our Service," led us to design and install a first public-facing device at the *Cité des Sciences et de l'Industrie* in Paris in early September 2024. This first demonstrator (figure 1), which invites participants to answer a series of questions using a limited set of gestures and facial expressions, allows us to evaluate the algorithms on the recognition of various body and facial expressions. The objectives of this public demonstration initiative are:

- To raise public awareness about the challenges of qualifying an algorithm as well as its ethical and ergonomic considerations.
- To inform the public about artificial intelligence applications with high social and societal impact.
- To enable broader training of the algorithm on facial expression and gesture recognition.

This initial, highly simplified system allows us to engage the public and generate data that will be useful for the development of the final device. The next step will focus on developing an initial artificial intelligence model and conducting experiments with three testers (residents) with different disability profiles to evaluate the accuracy of the algorithms.

Figure 1. Speak Out Project demonstrator. Left image: Exterior view of our demonstrator installed at the *Cité des Sciences et de l'Industrie*. Right image: A participant interacting with the demonstrator by using gestures to answer simple questions.

Conclusions & Recommendations

In conclusion, the proposed solution, with its innovative and personalized approach, seeks to enhance inclusion, self-determination, social relationships, and the agency of individuals with motor disabilities. By fostering well-being and positively impacting mental health, it addresses both practical and emotional needs. Central to this initiative is a strong ethical foundation, ensuring users retain sovereignty over their interactions with digital tools, free from imposed decisions or actions. This commitment to respecting freedom, autonomy, and personal preferences underscores the project's user-centric design. Moreover, the implementation of this solution will enable the collection of valuable data on use cases, ergonomics, functionalities, and other critical aspects, paving the way for continuous improvement and adaptability across diverse situations.

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TECHNOLOGY BEYOND THE NANOSCALE (TECHSCALE) – SOCIAL SCIENCES AND HUMANITIES PERSPECTIVES

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Keywords: Single-Atom Engineered Materials, Responsible Innovation, Public Perception, Ethical Implications, Societal Acceptance

Introduction

The TECHSCALE project aims to innovate Single-Atom Engineered Materials (SAEM) for applications in diverse fields such as sensing, sustainability, and healthcare, including areas like diagnostics and therapeutic technologies. **Beyond technological innovation, the project emphasizes the importance of comprehensive social impact assessments and strives to foster public acceptance of these advanced technologies**. To responsibly harness SAEM's transformative capabilities, the concept of "**responsible rational material design**" is introduced, merging scientific innovation with broader societal concerns. By prioritizing public interests, safety, and ethical transparency, this initiative promotes a balanced approach to technological progress that aligns closely with societal values and expectations.

Case Presentation

The TECHSCALE project employs empirical methodologies to evaluate public attitudes, ethical concerns, and risks associated with misinformation. These methodologies help identify the critical factors influencing public acceptance, ultimately promoting trust and societal support. Additionally, the project investigates the roles played

by media, policymakers, and industry stakeholders in shaping **societal perceptions**, advocating for transparent communication practices.

Results & Discussion

The findings highlight how social considerations such as transparency, ethical usage, and regulatory effectiveness significantly impact public acceptance of SAEM. It underscores the **necessity of interdisciplinary collaboration, integrating scientific advancements with insights from social sciences** to provide practical recommendations for stakeholders. These results emphasize the critical role interdisciplinary approaches play in achieving effective and ethical technological integration into society.

Conclusions & Recommendations

The study underscores the **importance of integrating social, ethical, and scientific perspectives to ensure the sustainable and responsible deployment of SAEM**. Ongoing efforts should refine public engagement strategies and evaluate the long-term societal implications of these innovations. Policymakers and industry leaders must collaborate closely to develop adaptive regulatory frameworks capable of responding swiftly and effectively to rapid technological advancements, ensuring SAEM technologies' ethical and socially acceptable integration.

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AN APPROACH FOR CONSIDERING THE INTERDEPENDENCIES AMONG CLIMATE SECURITY ACTIONS – SEVEN CASE STUDIES

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Keywords: climate change, biodiversity loss, adaptation to climate change

climate roadmaps, portfolio decision analysis

Introduction

Environmental threats such as climate change and biodiversity loss may cause danger to people, cause considerable property and environmental damage and weaken the conditions of economic activities.

Our case studies include designing the climate roadmaps in different contexts in Finland, Lithuania, Ukraine and Bulgaria, technology park development among Romania and Ukraine, and two university cases, one in selection of strategic actions and the other designing the responsible impact evidence.

Methodology

Addressing the interdependencies among actions, it is possible to detect and anticipate harmful impacts on the environment to ensure that their negative impacts can be prevented, and the damage sustained can be repaired as quickly as possible.

Considering the interdependencies systematically between actions (i.e. interactions) can be challenging, because the portfolio of actions can include tens of possible actions potentially leading to hundreds of pairwise interactions between them.

Results & Discussion

In this paper, we present seven case studies applying a structured approach based on portfolio decision analysis to support the consideration of interdependencies between actions in the selection of an efficient portfolio.

