Chapter 13
Focus on Skills for a Circular Built Environment in a New Curriculum Development

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Abstract Despite the increased research regarding the sustainability transition towards the circular economy (CE) model, the existing literature on adopting and implementing the CE concept reinforcing educational approaches in secondary education seems limited. Considering the current challenges and the critical role of education to empower built environment management students to explore new paths of sustainable development and grow into active citizens, conscious producers, and consumers, this contribution investigates new ways of effective tools for teaching CE and sustainability concepts. The literature review has revealed a research gap regarding the formulation of educational approaches to effectively support CE concepts for higher education students, particularly in Swiss Facility Management education. The paper describes and critically discusses how an introduction of CE to master-level students to the circularity and sustainability perspective, prepare them to build prosperity, and act circularly in the future. A list of skills is presented which can be bundled into one holistic education. This provides valuable information for developing suitable programme in Higher Education which aims at the use and development of competitive methods and solutions for managing existing and new buildings that will contribute to lowering greenhouse gas (GHG) emissions related to the production, use, management, and demolition of architecture in a life-cycle perspective should be based on these skills.

Keywords Circular economy · Real estate · Facility management · Education programme

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13.1 Introduction

Along with the European Union, Switzerland has committed itself to limit a global increase in temperature to 2 °C by 2050. On a global scale, the ambition is to reduce GHG emissions by 2050 to two tonnes CO_2-equivalents per capita and year if the concentration in the atmosphere is to be stabilized at 400–450 ppm CO_2-equivalents by the year 2100. The current Swiss average is 6 tonnes CO2-equivalents per capita per year [1].

The world population is constantly growing and is confronted with new needs for new buildings. This puts an enormous strain on our environment and our resources. The construction industry is responsible for approximately 33% of greenhouse gas emissions, 40% of waste generation and 40% of material consumption [2, 3]. Action plans for the Circular Economy (CE) include the gradual decoupling of economic activity from the consumption of finite resources and giving waste a second life. Recent efforts to take more concrete action include, above all, the development of new standardization activities such as CEN/TC 350/SC 1—"Circular Economy in the Construction Sector" and ISO/WD 59004—"Circular Economy" [4, 5].

The application of CE principles in real estate, building design and use (adaptability, durability, waste reduction and quality management) is mainly focused on new buildings where circularity can be embedded and enabled. Conversely, circularity has not been defined in the context of existing buildings [6].

CE must be viewed as a business strategy which adds value, not just a waste management or design strategy. Optimizing the use of buildings should also be brought into focus, rather than just considering them as potential material banks where components and materials can be recovered, reused, or recycled for new construction [6, 7].

IPCC (2007) and a study from Enkvist et al. (2007) report point to measures in the building sector as being the most economical, when compared to other important sectors [8, 9]. This reduction potential is "spread over hundreds of millions of individual buildings, each one presenting multiple and very diverse types of interventions" [10]. In addition, energy use in Swiss buildings contributes little to global GHG emissions due to extensive use of hydropower electricity [11]. However, real estate and the built environment exert a large influence on GHG emissions by means of transportation and land use planning, lifestyle and consumption, development of better materials and components, and life-cycle management of natural resources. The social dimension of sustainability is put more in focus. However, the development of a well-functioning society that provides a high quality of life for all citizens but only emits an average of two tons of CO2-equivalents per capita per year forms a huge challenge for all professions, not least in the building sector.

Despite these challenges there is need for a development of holistic built environment management skills for future workforce that can lead society to a more sustainable use of resources and adapt to future climate challenges. This linear model of resource consumption we are all used to has created an economy that largely depends

on energy use and other resources, resulting in climate change, pollution and depletion of natural resources. Moving towards a CE requires changes in attitudes and behaviors, adopting a new way of thinking and developing new competencies and skills.

