SirkTRE's Evolution or Circulution?: Diverse Pathways of Circular Systemic Solutions for a Net-Zero Timber-Built Environment

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1 Introduction

As the planet faces escalating environmental challenges, particularly in the realm of the built environment, the urgency to transition toward zero waste and zero emission strategies is more critical than ever. These strategies are essential to mitigate the profound ecological footprint of human activities, aiming to alleviate the environmental burdens we impose on our planet. Within this pressing context, the circular economy (CE) model emerges as a model of transformation, advocating for the establishment of sustainable, self-sufficient systems that significantly reduce environmental impacts while simultaneously fostering economic resilience. This model, fundamentally, is about creating an economic system dedicated to the elimination of waste and enabling the continual use of resources. It encompasses an extensive array of practices designed to extend the lifecycle of materials, promote efficient recycling and reuse, and decisively reduce the extraction and consumption of resources [1].

Introducing the 'Circulution' concept in this discourse underscores the application of CE principles specifically within the timber and construction sectors. This novel term encapsulates the necessity for both evolutionary and revolutionary approaches in the quest to foster a Net-Zero built environment. 'Circulution' embodies the dual pathways of innovation within the construction sector concerning timber use: evolution, which indicates a gradual, continuous development of sustainable practices and technologies; and resolution, which signals a significant, transformative shift toward groundbreaking innovations. This dual approach underscores the necessity for comprehensive and multifaceted strategies to accelerate the transition to a Net-Zero built environment, blending incremental improvements with radical, systemic changes.

The transition toward a CE necessitates profound shifts not only in our production and consumption patterns but also across the entire value chain. It demands the adaptation of market strategies, the innovation of business models, and a thorough reevaluation of management strategies to align with the diverse visions of stakeholders involved in the circular built environment. However, the concept of circularity is rife with contestation, characterized by diverse interpretations and expectations among stakeholders [2]. This contested nature of circularity highlights the importance of stakeholder expectations and consumer perceptions as pivotal elements that can significantly accelerate the transition process to a robust circular economy but can also hinder it if there are no shared visions and values

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[3]. Transitioning to new business models involves redefining value propositions for customers and reconfiguring value chains with partners to create and capture new value, indicating a strategic overhaul of traditional business practices [4, 5]. Achieving a true 'circulution' within the timber building industry necessitates the integration of governance structures, innovative business models, and active policy interaction. It highlights the need for collaboration among a multitude of actors across different sectors and the adoption of collective action. A CE organization cannot operate in isolation across the product or service lifecycle; previous research highlighted that it must engage with its stakeholders and comply with existing regulations, embodying the essence of collective action [6–9]. Observing a CE organization unfolds as an exploration of a collective project, involving regulations, practices, tools, devices, and the amalgamation of diverse values held by stakeholders. This collective endeavor prompts a deeper inquiry into the fundamental reasons behind the existence and emergence of enterprises and, more broadly, into the dynamics of collective action in the circular economy.

The Norwegian SirkTRE project (2022–2025) is at the forefront of pioneering a CE within the timber construction sector, with a clear mission to transform the way timber is utilized, reused, and recycled in the building industry [10]. The SirkTRE is co-funded by the Norwegian Green Platform initiative, which provides funding for enterprises and research institutes engaged in green growth and restructuring driven by research and innovation. SirkTRE was funded to address critical environmental challenges in the construction sector by promoting circular economy principles, particularly focusing on timber, to mitigate the ecological footprint of human activity. There are five focus areas, which are divided into 24 different work packages (Fig. 1). The five focus areas are wood-based plates and connections (SirkRESSURS), solid wood (SirkHELTRE), demonstration projects (SirkREALISERING), digital technology (SirkTEK), and standards (SirkINN). SirkINN envelopes also required coordination, communication, dissemination, and