Conclusions

Our approach aims to reduce the burden of assessing interactions by initially selecting a shortlist of actions based on specific heuristics and the use of holistic evaluation of interactions.

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THE FARM OF CIRCULARITY AND LOW-TECH

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Keywords: circularity, low-tech, farm, workshop, reparation

Introduction

The socio-ecological transition raises numerous challenges for our territories, such as climate change, biodiversity loss, and the decline of living ecosystems. In addition to "high-tech" engineering approaches, there is a need to train and raise awareness among engineers, entrepreneurs, and citizens regarding the socio-ecological transition, to develop a more sustainable mindset through "emerging" approaches such as sobriety, low-tech, regenerative engineering, and circular economy (reduce, repair, reuse, recycle, etc.). The "Circularity and Low-Tech Farm" project aims to provide a platform to foster participatory and sustainable socio-technical innovations, connecting citizens, industry and researchers.

Case Presentation

Currently, we are working on a project to renovate an abandoned farmhouse near ESTIA, transforming it into a flagship hub for low-tech and circular economy actions:

- Workshop Space: Repair workshops for everyday objects and bicycles, promoting sustainability and soft mobility. Upcycling and recycling workshops (e.g., textiles). Low-tech construction workshops.

- Training & Workshop Area: Hosting workshops for companies, citizens and students to co-design circular and low-tech solutions, and offering specialized training on low-tech and circular economy.

- Demonstration Area: Developing and showcasing prototypes and demonstrators based on circular economy and low-tech principles in a dedicated space.

The project is thus based on three fundamental pillars: applied research, training, and public knowledge dissemination as it includes conducting research thesis on user-centered design for low-tech technologies, and creating dedicated spaces for experimentation and teaching circularity and low-tech.

Results & Discussion

Collaborative research initiatives have already been launched, including ongoing studies on the acceptability of low-tech solutions [1] and workshops on circular economy [2 ; 3]. Initial results indicate a growing interest in these approaches, particularly within the fields of sustainable engineering and circular economy.

Regarding the physical site, we are currently in the study phase, evaluating the renovation of an existing farm.

Figure 1. Existing farm to be renovated

This unique site will serve as a platform to share research outcomes and practical applications in circularity and low-tech innovation.

Conclusion

This project represents a strategic opportunity for developing new skills in engineering and sustainable innovation. In perspective we hope to deploy new training program on Circular economy and Low-tech, strengthening academic and industrial collaborations, and disseminating the results to the general public.

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A SYSTEMATIC APPROACH TOWARDS CIRCULAR ECONOMY

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Keywords: circular economy, procedural model, toolbox, strategy, industry

Introduction

At the European level, a societal and political shift toward sustainability has evolved over the past decades. However, the global economy still largely follows a linear "take-make-waste" model, leading to premature disposal of products, components, and raw materials. This inefficiency has driven resource consumption beyond sustainable levels, requiring 1.7 Earths to meet global demands [1,2].

The 17 Sustainable Development Goals (SDGs) of the Agenda for Sustainable Development explicitly reference the industrial sector, promoting sustainability and resource conservation through goals such as “Industry, Innovation, and Infrastructure” and “Responsible Consumption and Production” [3]. Achieving the EU’s climate neutrality target by 2050 necessitates a transition to a circular economy, which reduces pressure on natural resources, lowers CO_2 emissions, and fosters sustainable growth and job creation [4].

As of 2022, Austria's circularity rate—measuring the share of reused materials in total material consumption—stood at approximately 13.8%, surpassing the EU average of 11.5%. Austria aims to increase this to 18% by 2030 through enhanced recycling, sustainable product design, and responsible consumption patterns [5].

Despite these ambitions, businesses face significant challenges in shifting from a linear to a circular economy. Key barriers include limited awareness, recyclability issues, financial constraints, and weak management commitment, alongside resource-related challenges such as a lack of trained personnel and experience [6].

Nevertheless, studies highlight multiple benefits and enablers of circular principles. Research confirms that circular economy practices contribute to long-term corporate success, with most surveyed companies recognizing their strategic importance [7].

Methodology

The research project tackles these challenges by developing a structured, methodological approach to transforming linear value chains into circular ones.

A comprehensive study is being conducted to assess the extent to which circular economy concepts are currently applied within Austrian industries. This includes a survey aimed at measuring the current share of circular value creation and identifying the predominant circular economy concepts, approaches, and practices in the industry today.

The developed approach focuses on various circular economy strategies, with a particular emphasis on extending product lifespans through key R-strategies: reuse, repair, remanufacturing, recycling, and repurposing [8]. Additionally, it considers the sustainable use and production of goods, as well as the efficient utilization of waste materials generated during manufacturing processes.

The following graphic illustrates the transformation process, which is structured into four key phases—analysis, planning, implementation, and control & adjustment. These phases are aligned with the project's core priorities and their corresponding results or methods to be developed.