> How should educational institutions prepare their students for this reality? Which skills should we educate real estate and facility managers, architects, engineers and other building professionals to be able to contribute to this political goal in an optimal manner? Given the still ambiguous definitions and meanings of the concept, education for a CE plays a key role, and how we can teach and learn remains a challenge. New theories on how the CE concept can be applied to promote sustainability should be developed

13.2 Literature Review

The programmes that were analysed can be found on the homepage of European Real Estate Society (ERES): https://www.eres.org/index.php/activities/edueres [12]. Real estate programmes are being offered by a wide variety of universities across Europe. The list contains an overview of all Bachelor, Master, and postdoctoral programmes with a real estate focus. The list was downloaded in March 2022 and subsequently analysed. Details were recently published, and details of the analysis results can be found in Wrase et al. [13]. 374 programmes were analyzed in this study. To conclude whether there is a link for these sustainability-dimensions in the education programmes at all, a chi-square test of independence was performed [14]. The word "circular" was found only in two module designations: one made by the College of Estate Management in the M.Sc. in Real Estate and the other found in the description used for the M.Sc. in Real Estate and Facility Management by the Zurich University of Applied Sciences [13]. Real Estate Management is the most frequently mentioned discipline in the higher education programmes. However, the question of whether learners are taught interdisciplinary in all disciplines related to the real estate life cycle, only the ZHAW M.Sc. in Real Estate & Facility Management programmes and the College of Estate Management with its M.Sc. Real Estate score higher [13]. The word "Sustainability" and the dimensions "Processual" (Knowledge of real estate management, facilities management, architecture, and civil engineering as the base layer of the understanding of processes around the lifecycle in real estate), "Economical", "Ecological" and "Empirical" are significantly presented in the analysed higher education programmes in real estate [13]. However, there seem to be gaps between the content of the courses and the dimensions "Technical" and "Social". University programmes provide education not in all the described dimensions. The dimensions "Processual", "Economical", "Ecological" and "Empirical" are presented in the higher education programmes in real estate, whereas there is a strong correlation between these dimensions and the content of higher education programmes in real estate [13]. Remarkably, the dimensions "Social" and "Technical" are not presented in the higher education programmes in real estate.

13.3 Curriculum Development

According to this analysis, university curricula of European higher education programmes seem to focus to some extend on the required content to prepare graduates for real estate sustainability management, but rarely integrate all the required knowledge about the whole lifecycle of a building set in the megatrend sustainability towards a circular built environment. While there are studies that compare the content of courses [15], the focus of these studies is (supposedly) within one discipline in real estate [16]. In this study we applied the framing method proposed by Lahtinen and Yrjölä (2019) [17]. This study is in line with the logic of the dimension "social", "Economical, "Processual", "Technical", "Empirical" and "Ecological" similar to Babosa and de Oliveira (2020) for Managers [18]. In turn we examine the interdisciplinary share of architecture, engineering, facility management, and real estate management in European higher education programmes. Sustainable management requires an understanding of all the disciplines and related skills associated with the real estate lifecycle.

13.3.1 Future Workforce for Circular Economy

One could argue that being skilled in all disciplines or knowledge dimensions is not essential. However, a study analyzing 600 job advertisements in the real estate sector revealed that most of the dimensions listed are highly sought after [19]. Specifically, the "social" dimension appears to be in exceptionally high demand. In contrast, this study indicates that real estate programs tend to underrepresent social competencies. It is challenging to track the extent to which students are socially empowered.

Employability is an important criterion for testing training programmes for their raison d'être [20]. However, due to the macroeconomic situation, most real estate markets worldwide are still in a booming or at least preferable phase [13]. Workers in the field of real estate have been in demand for decades now. However, this positive development obscures the fact that companies are not only looking for real estate experts, but also those who are knowledgeable in areas related to the real estate lifecycle and can help manage and lead the sustainability transformation. Overall, Wrase et al. found an indication that there are still deficiencies in higher education programmes in real estate when it comes to whether to empower students in sustainability transformation [13].