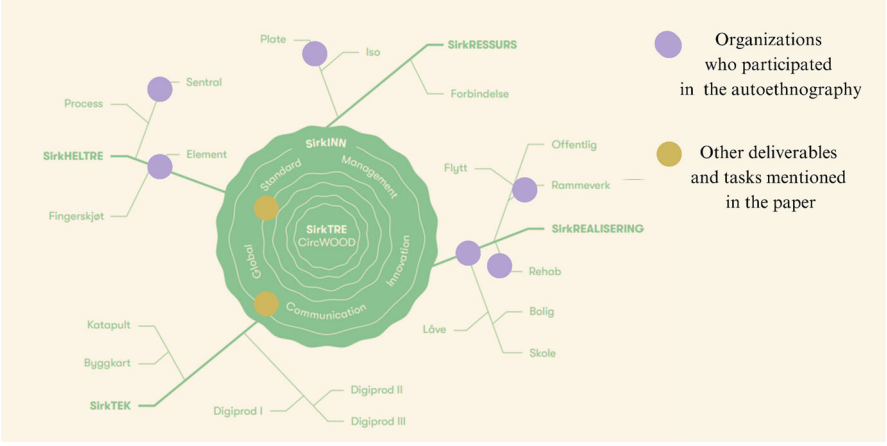

Fig. 1 The structure of SirkTRE, original design by the SirkTRE consortium, adapted by the authors

exploitation activities. The consortium counts almost 30 Norwegian industry partners from across the whole value chain (forestry, wood waste logistics, storage, prefab construction, product manufacturers, and architects), including a cluster organization, which represents more companies. Mostly only one to two partners are allocated to a work package. This means that SirkTRE has overall project objectives, but also envelopes dozens of sub-objectives (linked with the 24 different work packages). Most focus areas are managed by the project manager, Omtre AS, a startup that was founded to address some of the missing roles and responsibilities identified in the proposal writing stage in 2021.

However, this study was inspired by previous research [6–9] highlighting the necessity of stakeholder orchestration and compliance to achieve circularity in the construction sector. Additionally, it was driven by the recognition of the need for a midterm evaluation to assess hypotheses regarding collective learning and coordination, particularly in business model development and upscaling, given the initial structural disconnection of the project. One hypothesis posits that learning by doing addresses these less favorable initial conditions, while another suggests that the absence of companies providing digital enablers may hinder progress. Originally, the project aimed to have another Green Platform project complementing the focus on wood technology and architectural solutions in SirkTRE. Thus, the study serves as a reflective assessment for partners to evaluate necessary actions in the project's final phase, both internally and externally.

Hence, the main objective of this study is to analyze the evolution and resolution pathways within the project, focusing on its endeavor to establish a circular timber value chain for the construction sector and to identify policy recommendations, but also for the ongoing project. This objective will be addressed through the following research questions: How do the evolution pathways pursued by SirkTRE contribute to the transition towards a Net-Zero built environment? What practical strategies and interventions are employed by the SirkTRE consortium to implement circular systemic solutions within the construction sector, particularly concerning timber use? What are the main barriers, success factors, and key learnings derived from the SirkTRE project's implementation so far (in the first two years), and how do they inform future initiatives aiming to scale up circular systemic solutions within the construction industry?

2 Methodology

2.1 Analytical Framework: Evolutionary Lens, Termed 'Circulution'

As aforementioned, we propel our own evolutionary framework, 'circulution'. We build further on other existing evolutionary or economic evolutionary geography frameworks that have been used to analyze the governance of resources in the

transition toward a circular economy in various regions (e.g [12]). Marjanović and Williams [12] explored the uptake of circularity in a Dutch and Finnish region: Evolutionary Governance Theory provides a dynamic lens to understand the evolutionary trajectory of circular systemic solutions, capturing both gradual evolution and transformative shifts akin to the concepts of evolution and resolution highlighted in the title. By emphasizing the continuous interaction among actors, institutions, and discourses, Evolutionary Governance Theory offers insights into how governance structures and strategies evolve over time. However, the lens that [12] uses is based on observations of other phenomena, not on circular economy transitions per se. This conference paper takes a more grounded approach and, through autoethnographic investigation of a specific case (see Sects. 2.2. and 2.3), focuses on economic, political, technological, and strategic factors influencing the scalability and implementation of circular systemic solutions. In this way, we develop our own evolutionary framework, which we term 'circulution', to explore how these varied resources are orchestrated to facilitate the adoption of circular wood solutions in construction.