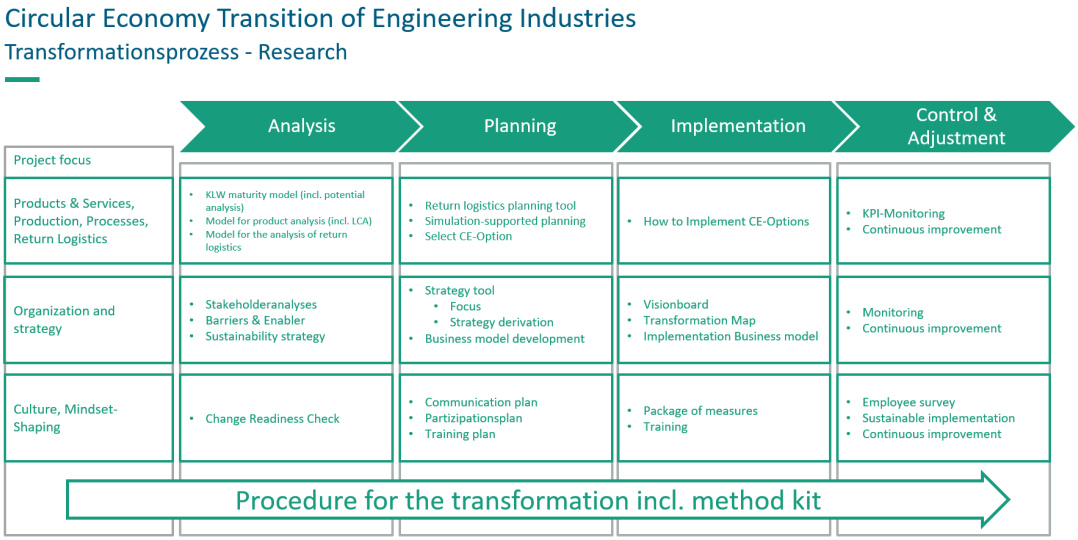

Figure 1. Procedure of the transformation path planned.

Results & Discussion

The research project involves the collaboration of four universities and institutions, each contributing its unique expertise to the initiative. To achieve the overarching objective of the process model, the project is structured into four distinct phases, with each phase employing

different methods and models. The coordination and integration of these methods and models into a comprehensive methodology ultimately result in a structured process model.

This methodological toolbox is designed for application within the target group—the Austrian industry—providing a diverse and extensive repertoire of methods, techniques, instruments, and models. By facilitating the adoption and implementation of circular economy principles, this toolbox accelerates the transformation process and aligns with Austria's climate protection strategy. Beyond offering practical guidance on achieving climate targets, it also establishes a framework and standardization, ensuring a structured and effective approach to sustainability in industrial practices.

Conclusions

The added value for companies resulting from this research project is evident in resource and energy savings, as well as in the structured support it provides for the transition towards a circular economy. By utilizing an adaptive, method-based Circular economy transformation model, this approach ensures an efficient and targeted transformation process. It achieves this by identifying company-specific circular economy potentials—spanning economic, ecological, and social dimensions — and implementing tailored R-strategies, such as reuse, remanufacturing, and recycling

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GREEN SKILLS FOR THE FUTURE OF WORK IN INDUSTRIAL COMPANIES

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Keywords: green skills, sustainable enterprise, green competences, green abilities, sustainable skills, sustainable competences

Abstract:

The purpose of this study is to find out the green skills demanded by the industry. Thus, a systematic literature review was carried out for this research, an in-depth analysis of the most relevant literature concerning the topic under research, in this case, the necessary green skills for industrial companies for its sustainable development. Additionally, the results have been contrasted with practitioners in the industrial sector of the Basque Country.

Despite the high expectations of Green Skills, Sern et al [1] address the importance of determining which are the necessary skills in certain sectors. This research contributes to that research gap by focusing on the industrial sector. There is a necessity for developing sustainable skills in employees [2,3], for creating sustainable organisational strategies and integrating green practices into organisational processes and roles. It highlighted the role of HR for a strategic development of the necessary skills [4].

This research contributes to schools, universities, and other learning institutions, as well as organisations, by identifying the skills that students and employees must develop to adapt to market needs [5]. Moreover, it will help specifically HR managers, in creating learning strategies to develop the most important green required to meet environmental demands.

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FOSTERING SOCIAL, ECONOMIC, AND POLITICAL INCLUSION THROUGH EDUCATION IN GREEN ECONOMY TRANSITIONS

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Keywords: education, green economy, policy frameworks, vocational training, sustainable development, inclusion

Introduction

The transition towards a green economy is increasingly seen as a necessary response to contemporary environmental, economic, and social challenges. However, ensuring that such transitions are inclusive and equitable remains a critical concern. Education plays a central role in fostering engagement with green economy principles, equipping individuals with the knowledge and skills required to participate in sustainable sectors. This study presents key insights derived from the *EU4Dual MCAST Green Economy Research Mapping Report*, which systematically examines Malta's green economy transition through an extensive review of academic and policy publications. The research investigates the extent to which education is integrated into sustainability transitions, highlighting gaps in green skills training, policy alignment, and multi-sector collaboration. While focused on the Maltese context, the findings offer broader relevance for other European states and regions undergoing similar transformations.