13.3.2 Future Skills

Bearing in mind the findings of this analysis, the next important step towards introducing sustainability and circular economy management in real estate at higher

education level would require a new set of skills. As stated above, the understanding of the real estate lifecycle and the inter- and transdisciplinary perspective of the different dimensions of sustainability taught in higher education can lead the future workforce to a holistic approach of sustainability and empower them to transition towards a circular economy of the built environment. The main scope of the programme must therefore relate to the general issue of sustainability including environmental as well as economic and social focus. The transformation of the existing real estate market is the most important step in developing an environment that fulfils the main key goals [21].

(1) Climate change mitigation, (2) climate change adaptation, (3) sustainable use and protection of water and marine resources, (4) transition to a circular economy, (5) pollution prevention and control, and (6) protection and restoration of biodiversity and ecosystems. Not mentioned are general skills related to "social, "processual" and "empirical". These will be assumed to be existing as well without detailing it here.

Considering the high demands of transdisciplinary skills to address the sustainable transformation and in particular the circular economy, the curriculum must thrive to educate built environment workforce on the:

- Sustainability consequences of transformation
- Quality of real estate concept with respect to circularity
- Quantity of real estate quality and circularity potential
- Quality of circularity concept
- Management consequences of circularity concepts.

Skills related to Sustainable Finance and Governance

The students need to be enabled to adopt a critical and reflective attitude towards today's sustainability practices throughout their studies. A well-founded introduction to the history of sustainability discourse and to the relevance of different sustainability concepts for the governance of real estate and facility management builds the basis. Then, skills of real estate-related financial and economic knowledge such as the time value of money, capital market theory and capital costs, financing and capital structure, company value, investments and risk management are needed. One focus is on the question of how factors from the areas of environment, social, and governance can be included. This enables students to are examine and evaluate most important players in the field of sustainable finance, green financing instruments, sustainability ratings and political influences.

The skills further base on knowledge of History-based overview of sustainability concepts and their different ethical implications (focus on sustainability and climate ethics). This provides insights to the relevance of different sustainability concepts for the governance of real estate and facility management as well as standard corporate finance concepts that also apply to real estate financing. It provides an understanding of the time value of money, knowledge of capital market theories and how financial markets work. This enables students to participate in discussions about capital budgeting considerations. Other skills include financial modelling and valuation and

estimation of the cost of capital, definition/information on the origin of sustainability in finance and discussion of the relevance of sustainability for various actors in the financial sector. Finally, options for assessing and quantifying sustainability for the critical assessment of non-financial properties of projects, products and companies, followed by insights into how sustainability aspects can be integrated into common corporate finance instruments such as discounted cash flow. The skills include understanding of sustainability and financial analysis and ability to participate in discussions of the relationship between sustainability and profit-oriented factors, including sustainability aspects in various forms of financing and investment processes.

Skills related to Strategies in Sustainability

A comprehensive understanding of sustainability and its application to the area of real estate and facility management is conveyed. This includes ecological, economic and social aspects as well as consideration of the entire surrounding ecosystem. Skills further include presenting and analyzing common sustainability planning, certification, monitoring and reporting as well as methods for procurement and quality assurance of construction and FM services and name their advantages and disadvantages as well as convey the implementation in selected strategies.

The skills include areas for influencing the sustainability of buildings, districts and cities over the lifecycle with a focus on the transformation of existing structures. It enables the translation of abstract sustainability concepts into concrete sustainability and investment strategies and development of corresponding (quantifiable) goals and measures in a real estate-related context. Economic advantages and disadvantages as well as conflicting goals and synergies of different sustainability goals need to be presented and sustainability rating systems and criteria, sustainability planning, certification, implementation, monitoring and reporting concepts and tools introduced. The skills further include understanding of methods for the sustainable procurement and quality assurance of real estate services over the entire life cycle and offers opportunities and limitations of the tools, instruments and methods and to be discussed from the perspective of research.

Skills related to Circular Economy Management

The real estate industry is responsible for tying up many resources, sometimes for decades. To deal with the limited resources available in an economical and environmentally friendly manner, the change from linear to circular real estate management and sustainable building design, use and management is essential. The sustainability and circularity assessment is another element for assessing, (further) developing and applying the impact of the built environment on the climate and nature, also against the background of corporate, owner and user responsibility.