2.2 Methodological Choice: Collaborative Autoethnography

We opted for a collaborative autoethnographic approach to delve into the multifaceted dynamics of the SirkTRE project. This methodological choice allowed us to blend personal experiences, insights from interviews, and reflections on collective actions within the project context. By engaging with various stakeholders and social scientists involved in the project, we aimed to co-create a rich narrative that captures the complexities, challenges, and successes of SirkTRE's journey towards circular systemic solutions. Through this collaborative endeavor, we sought to provide a holistic understanding of the project's evolution and its implications for sustainable transitions in the timber-built environment. Reflecting on the collaborative autoethnographic approach employed in this study, several strengths and limitations come to light. One notable strength is the rich and nuanced understanding of the research subject derived from the integration of multiple perspectives and experiences. Additionally, the collaborative nature of the approach fosters a sense of ownership and empowerment among participants, enhancing the credibility and relevance of the research findings. However, the approach also presents certain limitations, including the potential for bias or subjectivity inherent in self-reflection and interpretation. One mitigation measure was the omission of solutions developed by Organization G, which was the organization of the first author, which means less representation of, for example, SirkTEK. The focus of this chapter was on external challenges, but there were also hints of internal challenges, for example, lack of entrepreneurship/intrapreneurship in the involved organization and lack of internal resources (financial, competence, capacity, etc.) to scale up inventions to innovations. The investigation of internal challenges might be rather done by researchers in outsider roles. Moreover, coordinating multiple voices and viewpoints in the

analysis process can be complex and time-consuming, requiring careful navigation of interpersonal dynamics and power relations. Due to its autoethnographic approach, his study focused on one consortium but did not compare with other consortia focusing on other products, services and materials, which omits insights about other reasons hindering innovation.

2.3 Data Collection and Validation

This study utilized a multiple-case study approach [11], focusing on interviews with representatives from six partner organizations within the SirkTRE consortium. They are labelled as Organizations A, B, C, D, E and F (see also Fig. 1 for their position in the SirkTRE consortium). The six interviewees are mostly engineers or general managers of architectural firms, manufacturing companies, storage places and environmental consultancy. The first author contacted many contact persons of the SirkTRE consortium for a study on mid-term evaluation of the barriers and key factors for upscaling their solutions., but only these representatives replied to the call. The first author, coming from Organization G, conducted these interviews, transcribed them, and then shared the transcripts with the respective partners for validation and consensus to ensure accuracy and alignment with their perspectives. Based on the insights gained from these validated interviews, the first author crafted an initial draft, capturing the developmental history, and personal reflections on the successes and challenges faced by SirkTRE and its participants. Following the creation of this initial draft, a series of feedback rounds were initiated, involving the interviewees from the partner organizations as well as social scientists who have been closely observing the SirkTRE project. This collaborative review process allowed for a richer, more multifaceted exploration of the themes identified in the interviews, ensuring that the manuscript accurately reflects the collective experiences and insights of those deeply involved in the project. Through this iterative process of drafting, feedback, and revision, the study aims to provide a comprehensive and nuanced understanding of the SirkTRE project's endeavors to foster circular systemic solutions within the construction industry.

3 Results: Diverse Pathways of Circular Systemic Solutions for a Net-Zero Timber-Built Environment for 2021 to 2023

The exploration of circular systemic solutions within the SirkTRE project unveils a rich menu of innovative approaches aimed at achieving a net-zero timber-built environment. Pathways in sustainability and innovation contexts are strategic approaches designed to achieve long-term goals by addressing complex challenges