Case presentation

The study employs a systematic keyword search methodology to identify relevant publications that explore the intersection of education and the green economy. This approach enables a comprehensive mapping of existing research, providing insights into how educational structures align with national sustainability strategies. The analysis identifies seven key thematic areas: renewable energy, sustainable agriculture, circular economy, green technology, biodiversity conservation, climate change mitigation and adaptation, and eco-friendly transportation. These themes frame the discussion on how education contributes to preparing societies for the demands of green economic transitions. Each thematic area is examined in relation to existing frameworks, workforce development strategies, and the broader socio-economic implications of sustainability transitions. The study further investigates the extent to which current educational provisions address the skills and knowledge required for employment in emerging green sectors.

Results & discussion

The analysis highlights several critical challenges that must be addressed to enhance the role of education in facilitating green economy transitions. One of the most pressing issues is the inconsistent integration of sustainability principles across different levels of education. While green skills are increasingly recognised as essential for the future workforce, vocational training and lifelong learning programmes remain fragmented, limiting opportunities for individuals to engage with sustainability-related careers. Furthermore, policy frameworks governing education and sustainability are often misaligned, leading to gaps in implementation and missed opportunities for fostering an inclusive transition. The lack of collaboration between educational institutions, policymakers, and industry stakeholders further exacerbates these challenges, restricting the development of responsive and dynamic educational initiatives.

Towards the later stages of the analysis, the discussion shifts to the implications of these findings for social, economic, and political inclusion. The study emphasises that without targeted interventions, green economy transitions risk deepening existing socio-economic inequalities by limiting access to training and employment in sustainability-driven industries. Addressing these disparities requires a coordinated approach that ensures educational policies align with labour market needs, enabling broader participation in the green economy. While the study focuses on Malta, these findings hold significance for other regions facing similar structural and policy constraints in integrating education into sustainability transitions.

Conclusions & recommendations

Education is a fundamental enabler of inclusive and sustainable green economy transitions. However, systemic gaps in policy coherence, training provision, and institutional collaboration continue to hinder its full potential. Strengthening the role of education in sustainability transitions requires a multi-pronged approach that includes the development of integrated policy frameworks, the incorporation of sustainability principles into curricula at all levels, and increased investment in vocational training and lifelong learning opportunities. Furthermore, fostering stronger partnerships between education providers, industry leaders, and policymakers is essential to ensuring that green skills development remains adaptive and relevant to evolving economic and environmental needs.

Although this study centres on the Maltese experience, its findings are applicable across different national contexts where education is positioned as a mechanism for sustainable development. The research underscores the necessity of adopting evidence-based policymaking to bridge existing gaps and facilitate equitable participation in the green economy. By addressing these challenges, education can serve as a transformative force in achieving an inclusive and resilient sustainability transition, contributing to broader European and global objectives in sustainable development.

BUILDING RESILIENCE THROUGH ARTS: A MULTIDISCIPLINARY APPROACH TO SOCIAL INCLUSION

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Keywords: arts-based methods, inclusiveness, resilience, social inclusion, well-being

Introduction

Today, taking care of well-being is seen as a shared, collective societal responsibility. To achieve it we need a common vision and shared values that we can all rely on to strengthen mutual trust and community. What factors then build faith in one's own possibilities and those of others to shape a better future.

Case presentation

Art Without Barriers – Inclusiveness Through Art (1.9.2024-28.2.2027, ESF+) -project (2025) recognizes that various uncertainty factors, such as environmental, economic, and social issues, have increased feelings of insecurity. The project has set out to examine how the mental resources of socially and culturally disadvantaged people, especially young people in challenging situations, can be strengthened. The central starting point is the use of arts and arts-based methods to strengthen the well-being and mental resources of young people and other socially disadvantaged people. While many young people in Finland are doing well, there is polarization in well-being, increased anxiety, and mental health concerns (MEC 2024, 10, 21-22).

The project addresses key challenges in the North Savo region, such as youth marginalization, mental health issues, social isolation, and the poor integration of immigrants. Project actors have noticed that many young people in the area face significant emotional and psychological challenges, often leading to social isolation (e.g. Finnish Institute for Health and Welfare 2025). Furthermore, actors have observed that socially disadvantaged people do not have sufficient access to art services, putting them at a disadvantage in terms of cultural participation. The experience of social and cultural

exclusion, in turn, weakens the sense of belonging and attachment to the region, employment, studies, and society. The project utilizes arts-based methods and multidisciplinary collaboration to promote social and cultural inclusion, thereby supporting employment, well-being, equality, and participation.

The project's goals and areas of activity strongly correspond to conference themes and the global challenge of the green economy, especially in the subject areas of human security and social, economic, and political inclusion. This collaborative initiative between Savonia University of Applied Sciences and Kuopio Art Museum aims to develop an inclusive and multidisciplinary service model, where the arts support well-being, resilience, and a sense of belonging. It offers arts-based activities to young people, immigrants, and vulnerable groups, helping them strengthen their social connections and autonomy.