The necessary skills to handle these perspectives on converting the existing linear economic systems into circular economy systems include knowledge about circular economy strategies and design options as well as challenges for circular economy systems in the real estate context.

The understanding of building as a layered model—system separation in building construction and possible future Closed loop systems of the future (energy or material focus?) as well as principles of circular planning/building/use/operation are demanded skills. Further skills include methodological approaches and benefits of environmental assessment (also of buildings), impact on carbon accounting at portfolio level as well as cost accounting of waste avoidance and sustainably optimized dismantling in a quantitative manner. Further, basic understanding of enhanced models as "From waste to recyclables: recycling and recyclables management methods", "Urban Mining—Use today's inventory as a material reserve", "the Madaster vision: materials with identity" are needed and build the basis for developing own sustainability and circularity certificates.

Skills related to Built Environment Transformation

The stock of buildings and infrastructure outweighs the volume of new construction projects. The challenge lies in needs-based, multi-factorial, optimized modernization and/or conversion. In addition to the conventional developer aspects, sustainability, lifecycle and public concerns must be understood in a holistic solution. The transformation of the built environment is a complex task that indicates higher demands on real estate expert skills: The projects derived from a strategy and to be developed should enable the economic, ecological and social feasibility of sustainability at management level and be able to achieve implementation and conversion.

The necessary skills include the knowledge of classification of system boundaries of buildings, properties, areas, etc. It further includes peculiarities of

- re-development/transformation of existing buildings
- project management during re-development.

Then, it requires the appraisal of socio-cultural and institutional aspects in development, discussions of areas influencing sustainability in real estate and obstacles in practice; portfolio versus area perspective; Perspective space and infrastructure, but also people and organization.

The skills must provide a classification of digital (communication) options to be able to communicate and present complex issues in a way that is appropriate for stakeholders followed by discussion of multidisciplinary decision criteria in re-development. It also includes planning and construction accompanying facility management in re-development, risks in re-development, and the integration and implementation of economic, ecological and social sustainability using digital methods and tools. The students develop presentation skills to communicate their project work in a simulated management board meeting in the "Ethics, Leadership, Change" module.

13.3.3 Interdisciplinary Students and Staff

To co-ordinate professions, we need to co-ordinate education. Therefore, students need to be trained in interdisciplinary teams and by an interdisciplinary teaching staff. In this manner, the students get to know various distributions in responsibilities and tasks throughout the design process and learn in practice the integrated design strategies that can ensure usability and synergy of their design project with its surroundings and users.

The teaching staff ideally consists of a mixture of professionals from built environment practice and research to provide the students with professional perspectives from a wide variety of actors ranging from the latest scientific discoveries to actual management experiences. The fixed core of teachers, extended by invited guest teachers, present the students with a curriculum that aims at making maximum connections among the different institutions and professions.

One of the most important insights the students learn is the importance of building and managing interdisciplinary teams. Given the complexity of modern-day real estate tasks, it is an absolute necessity to complement one's own expertise with others into a constructive co-operation. While real estate and facility management students still occasionally consider interdisciplinary co-operation as unnecessarily time-consuming and frustratingly reducing their own chance at achieving a high grade, the best manner in which to counteract these prejudices is to guide the students towards a positive experience and give them time to recognize and respect the contribution the other profession's expertise can make to create a high-quality design project [22].

13.4 Discussion

For future built environment professionals to be able to translate the climate and resource challenges in society into a fitting form of the built environment, they need to not only understand the use and development of sustainable building methods and solutions, but, above all, to know how to integrate this knowledge into their everyday decision-making routines. They need to become creative, active professionals who can keep themselves updated on relevant theories, understand how they interact, and currently update their design routines according to this new knowledge. In this manner, the future workforce gets familiar with different ways in which to work professionally with the built environment and get a good foundation to mix and recombine the different elements into a meaningful whole.