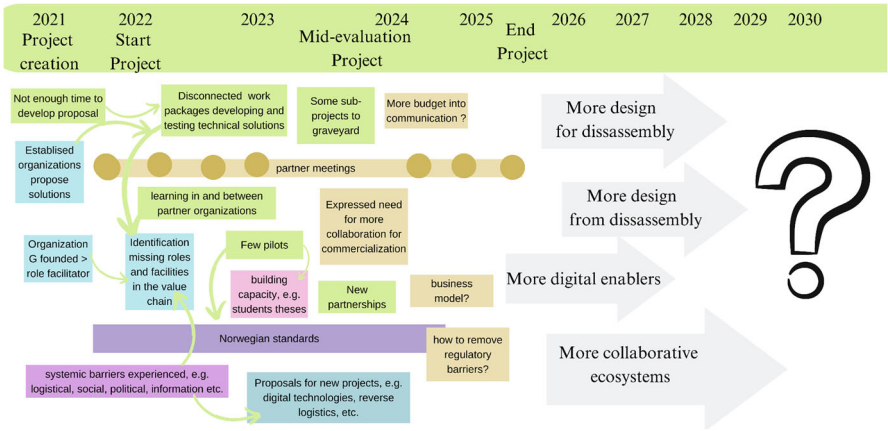

Fig. 2 Timeline of observations in SirkTRE and the possible diverse pathways unfolding for a circular future with net-zero timber built environment

such as climate change or resource scarcity. They are multidimensional, incorporating technological, economic, social, and environmental aspects, and are dynamic, evolving over time to adapt to new challenges and insights. These pathways are systems-oriented, focusing on the interconnectedness of various factors within a system, and are developed through the engagement of diverse stakeholders to ensure inclusivity and broad support. Specifically, in projects aiming for a net-zero timber-built environment, pathways would integrate circular economy principles, innovative construction techniques, and digital tools for material management, emphasizing collaboration across the construction value chain to achieve sustainability objectives efficiently. This section presents an overview of these pathways for SirkTRE (Fig. 2).

3.1 Design for Disassembly and Reuse

The development of modular and reusable interior wall systems represents a significant innovation within the SirkTRE project, particularly highlighted in the work of organizations like D and E. These systems, designed for ease of disassembly and reassembly, stand at the forefront of extending material lifespans and embodying adaptability and flexibility in architectural design. Organization E's approach to this challenge includes the conceptualization and creation of a building model that supports resident participation and transformation over time. Their system is not just about constructing a space but enabling it to evolve according to the needs of its occupants, thereby reducing the need for new materials and minimizing waste. This model is inspired by broader, systemic solutions that consider the entire lifecycle of a building, emphasizing the importance of user interaction and the potential for spaces to adapt and change. Organization D delved into the technical and practical aspects

of implementing circular solutions in the building industry, focusing on the development of a fully reusable interior wall system made from reclaimed timber. Their prototype demonstrates the feasibility of using reclaimed materials in new constructions, offering a tangible solution to the industry's challenge of interior fit-outs that typically have a short lifespan. By designing for disassembly, Organization D's wall system can be easily relocated, reconfigured, or updated, significantly contributing to waste reduction and resource efficiency. Both organizations, through their work, highlight the crucial role of collaboration across the value chain, from material sourcing to construction and beyond. Their projects underscore the potential of modular and reusable systems to not only reduce waste but also to foster innovation in building design and construction. By pushing the boundaries of what is possible with reclaimed timber and modular construction techniques, these initiatives pave the way for a more sustainable, adaptable, and circular building industry.

3.2 Design from Disassembly: Building Models Utilizing Reclaimed Timber

Another pathway is the comprehensive building model that integrates reclaimed timber into its core design. This model not only champions the use of recycled materials but also emphasizes the importance of building systems that can adapt to future needs without requiring extensive modifications. The commitment to using reclaimed timber not only reduces demand for virgin resources but also highlights a valuable shift towards valuing existing materials in the construction sector.

A notable omission within SirkTRE's initial stages was the lack of focused task forces on developing viable business models for these circular solutions. None of the interviewed organizations had any input on business model development for reclaimed timber as it was out of scope for them. This omission was visible after conducting all interviews. This gap has hindered the broader adoption and commercialization of the innovations. However, insights from 2024 suggest a promising shift, with SirkTRE increasingly directing its attention towards overcoming commercial barriers and fostering market readiness for circular construction practices. This evolution marks a crucial step in moving from concept to commercial viability, underscoring the project's role in leading the construction industry towards a more sustainable and circular future.