Key actions of the project:

- Development of a new service model that combines multidisciplinary art and well-being services (WP1)
- Customer-oriented and inclusive artistic activities (WP2)
- Needs-based coaching and training (WP3)
- Customer-centered development of accessible communication (WP4)

Results & Discussion

To support young people's well-being, a systemic approach, multidisciplinary cooperation, educational opportunities, and active participation in decision-making are essential (Ignatowski et al., 2021, 80-82, 93-95; MEC, 2024, 24-28). Human security, in turn, is promoted through protection and empowerment strategies based on four principles: person-centeredness, holisticness, context-specificity, and prevention (UNTFHS 2025), all of which are also strongly present in arts-based work approaches and methods. The Global Youth Wellbeing Index 2017 highlights the positive correlation between security and well-being (IYF 2017, Overview).

The project considers participation, resilience, self-esteem, and communication through art:

- What factors build and enhance participation and community cohesion?
- What expertise is needed to implement these practices?
- How can this expertise be strengthened through art education?

Evaluating the impact of project’s artistic and training activities helps us better understand the development of inclusion and resilience.

Conclusions & Recommendations

Impact assessment among target groups of artistic and educational activity, by focusing on the experience of participation is a relevant factor in the development of education and cooperation that strengthens social inclusion.

Present themes of continuing education and international cooperation at Savonia UAS are:

- How arts-based methods can be used to support human security in our time?
- A safer space as a pedagogical starting point
- Mental crisis resilience – the role of social and cultural inclusion as a reinforcement of resilience

By expanding arts beyond the walls of the museum, the project makes the arts accessible to everyone and creates an open, welcoming environment where everyone feels valued. Through interdisciplinarity, the project promotes community well-being and ensures sustainable and inclusive arts services, even when facing future resource challenges.

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BIODIVREGIO: INTEGRATING BIODIVERSITY INTO REGIONAL AGRICULTURAL VALUE CHAINS

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Keywords: biodiversity, regional value chains, food retail, sustainable agriculture, consumer preferences, Baden-Württemberg

Introduction

Biodiversity is increasingly recognized as a critical factor in sustainable agriculture. The EU-funded **BiodivRegio** project explores strategies to integrate biodiversity into agricultural practices and regional value chains, focusing on beef production from extensive grasslands and maize-bean cropping for human consumption. This interdisciplinary initiative involves DHBW Mannheim, the University of Applied Sciences Nürtingen-Geislingen, and the University of Hohenheim. By addressing biodiversity challenges in food production and distribution, the project aims to develop scalable business models that enhance ecological sustainability while maintaining economic competitiveness. Additionally, the project seeks to bridge the gap between theoretical knowledge and practical implementation, fostering collaboration between academic institutions, businesses, and policymakers to ensure a holistic approach to biodiversity-friendly agriculture.

Methodology

The project employs a multi-stakeholder approach involving dual partner companies, food retailers, and agricultural producers. It evaluates existing biodiversity labels in the retail sector and investigates novel distribution models for beef and plant-based products originating from biodiversity-supporting production methods. Furthermore, the concept of "regionality" is analyzed to understand its measurement and its influence on consumer preferences across demographic segments. Digital networking solutions and platform-based approaches are developed to mitigate cost disadvantages associated with biodiversity-friendly production. Socio-economic analyses accompany these innovations to assess their feasibility and market acceptance. The methodological approach combines qualitative and quantitative research, including expert interviews, consumer surveys, and case studies of best practices. In addition, pilot projects are designed to test the

effectiveness of the proposed models under real-market conditions, ensuring that theoretical insights translate into actionable strategies.

Results & Discussion

Initial findings indicate that biodiversity-enhancing agricultural practices face challenges related to market access and consumer awareness. The evaluation of biodiversity labels suggests that consumer trust varies significantly across different labeling schemes. Additionally, regional value chains benefit from platform-based networking solutions that facilitate the direct linkage between producers and retailers, reducing inefficiencies and transaction costs. Pilot trials confirm the economic viability of new distribution models, although scaling remains a key challenge. The results highlight the need for enhanced marketing strategies to communicate biodiversity benefits effectively. Furthermore, the research underscores the role of digital platforms in connecting small-scale farmers with larger distribution networks, enabling them to overcome logistical barriers. The study also finds that regulatory frameworks play a crucial role in shaping market conditions, necessitating close cooperation between stakeholders and policymakers to create a supportive environment for biodiversity-friendly agricultural practices.