All Real Estate and Facility Management professionals need to be able to handle challenges related to climate change and resource scarcity, and realise that this reality affects professional ethics, regulations and skills required in practice and research. Ever more strict building regulations require for even 'ordinary' transformation projects to stress low carbon emissions and high energy efficiency. As professionals,

the students will be expected to not only work on projects with a set of measures and targets that put energy and greenhouse gas emissions at the heart of their performance, but also be able to negotiate the performance targets of the project with the building owner and real estate team while thinking about the long-term transformation of society and the development of innovative strategies.

In addition to management experience and theory, evaluation and reflection form an important part of the students' learning environment. To transform to a well-functioning real estate and built environment, the students need to build a thorough knowledge of a project's local physical and social site as well as its cultural history and recognize the consequences of the existing structures and dynamics for the design of their project. They need to know how to integrate sustainability issues with circularity models. The real estate industry is still in the beginning of recognising the long-term goals of CE.

It became obvious that a main task of future real estate and facility management research should focus on quantifying real estate qualities and qualifying facility management quantities with respect to circularity and sustainability. This must begin with the development of a common vision for real estate and facility management professional. The skills structure needed for these workforces support group work in different transformation stages that will enable participants to develop energy efficient transformation solutions and to effectively communicate them between the different domains (real estate and facility management).

The list of skills illustrates the importance of the questions a real estate and facility management professional should ask at the start of, during and after having finished a transformation project, to affect the building and environmental programme and the transformation's consequential performance. It also teaches the students how to assess which measures work best under given circumstances within a given budget, the different outcomes of various contracting frameworks and the negative consequences of types of actors not being engaged in the project from day zero.

13.5 Conclusions

We proposed a list of skills focusing on different aspects of the transition of the built environment towards circularity. This proposed list of skills for a Master course in Higher Education equips the students with extensive knowledge and experience that prepare them for a challenging, rapidly changing profession. There is a dire need for a real estate policy that encompasses the new technological opportunities at the same time as improving quality of life and circularity whilst reducing environmental impact. The development of a CE is pre-requisite for a zero-emission built environment. It creates a new physical framework for large parts of society, reflecting cultural values, existing structures, and the new layers of the future. In that sense the concept of CE challenges the current linear model of production and consumption, exploiting the planet's raw resources, manufacturing and using the product, and disposing of waste. That is a conceptual change in education from the traditional

linear to the circular model of production and consumption. That involves educational curriculum improvements about resource reuse, recycling, sources prioritization, and their efficient use.

Theoretical challenges are plentiful when recognizing that the physical state of a building is the result of the complex interaction of a very large set of physical components. The integration of these interactions on behavioral simulation poses major modeling and computational challenges that must be discussed. Its ability to deal with the resulting complexity of scale and diversity of component interactions has gained building simulation a uniquely recognized role in the prediction, assessment, and verification of real estate performance. A real estate industry that does not look for definitive solutions and permanent projects, but for structures that can continue to adapt to the need of society and citizens: More built environment for less CO_2.

Green jobs and green entrepreneurship have a future in a modern form of economic activity that responds to business needs for profitability and growth, but at the same time considers the environmental limitations, treating circularity as an opportunity and not as an obstacle. We noticed that more and more real estate companies are seeking to help environmental protection and limit climate change by investing in the research and development of green technologies and practices. Therefore, to serve the new vision for society and the economy by respecting the principles and values of circularity and sustainable development, the need for research in education and the essential contribution of the educational system, of the formal, informal, and non-formal education, occurs. We hope we contributed to the current state-of-the-art on educational policies regarding the role of circular economy in sustainable development, to share a good and innovative practice of CE and sustainability teaching and learning in different countries, to open and encourage a critical discussion on the topic.

We recommend practical educational strategies hoping (i) to encourage teachers to adopt innovative teaching methods and share good practices of the CE teaching and (ii) to urge education policymakers to integrate the CE vision into school curricula.