3.3 Digital Enablers Like Product Passports, Tracing and Tracking Technologies

In the quest for circularity within the SirkTRE project, Organizations A and B have highlighted the pivotal role of digital innovations, particularly emphasizing the potential of digital product passports. Organization A sees digital tools as essential

for tracking the lifecycle of wood products, from production through reuse. Their project focuses on understanding how products can be effectively returned to the manufacturing process or repurposed, with digital tracking systems offering a way to monitor product history and facilitate this circular process. In the journey toward circularity, Organization A encountered significant challenges related to information and data management, which have implications for their product development processes. One of the primary hurdles was the lack of detailed, accessible data on the lifecycle and usage history of wood products. This gap made it difficult for Organization A to accurately assess the potential for reuse and remanufacturing of their existing products and to develop products that could easily be integrated into circular systems. Additionally, the absence of standardized data formats and platforms for sharing information across the construction industry ecosystem further compounded these challenges. As a result, these information and data challenges not only slowed down Organization A's product development but also highlighted the critical need for comprehensive digital solutions, such as the digital product passports discussed, to support the transition to a circular economy in the timber construction sector. Organization B, on the other hand, brings a practical perspective to the implementation of digital passports. They underscore the challenges faced in the current regulatory environment, which often does not favor the reuse of materials due to stringent classification standards. However, they also see digital passports as a solution to these challenges, by providing a transparent and accessible record of material quality, safety, and reuse potential. This could, in turn, influence policy changes and encourage greater acceptance of reused materials in the construction industry. Both organizations underline the necessity of robust, user-friendly digital platforms that can integrate seamlessly with existing industry workflows. The envisioned digital passports would not only store critical material data but also include information on dismantling and reassembly instructions, further supporting the circular economy model. This approach aims to bridge the gap between the potential for material reuse and the current practices dominated by linear consumption. Despite the enthusiasm for digital enablers, there is a gap in SirkTRE's initial focus on these technologies. The early stages of the project did not prioritize the development of digital tools as a central component of circular solutions. However, the evolving insights from Organization A and Organization B suggest a growing recognition of the importance of digitalization in achieving the project's circular goals. This shift points towards a more integrated approach, where digital enablers are seen as critical to the success of circular construction practices, potentially transforming the way materials are managed across their lifecycle.

3.4 Collaborative Ecosystems and Value Chains

Expanding the collaborative ecosystems and innovative value chains within the timber construction industry, SirkTRE exemplifies the transformative potential of cross-sectoral collaboration for advancing circularity. The initiative notably includes

contributions from policy entities like Standards Norway [13] and spans to hands-on industry practitioners, establishing a broad, collaborative network. However, insights from consortium members like Organizations C and D underscore a missed opportunity for more integrated collaborative tasks or work packages that could have fostered deeper synergies across the value chain. They highlight a longing for structured collaborations where partners representing diverse segments of the value chain are intentionally brought together to leverage their unique contributions towards circular solutions. Organization F's experiences further illuminate the challenges of consortium formation, noting the time-intensive nature of assembling a diverse group and the difficulty in identifying and exploiting linkages between partners unfamiliar with each other or who are nascent in their circularity journey. This feedback underscores a critical gap in the consortium's operation, suggesting a need for mechanisms that foster closer collaboration and knowledge exchange among partners. It points to the potential benefits of incorporating collaborative tasks explicitly designed to bridge different areas of expertise, encouraging innovation through shared knowledge and co-creation. The initiative's focus on establishing supportive standards and advocating for policy adjustments further showcases its dedication to overcoming regulatory hurdles and fostering an industry-wide shift towards circular solutions. While the journey reveals areas for improvement, particularly in enhancing partner collaboration and integration, SirkTRE's comprehensive approach continues to drive the timber construction industry closer to achieving a net-zero, circularly built environment, demonstrating the critical role of partnerships in achieving systemic change.

4 Major Challenges and Key Success Factors So Far

The SirkTRE project, with its diverse consortium and ambitious goals, has fostered the development of multiple circular solutions within the construction sector, addressing the urgent need for sustainable practices. A more grounded lens, with the aim to propose a circulation framework, provides a comprehensive understanding of both the evolution and revolution of the outcomes, challenges, and the path forward for these solutions. The different pathways within SirkTRE illustrate not only the successes but also the challenges, including how economic, political, technological, and strategic decisions can impact the scaling up/out or ending.