Conclusions

BiodivRegio contributes to the development of biodiversity-friendly agricultural value chains by integrating scientific research with practical implementation. The findings underscore the importance of aligning ecological objectives with economic incentives to ensure long-term sustainability. Future research will focus on refining business models and scaling successful pilot initiatives. The project provides valuable insights for policymakers, agricultural stakeholders, and retailers aiming to enhance biodiversity within regional food systems. Additionally, the project highlights the necessity of consumer education and engagement to drive demand for biodiversity-supporting products. Through interdisciplinary collaboration, innovative digital solutions, and practical field trials, BiodivRegio aims to create a lasting impact on regional food systems, promoting both ecological resilience and economic viability.

GREEN INSURANCE AS A TOOL SUPPORTING SUSTAINABLE DEVELOPMENT

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Keywords: green insurance, sustainable development, green economy, ecology, insurances

Introduction

The pursuit of sustainable development and the fight against progressing climate change are among the priorities of actions undertaken by individuals and economic entities implementing various pro-ecological solutions, such as renewable energy sources [1], environmental education [2], and ESG reporting [3]. Pro-ecological activities are also evident among insurance companies, which have developed insurance products that support environmental protection, known as "green insurance" [4], which provide protection against the effects of various random events while supporting environmental conservation efforts [4]. Green (pro-ecological) insurance includes: motor vehicle insurance, corporate insurance, home insurance, liability insurance, travel and life insurance [4]. The broad range of green insurance products demonstrates that through various pro-ecological incentives, individuals and businesses can have a real impact on environmental protection. Therefore, it is essential to analyze their influence on sustainable development.

Methodology

The aim of this paper is to present the impact of green corporate insurance on the behavior of society and businesses, with particular emphasis on the concept of sustainable development. The analyses conducted serve as the foundation for answering the research question: Do green insurance products serve as a tool supporting sustainable development? To achieve this goal, a critical review of the literature on ecological insurance was conducted, along with an assessment of the described green insurance products in the context of their impact on sustainable development worldwide. The critical analysis was based on publications from the Scopus database, obtained through the selection of the following keywords: “green

insurances" and "sustainability". The retrieved list of publications was further classified into thematic clusters and publication years using the VOSviewer program, which enabled an additional identification of research trends.

Results & Discussion

The verification of keywords in the Scopus database enabled the retrieval of 128 publications. Based on bibliometric analysis using the VOSviewer program, which classified the data according to keywords, a total of four thematic clusters were identified, two of which showed a strong connection with insurance and sustainable development. This highlights the significance of the discussed topic in scientific research. The identified connections with similar keywords allowed for a comprehensive literature study. The analysis of the literature from the collected database has demonstrated the real impact of green insurance on encouraging enterprises to take actions towards sustainable development. As researchers observe, the goal of green insurance should be to encourage pro-environmental investments and actions aimed at reducing the carbon footprint [5]. Example results of the analysis are presented in Table 1. To increase their real impact on the environment, insurers should expand the scope of green insurance policies, create insurance products for innovative enterprises, and promote claims management practices that reduce waste [10,11]. The conducted review has shown that green insurance can contribute to the sustainable development of enterprises by enabling ecological initiatives. However, its current real impact on the environment remains minimal, which needs to be improved in the future.

Table 1. The impact of green insurance on the sustainable development of enterprises and business activities

Authors	Year of Study	Environmental Benefits	Benefits for Enterprises and Business Activities
Sholoiko, A., Matsybora, T., Shevchenko, L. [6]	2022	No data	Due to ongoing climate changes, the current form of insurance is ineffective and requires reform
Li, B., Du, Z., Wang, M. [7]	2022	No data	Opportunity to increase profits and acquire additional capital for SMEs operating in the green supply chain
Wu, Q., Chiu, Ch-H. [5]	2023	Incentive to reduce CO_2 emissions	Increased opportunities for SMEs willing to invest in green technologies, improved production levels, higher profits, and potential cost savings
Zhang, J., Ren, L. [8]	2024	No data	Support in managing environmental risk, an effective incentive for enterprises to transition to a green economy (through lower insurance premiums)
Zhong, J., Wang, Z.,	2025	No data	Encouragement of green transformation, alleviation of financial constraints,

Deng, Y. [9]			increased efficiency of ecological innovations, support for economic technology development

Source: own studies based on [5, 6,7,8,9].

Conclusions

The concept of developing green insurance serves as a crucial tool enabling society to undertake ecological actions. The obtained research results have demonstrated various benefits arising from the implementation of such solutions. It is worth noting that only in one case was a real impact observed in the form of CO_2 emission reduction. This indicates that further research is needed to reveal the actual environmental impact, which will highlight the essence of sustainable development in the context of its effect on the environment. Additionally, further analyses are required to assess its impact on people's lives and the actions they take.

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CIRCULAR ECONOMY EDUCATION IN THAILAND AND INDIA – A COMPARATIVE STUDY

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Keywords: circular economy, India, Thailand, education, sustainability

Introduction

The integration of Circular Economy Education (CEE) in Thailand and India plays a vital role in fostering sustainable development and improving resource efficiency. Circular economy (CE) principles, including reuse, repair, remanufacturing, and recycling, have been embedded within the educational frameworks of both countries to address pressing global issues such as resource depletion and waste management (Ellen MacArthur Foundation, 2021). This study aims to compare the implementation of CEE in Thailand and India, analyzing its impacts, challenges, and opportunities for further development.

