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Practices and Trends in Continuing Engineering Education at Scandinavian and Mexican Universities

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Summary

This study aims to explain the activities of universities within Continuing Engineering Education (CEE) by conducting a mapping study based on data from different technical universities in the Scandinavian countries and Mexico. The main objective is to explain the patterns related to current CEE practices, the trends identified in cross-collaboration, and the new paradigm for the flow of knowledge between universities, companies, and professional workers.

Keywords: continuing engineering education, educational innovation, lifelong learning, industry 4.0, professional development.

Type of contribution: Research extended abstracts.

1 Introduction

Organisations such as the World Economic Forum (WEF) and the Organisation for Economic Cooperation and Development (OECD) have published international reports related to the future of work, the reskilling revolution, and the relationship between Employment, Skills, and Workforce Strategy for the Fourth Industrial Revolution (Hughson & Wood, 2020; Ratcheva et al., 2020). The conditions of rapid evolution in Industry 4.0 and its accelerated technological advances seem to require more research in CEE in the universities themselves so that graduates develop a lasting culture of lifelong learning (Zhang et al., 2020). The CEE should be considered a great ally to achieve not only the upskilling and reskilling update in the technical and technological competencies of Industry 4.0 but also for the formal and informal training in the skills and competencies that professionals require throughout their engineering careers. Additionally, there is still the unresolved problem of the impact of COVID-19. Post-COVID issues posed new challenges for education in general and severe problems for the CEE (for example, the accelerated implementation of digitised versions of some processes and the difficulty of virtually carrying out specific training) (Nayak et al., 2022). The interest in this work started during the 18th World Conference on Continuing Engineering Education in June 2022, where "A Panoramic View of the State of Continuing Engineering Education in Europe" was discussed and put into perspective, i.e., to Mexico. Thus, the main objective of this study is to describe the different cultures, processes, and CEE approaches, practices, and trends identified in cross-collaboration between universities, companies, and professional workers. The study considered different layers: macro factors (national and international) that refer to other countries and their contexts: labour market and education system; and *meso factors* (learning providers) that refer to the different providers and organisations, considering the management of the programs. The scope of this study does not allow any

analysis of the *micro factors* (individual) that refer to the individual level construct, such as psychological and socio-cultural, demographic, and economic factors. The study considers two Research Questions on the way to identify the patterns related to current CEE practices and trends:
RQ1: What is the current panorama of CEE in countries of two geographically independent regions: Scandinavia (Denmark, Norway, Sweden, Iceland, and Finland) and Latin America (Mexico)?
RQ2: What trends and innovative practices related to CEE are ongoing in those regions?

2 Methodology

The literature non-systematic literature review carried out in the present study is a review that seeks to identify linkages among Higher Education Institutions, industry, and society. The keywords for the search, derived from the RQs mentioned above, were *"continuing education"*, *"continuous professional education"* and *"engineering"*. However, the study limited the search to the Scopus database and the last ten years (2013-2022). As a result, we found only 46 document results using the search term *"continuing engineering education"* and 135 document results using the search terms "continuous professional development" AND "engineering" AND *"computer sciences"*, with the following characteristics:

- Three publications with the European Commission as Funding Sponsor (2016, 2020, and 2021) exist.
- Regarding universities, the TOP 10 were: Oklahoma State University (*n*=9); Aalborg University (*n*=9); University of Johannesburg (*n*=8); Koch Engineered Solutions Institute SM (*n*=7); John Zink Institute (*n*=6); University of South Carolina (*n*=6); University of Limerick (*n*=6); The Open University (*n*=6); Trinity College Dublin (*n*=5); University of Leicester (*n*=5).
- Of the 28 articles published in 2022, 7 are chapters belonging to the book "*Continuing Engineering Education Handbook*" (https://doi.org/10.52305/ZRNH8663).

The data collection resulted from descriptive document analysis, e.g., global, national, and institutional reports and whitepapers. We analysed those documents to identify CEE activities and thus give voice and meaning to the data and further highlight trends and the future of CEE based on the CEE mapping.

3 Mapping of the Scandinavian countries CEE

3.1 Panorama of the CEE in Scandinavian countries

CEE activities across Scandinavian universities are diverse, as the Nordic STEM Report (2021) reflects. We interviewed CEE staff from nine Scandinavian universities in Denmark, Sweden, Iceland, Finland, and Norway, who describe the contemporary practice and imaginaries regarding the future of CE. The number of participants in postgraduate education in Scandinavia is limited. In 2021, 1220 individuals participated in continuing education (CE) in Denmark out of a population of around 5,8 million. Likewise, there has been a tendency to prioritize CE in the humanities and social sciences instead of engineering and natural science courses. When describing the Scandinavian CEE praxis, two organisational approaches emerge. The "open university" (OU) courses are managed centrally and constitute accredited and continuously scheduled classes. The accreditation of the OU corresponds to the European Qualifications Framework (EQF), equalling EQF levels 6 and 7, which is the BS.C and MS.C degree. OU covers MBAs, Diplomas, Open Seat-, Full Time on Part, Time courses, and Single Subjects, partly funded through government funding. This situation reduces the financial burden on the participants but heightens the formal obligations for CEE activities.