4.1 Technical–Economic Dimension

A recurring theme across the experiences of the SirkTRE partners is the balancing act between technical feasibility and economic viability. Innovations like modular and reusable interior wall systems and comprehensive building models utilizing reclaimed timber exemplify technical successes with significant environmental

benefits. Technologically, the SirkTRE project showcases an array of innovations aimed at enhancing circularity in construction. The progression from conceptual stages to real-world prototypes in some projects illustrates a successful translation of innovative ideas into practical applications. However, technological limitations are also apparent, particularly in scaling up these solutions for broader market adoption. The economic acceptability of these solutions often hinges on overcoming market inertia, regulatory barriers, and the upfront costs associated with adopting new technologies. One of the key challenges, remarked by several interviewees, facing the reuse of reclaimed timber is the cost competitiveness relative to virgin materials. The collaboration with stakeholders such as Standards Norway indicates a movement towards establishing supportive policies and standards, yet the pathway to economic viability remains a challenge, underlined by concerns over the scalability of solutions within current market structures. Challenges related to the integration of digital enablers, such as digital product passports, and the need for more advanced technological solutions to streamline the reuse of materials are underscored. Moreover, the disparity in Technology Readiness Levels among different solutions indicates varying degrees of maturity and market readiness, which could impact the project's overall success.

4.2 Ethical–Political Dimension

The ethical–political dimension highlights the project's alignment with broader societal, economic, and environmental goals. SirkTRE partners reveal a collective ambition to contribute significantly to Norway's CO_2 reduction targets and to foster a more sustainable construction industry. A strong emphasis on environmental sustainability as a primary motivation behind the circular solutions is evident. Projects ranging from reusable interior wall systems to comprehensive building models utilizing reclaimed timber exemplify a commitment to reducing waste and carbon emissions. However, environmental challenges such as the classification and standardization of reclaimed materials, as well as the need for broader life cycle assessments, are highlighted. The difficulty in measuring the direct environmental impact of the SirkTRE project on the broader value chain and sector points to a gap in comprehensive environmental reporting and assessment methodologies within circular construction practices. In addition, the realization of these goals is contingent upon navigating political landscapes, securing governmental support, and influencing policy changes to favor circular practices. The CO_2 accounting system remains a work in progress with significant political dimensions, as major corporations lobby intensively to shape a system that prioritizes their interests. As [14] illustrated, the current policy landscape in Norway does not view construction material circularity as a policy objective at any governance level and lacks economic, capacity building and regulatory tools to advance wood circularity in construction under-utilizing the influence of top-down mechanisms. The engagement with policymakers and standard-setting bodies marks steps towards these ends, but the pace of political and regulatory support is a noted barrier.

4.3 Developmental Dimension

SirkTRE's impact is also measured through its developmental growth, encompassing geographical expansion, stakeholder engagement, and performance metrics. While the project has successfully fostered a collaborative ecosystem, expanding its influence beyond initial boundaries remains challenging. The diversity of stakeholders from various sectors enhances the project's richness but also complicates coordination efforts. These observations in SirkTRE are aligned with other observations in other ecosystems and projects and previous research highlighting stakeholder coordination as an enabler of CE in the construction sector [6–9]. Growth in terms of legal status changes, sales evolution, or geographical presence is indirectly influenced by the project's ability to navigate and adapt to the evolving landscape of the timber construction industry. Concerning the geographical dimension, the Norwegian ecosystem has path dependencies (e.g. forestry infrastructures, and incineration plants competing for wood waste resources) that can hinder the uptake. In addition, spatial capacity building and planning for a circular built environment are not present in Norwegian circular economy discourse and actualization, while these are required policy instruments [15, 16]. Litleskare and Wuyts [16] addressed findings from qualitative interviews and focus groups with architects, stakeholders in the wood industry and inhabitants of urban timber buildings. They found that the choice of using wood efficiently and adapting circular construction goals in the wood industry is partially guided by values, ideas and convictions of implementing practices that benefit society. The governance aspect within SirkTRE reveals a complex interplay of regulatory frameworks, industry standards, and collaborative dynamics. The project's goal to create new value chains and influence policy through the development of new standards and practices is commendable. Yet, the interviews disclose a notable barrier in the form of existing regulations that do not fully accommodate or incentivize circular solutions, thereby hindering wider adoption. Furthermore, the interviews reflect a need for enhanced governance mechanisms within the SirkTRE consortium itself. A more integrated approach, facilitating better cooperation and knowledge exchange among partners, is essential for overcoming silos and leveraging the collective expertise toward achieving the project's ambitious goals.