Case Presentation

Thailand

Thailand has adopted the Bio-Circular-Green (BCG) Economy Model as a strategic framework to incorporate CE principles into education. Government policies, including the 13th National Economic and Social Development Plan (Government of Thailand, 2021) and the Roadmap for Plastic Waste Management 2018-2030 (Government of Thailand, 2018), support the integration of CEE into curricula (National Economic and Social Development Council [NESDC], 2021). Educational institutions such as the Asian Institute of Technology (AIT) play a significant role in offering academic programs focused on CE, aiming to promote sustainable growth and address environmental challenges (AIT, 2023). Environmental education is crucial in Thailand for tackling pollution, plastic waste, and advancing sustainability (Earth5R, 2023) (Government of Thailand, 2022).

India

In India, the National Education Policy (NEP) 2020 emphasizes experiential learning and environmental education at all levels, reinforcing CEE (Government of India, 2020). Prestigious institutions such as the Indian Institutes of Technology (IITs) and Indian Institutes

of Management (IIMs) contribute significantly by driving research and innovation in sustainable business models. India's policy framework also includes the Swachh Bharat Mission, which promotes waste management and sanitation efforts, supporting circular economy practices (Government of India, 2014). Additionally, the Plastic Waste Management Rules establish guidelines for reducing plastic waste and improving recycling infrastructure nationwide (Government of India, 2016).

Results & Discussion

Impacts

In Thailand, CE integration has increased awareness and participation in sustainable practices among students and communities. Educational institutions have become hubs for CE initiatives, fostering innovation and collaboration (AIT, 2023). Similarly, in India, experiential learning has led to the practical application of CE concepts, engaging students in real-world environmental challenges. The involvement of institutions like IITs and IIMs has further propelled research and development in sustainable technologies and business models (Ministry of Education, 2020).

Challenges

Despite policy frameworks, challenges remain in fully integrating CEE. Thailand faces policy enforcement gaps and resource limitations that hinder the widespread adoption of CE practices (Sustainability Indorama Ventures, 2024). While India's NEP 2020 provides a solid foundation, the country's vast and diverse educational landscape presents challenges for uniform implementation. Additionally, aligning traditional educational methods with CE concepts requires significant curriculum development and teacher training efforts (Ghosh, 2023).

Opportunities

Cross-country learning opportunities present an avenue for strengthening CEE. Thailand and India can benefit from exchanging best practices, engaging in collaborative research, and developing joint educational programs. Public-private partnerships can help overcome resource constraints by enabling infrastructure development and CE-related programs (Shirpurwala, 2023). Furthermore, integrating digital tools can enhance the accessibility and effectiveness of CEE, making it available to broader audiences (Sustainability Indorama Ventures, 2024).

Conclusions & Recommendations

The integration of Circular Economy Education in Thailand and India has advanced sustainable development and resource efficiency. However, policy enforcement challenges and resource limitations continue to pose barriers. To enhance the impact of CEE, both

countries should strengthen policy implementation mechanisms, invest in capacity-building programs for educators, and foster cross-country collaborations. Additionally, engaging the private sector through partnerships can provide essential resources and expertise to support CE programs. By addressing these challenges and capitalizing on opportunities, Thailand and India can solidify their commitment to sustainability and serve as global models for CE integration in education.

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SHAPING FUTURES: CREATION OF A VIRTUAL REALITY APPLICATION TO SUPPORT YOUNG PEOPLE IN VOCATIONAL ORIENTATION

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Keywords: Career orientation, virtual reality, virtual learning, design thinking, career exploration

Abstract

Career orientation is vital for young people, yet navigating numerous occupational fields remains challenging. Traditional career guidance methods are losing effectiveness, making vocational orientation essential for modernization.

This study examines how to develop a virtual reality (VR) application to improve career guidance and increase interest in specific professions. A VR prototype was designed for the landscape gardener apprenticeship in Austria. The prototype was iteratively created using design thinking methods.

Findings indicate that VR is an innovative tool for career exploration, making professions more engaging, bridging knowledge gaps, and reducing bias.

Introduction

Vocational orientation is essential in shaping young people's careers, but exploring all available options might be challenging. With the rise of digital technologies like virtual reality (VR), career guidance is being transformed (Smutny et al., 2019). VR offers immersive experiences that allow young people to explore different professions interactively (Ravichandran & Mahapatra, 2023). This study investigates VR's potential in vocational orientation, specifically focusing on landscape gardening, a profession gaining importance due to sustainability trends.

In Austria, students face the challenge of choosing from 331 apprenticeships, making in-depth exploration difficult (AMS Berufslexikon, 2024). This research, part of the author's master's thesis, explores how VR can make career guidance more accessible and informative.