Additionally, the requirements depend on national legislation and constitute specifications for admission and conduction of CEE. An example of this is the admissions requirements for an MBA, which is a BSC and two years of work experience, or for the Empty Seat courses, where participants can take up an empty seat for cheap and participate in ordinary BS.C. and MS.C. courses and receive credits if they fulfill the requirements and exams. According to the Scandinavian universities, the problem with OU courses is the limited flexibility due to the formal regulations. Universities bypass these limitations through commercial courses (CC), which

are organised internally at the university or through university external holding companies. Commercial courses are often not accredited or state-funded, but participants or employers finance them. Commercialised CEE includes a range of products such as workshops, single courses, micro-credentials, or MOOCs spanning hours or days, to more extended programs such as commercial MBAs. Besides increased flexibility, universities emphasise the advantage of new revenue through CC. The synergy between BS.C. and MS.C. level and CEE courses is typical for the Scandinavian CEE. Specific for CEE is the use of Problem-Based learning, group work, and utilisation of teachers from industries to ensure that the CEE meets the professional needs of adult learners and companies.

3.2 CEE trends in Scandinavian countries

Looking into the future of CEE, Scandinavian universities believe that CEE will constitute an essential part of the university's activities and business. The fact influences the political discussions, e.g., Aalborg Universities (AAU) strategic agreement with the Danish government, where AAU pledged to provide new CE courses within the engineering field. Academic staff also consider CEE as having a vital role in the future *"[...] maybe in the future we have as many [...] ordinary students as we have continuous learning students*".
Scandinavian universities need better organisational structures, e.g., by creating holding companies, streamlining administrative systems, and implementing new incentive structures. The situation raises a conscious wish to move away from CEE based on the individual employees' passion and playing a minuscule role on an institutional level. Instead, having CEE constitutes a vital role in the university strategy. The interviewed universities agreed on the need for better cooperation between universities and the private and public sectors. The universities wish to utilise a dialogue-based approach to facilitate collaboration through market research, student networks, and courses aimed at adult learners with a non-formal educational background to ensure that CEE reflects professional needs. Finally, the universities underscored the need for flexible CEE activities, making CEE easily accessible for companies seeking a competence boost by implementing digitalization and micro-credentials. There exists an agreement that universities must utilise CEE to facilitate personal development and lifelong learning as in current society, individuals spend evermore years in the labour market "*[...] if we're going to work until we're 70, we have to have a system that can handle 45, 50-year-old engineers coming back and taking a one-year master's degree to reskill because what they studied 25 years ago isn't valid anymore*".

4 Mapping of the Mexican CEE

4.1 Panorama of the CEE in Mexico (Macro Level)

Data for the first quarter of 2022 from the National Occupation and Employment Survey (ENOE) shows that the number of employed professionals in the country is 10.5 million. Of the total population in Mexico, 237 thousand 617 students are currently studying a specialty, master's degree, or doctorate, according to data from the National Information System of Educational Statistics in Mexico of the federal Ministry of Public Education. According to the Organization for Economic Cooperation and Development (OECD), in Mexico, there are about 6.6 million people, representing 0.7 percent of the total population, who have a master's degree, and about 400,000 have a Ph.D. degree, representing 0.1 percent of the total population. Master's degrees in business or MBA are in great demand, so there are different rankings for this type of study. To be considered among the most prestigious and significant rankings worldwide, business institutions must have accreditation from the Association to Advance Collegiate Schools of Business (AACSB), the Association of MBAs (AMBA), or the European Quality Improvement System (EQUIS). The rankings evaluate the school based on its students' results at the end of their studies. It is possible to review the methodology of each ranking in detail on the official websites of said publications. Elements such as the requirements for the selection of students, and their average GMAT scores, salary increase, job growth and success, networking, and entrepreneurship index, perception compared to other business schools, consider the quality perceived by recruiters, and the return on investment against the cost of tuition, among others. Only two Mexican

Institutions belong to the QS Global MBA Rankings, Latin America 2022: EGADE Business School (with an overall score of 65.3) and IPADE Business School (with an overall score of 50.2).