References

1. Bundesamt für Umwelt (Bafu) (2022) Die Schweiz senkt die Treibhausgasemissionen, https://www.bafu.admin.ch/bafu/de/home/themen/klima/dossiers/klimakonferenz-cop21-von-paris--abkommen-ueber-die-international/die-schweiz-senkt-dietreibhausgasemissionen.html#-1491583269. (in German: Switzerland reduces its GHG emissions). Last Accessed 08 Feb 2023
2. Hossain MU, Ng ST (2018) Critical consideration of buildings' environmental impact assessment towards adoption of circular economy: an analytical review. J Clean Prod 205:763–780. https://doi.org/10.1016/j.jclepro.2018.09.120
3. Ness DA, Xing K (2017) Toward a resource-efficient built environment: a literature review and conceptual model. J Ind Ecol 21(3):572–592. https://doi.org/10.1111/jiec.12586
4. CEN/TC 350/SC 1—Circular economy in the construction sector. CEN
5. ISO/WD 59004—Circular economy. International Standardization Office. ISO

6. Kyrö RK (2020) Share, preserve, adapt, rethink–a focused framework for circular economy. IOP Conf Ser Earth Environ Sci 588:1–8. https://doi.org/10.1088/1755-1315/588/4/042034
7. Adams KT, Osmani M, Thorpe T, Thornback J (2017) Circular economy in construction: current awareness, challenges and enablers. Waste Resour Manag 170:10
8. IPCC (2007) Climate change 2007: contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, pp 746–807
9. Enkvist P-A et al (2007) A cost curve for greenhouse gas reduction. McKinsey Q 1:35–45
10. Cheng C et al (2008) The Kyoto protocol, the clean development mechanism and the building and construction sector. In: A report for the UNEP sustainable buildings and construction initiative. United Nations Environment Programme, Paris, France, p 88
11. Jones P et al (eds) (2009) European carbon atlas. In : Low carbon urban built environment. The Welsh School of Architecture, Cardiff, p 220
12. ERES European Real Estate Society (2022) Real estate educational programmes, https://www.eres.org/index.php/activities/edueres. Last Accessed 13 Mar 2022
13. Wrase I, Haase M, Wang-Speiser Z (2023) Towards a circular built environment–focus on the new M.Sc. program in real estate and facility management. Front Sustain Sect Circ Econ 4. https://doi.org/10.3389/frsus.2023.1163394
14. Cohen J (1988) Statistical power analysis for the behavioral sciences. Taylor and Francis, New York
15. Keramitsoglou K, Litseselidis T, Kardimaki A (2023) Raising effective awareness for circular economy and sustainability concepts through students' involvement in a virtual enterprise. Front Sustain Sect Circ Econ 4. https://doi.org/10.3389/frsus.2023.1060860
16. Kans M (2021) A study of maintenance-related education in Swedish engineering programmes. Educ Sci 11(9):535. https://doi.org/10.3390/educsci11090535
17. Barbosa MW, de Oliveira VM (2021) The corporate social responsibility professional: a content analysis of job advertisements. J Clean Prod 279:123665. ISSN: 0959-6526. https://doi.org/10.1016/j.jclepro.2020.123665
18. Lahtinen S, Yrjölä M (2019) Managing sustainability transformations: a managerial framing approach. J Clean Prod 223:815–825. ISSN: 0959-6526. https://doi.org/10.1016/j.jclepro.2019.03.190
19. Wrase (2022) Real estate consideration in education. Submitted
20. Witt E et al (2013) Towards a frame-work for closer university-industry collaboration in educating built environment professionals. Int J Strateg Prop Manag 17(2):114–132
21. Envoria (2023) EU taxonomy overview, https://eu-taxonomy.info/info/eu-taxonomy-overview. Last Accessed 30 Mar 2023
22. Nicol D, Pilling S (2000) Architectural education and the profession. Preparing for the future. In: Nicol D, Pilling S (eds) Changing architectural education. Towards a new professionalism, Spon Press, London, pp 1–26