Case Presentation

This study followed a qualitative approach, utilizing expert interviews and an iterative design process to develop the VR prototype. Semi-structured interviews were conducted with experts in landscape

gardening and VR, with data analyzed through qualitative content analysis. Design thinking methods were used to generate ideas, which were then visualized using an affinity diagram. A user journey, user flow (figure 1), and storyboard were created to illustrate the application's interactions.

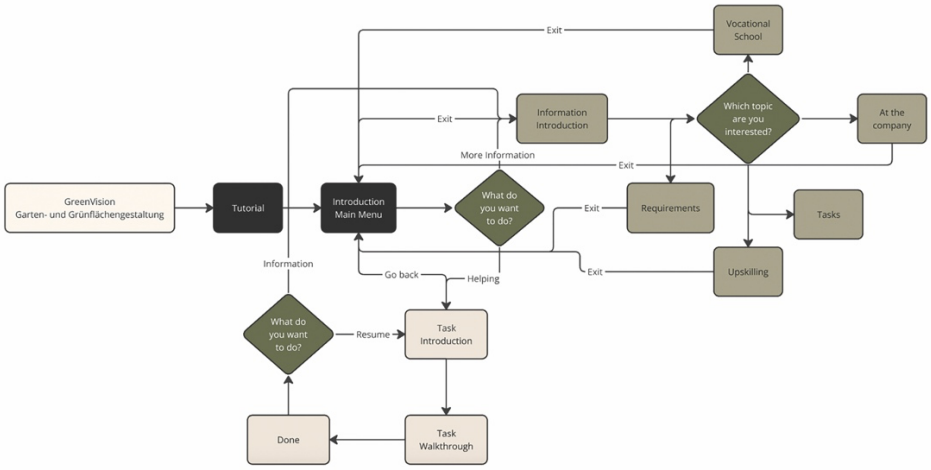

Figure 3: User Flow

Then the low-fidelity (lo-fi) prototype was created and tested through usability tests. Feedback from these tests informed the creation of a high-fidelity (hi-fi) prototype (figure 2, figure 3), which was also tested, followed by a follow-up survey. To assess whether the VR application helped with career orientation, a pretest-posttest workshop design was used, involving 7 participants aged 13-16.

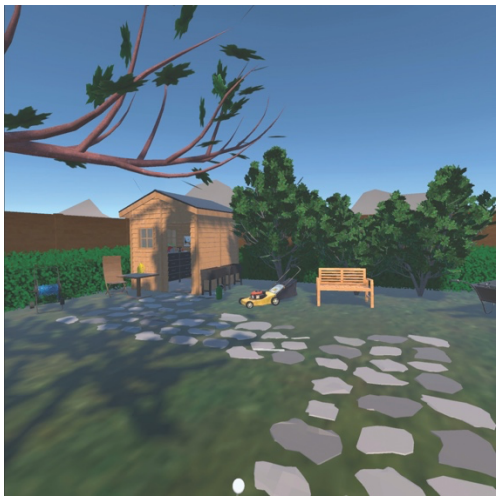

Figure 4: High-fidelity prototype 3D scene

Figure 5: High-fidelity prototype job description

Results & Discussion

Survey data was categorized into demographics, VR experience, prior knowledge of landscaping, and VR's influence on career choice.

- Demographics: Seven respondents, mainly female, aged 13-14.
- Experience with VR: 57.1% had prior VR experience, but all participants gave positive feedback, with no reports of discomfort.
- Prior Knowledge of Landscaping: Most had a general understanding of landscaping, mainly related to plants and gardens. After using VR, five out of seven reported a better understanding, and 14.3% expressed an interest in learning more.
- Influence of VR on Career Choice: 71.4% were open to considering landscaping as a career, and 40% of those interested said the VR experience influenced their decision.
- Interest in VR for Career Guidance: All participants showed interest in VR for exploring other careers, such as agriculture, healthcare, and animal care.

The target group of 13- and 14-year-olds is ideal for career orientation, and despite an uneven gender distribution, all participants had positive anticipation of the VR tool. The VR application helped to address misconceptions about landscaping, improving participants' understanding of the profession.

Many participants reported that the VR experience enhanced their perception of landscaping and expressed interest in using VR for exploring other professions.

Gender differences were observed in the willingness to explore the VR environment, with males being more intuitive in navigation. Females were more cautious, and some participants skipped text, suggesting room for improvements in interface design.

Conclusion & Recommendations

This study has limitations, including a small sample size and gender imbalance, which limit the generalizability of the results. Future studies should pre-test survey questions with the target group. The VR application focused more on technical aspects and did not cover other key parts of the landscaping profession, such as gardening and design. Furthermore, the information scene in the VR application was less engaging compared to the interactive elements, indicating that integrating informational content into the game-like environment could improve engagement.

Feedback, such as adding a quest log, should be considered in future versions to improve user experience.

In conclusion, VR holds significant potential for enhancing career orientation. It provides an immersive and engaging alternative to traditional career guidance methods, offering young people the opportunity to explore professions in a modern way. Regular user testing and early involvement of stakeholders are critical to refining the technology. While VR is promising, ensuring its physical and psychological safety for minors is essential.

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