4.2 The case of Tecnologico de Monterrey and CEE trends in Mexico

EGADE (Graduate School of Business Administration) Business School is part of the 1% of business schools worldwide that have obtained triple International accreditation: it has been evaluated and endorsed by the three prominent accreditation organisations worldwide (AACSB, AMBA, and EQUIS). EGADE School currently has three internationally positioned programs in the main rankings: the *Full-Time MBA in Innovation & Entrepreneurship*, the *Master's in Finance*, and the *Master's in Business Management*, which was ranked #1 in Mexico and LATAM for the second consecutive year. Regarding the CEE options at Tecnologico de Monterrey, the program most required by engineers (minimum two years of professional experience) is *The Master's in Engineering (MCI),* which seeks to face the current challenges of a global society: overpopulation, hyperconnectivity, and the irreversibility of climate change and loss of natural resources; and *The Master's in engineering management (MEM)* that is aimed at engineers employed in large multinational companies and seeks to develop communication, leadership, and project management. In the last admission of EGADE Business School students, the master's degrees in business had the following distribution of students: MBA, 39% of engineering students; MAF students, 33% of engineering students; MBD, 49% of engineering students. One of the trends integrated into the master's programs at Tecnologico de Monterrey is the incorporation of courses, micro-courses, and webinars by professors on engineering topics such as Logistics Trends and Supply Chains, as well as Machine Learning Models in risk management in the MBA and the MAF; and the issue of the Impact of Analytics on the Transformation of the Company, in the MBD. These topics are complemented by carrying out real projects with companies where students put into practice the knowledge taught in the classroom. It is interesting to highlight the inclusion of technologies for learning through educational innovation in various courses, alternative learning such as cybersecurity in business, virtual introduction to Virtual Reality in industry, and introduction of *blockchain for business* to reinforce knowledge and even obtain a certificate.

Additionally, a virtual campus in the metaverse opened last year. Considering the Meso level, some of the most innovative CE trends we can mention are related to the aspects of didactics and the modular structure of the programs. Two examples of the Tecnologico de Monterrey educational strategies are Massive Flexible Digital Masterclass Model (MFDM) and distance programs with LIVE interactions. MFDM follows a masterclass approach using challenge-based learning and flipped classrooms as pedagogic techniques to promote the development of competencies and skills. LIVE are online programs that combine two types of learning, synchronous and asynchronous.

5 Findings and Discussion/Conclusion

Though there has been public recognition of the need for lifelong learning in engineering education, CEE still needs scholarly attention. The purpose of this study was to deliver a mapping of contemporary practises and imaginaries regarding the future of CEE in Scandinavia and Mexico. Firstly, it is necessary to emphasise the different educational traditions on a macro level. In Scandinavia, CEE encompasses formal and informal postgraduate education, whereas CEE constitutes courses at MA/Ph.D. level in Mexico. This difference in conceptualization may reflect that getting a tertiary education is more widely spread in Scandinavia than in Mexico, creating a different understanding of CE (UNESCO Institute for Statistics, 2016). When researching CEE, it is necessary to keep this conceptual discrepancy in mind. Financing and administration of CEE is another point of difference at a macro level. CEE in Mexico is developed as a part of the university focal point and financed by the participants, and the welfare state partly subsidises the CEE in Scandinavia.

To attain greater flexibility, Scandinavian universities look to developing CEE, which places the financial burden on the learner but enables more flexible CEE initiatives. The administration and organisation of CEE still constitute a minor role compared to regular BS.C. and MS.C. courses in Scandinavia. However, the interviewed universities articulate desires towards better administrative and incentive structures, ensuring

that CE will make up a more significant role on an institutional level in the future. Although CEE refers to two different levels of education across Scandinavia and Mexico, the mapping reflects a common goal with the development of CE in engineering. Not only does CEE secure upskilling for the individual learner and companies, but the significant role of CE in humanities, social sciences, and business may point towards a need for non-traditional competencies, such as business and communication skills. Those options are ideal for individuals seeking professional development in engineering. This change in professional profile through CEE will be examined in future work by the authors of this paper. At a meso level, both Scandinavian- and Mexican technical universities implement problem- and challenge-based learning to ensure the professional relevance of the courses offered to the participants. Collaboration with corporations is put forward as the way to ensure the relevance of CE in the upskilling of engineers and create the possibility for corporations to utilise CEE to implement problem-solving- and collaboration skills as a part of a professional profile. The need for collaboration put forward new demand for flexible CEE courses, fitting the schedule of companies and working adult learners. Both Mexican and Scandinavian universities put forward the use of digital- and blended learning and short formal and in-formal courses, such as micro-credentials, workshops, and flexible masters, to meet the demands for flexibility. At the Micro level, we observe that the tradition of "social purpose," in which CEE is a lever for empowerment and emancipation, has passed to a *"learning to earn money",* in which CEE is a lever for economic growth and global competitiveness. Perhaps this is why one of the trends in continuing education for engineers is to seek to develop knowledge and skills in business issues to complement the technical knowledge learned at the university. In that way, workers can potentiate opportunities to occupy senior management positions in corporate or possibly detonate their enterprises to generate jobs.

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