4.4 Inventiveness and Regulationist Dimension

The project's capacity for innovation and the establishment of new rules and coordination mechanisms is critical. The development of digital enablers like product passports and the exploration of novel construction models demonstrate a high degree of inventiveness. Yet, the formation of collective action and the implementation of new practices are impeded by existing regulatory frameworks and industry

standards. Efforts to negotiate and coordinate within the consortium and with external entities reveal the complexities of aligning diverse interests and visions for a circular future.

5 Conclusion, Implications and Recommendations

The findings offer valuable insights into the governance of circular systemic solutions in the timber-built environment. SirkTRE's journey can be aptly described as a 'Circulution', a term that encapsulates its evolutionary path towards fostering circular systemic solutions within the construction industry. This progression is characterized by the project's ambitious aim to integrate circular economy principles into the timber construction sector, navigating through a complex landscape of technological, economic, ethical–political, and developmental dimensions. SirkTRE has successfully sparked innovation by developing modular and reusable interior wall systems and comprehensive building models utilizing reclaimed timber and leveraging digital enablers like product passports. However, the solutions are still at a low technology readiness level (TRL), and some solutions score lower at the market readiness level (MRL).

These inventions not only showcase the project's technical and economic achievements but also its commitment to ethical and political values, emphasizing sustainability and resource efficiency. Participants got access to knowledge on diverse topics from wood technology to circular business models, training programs, educational initiatives, and networking opportunities in promoting awareness and understanding of circular economy principles and practices. However, the circulution of SirkTRE is not without its challenges. The project has encountered obstacles in fully realizing its goals, stemming from a need for more robust collaborative ecosystems and value chains. Various partners shared a desire for more integrated efforts and knowledge sharing among partners, highlighting the importance of collaboration in overcoming barriers to circularity. Moreover, there's a recognized need for addressing the scale-up challenges, particularly in terms of business models and regulatory support, which were less emphasized in the project's early stages. The SirkTRE partners underscore the importance of supportive policy frameworks in facilitating the adoption of circular practices in timber construction. They highlighted the need for clearer regulations on material reuse, standardized guidelines for sustainable timber sourcing, and streamlined permitting processes to incentivize circularity. To advance the adoption of circular systemic solutions in the construction sector, policymakers and the science-policy interface are advised to refine regulations and standards to better support circular practices, foster public-private partnerships for co-creating circular economy models and introduce financial incentives for circular solutions. Additionally, bridging the gap between science and policy involves disseminating SirkTRE's innovations and sustainable construction practices widely, establishing collaborative platforms for stakeholder engagement across the construction value chain, and promoting education and training focused

on circular economy principles and sustainable building techniques. Several key implications emerge, shedding light on the challenges and opportunities for advancing circularity in the sector. The recommendations for the final phase of SirkTRE focus on enhancing these collaborative efforts, suggesting the formation of task forces or work packages that foster inter-partner collaboration, thus ensuring a more cohesive approach to circularity. Additionally, the project is encouraged to deepen its engagement with policymakers and the science-policy interface to facilitate the broader adoption of circular systemic solutions. In conclusion, SirkTRE's successes and challenges alike offer valuable lessons for future endeavors in this field, underscoring the need for continued innovation, policy support, and, most critically, collaborative action. This study demonstrates a way for practitioners to evaluate their project-based collective learning and innovation and the diverse pathways to reach their bigger and smaller goals. As SirkTRE enters its final phase, the focus on overcoming existing barriers and leveraging the project's achievements can further propel the construction industry toward a more sustainable and circular future. Strategic emphasis on cross-project collaboration, stakeholder engagement, scalability, and digital innovation is essential. It is recommended that the consortium intensify efforts to foster cross-work package synergies through regular interdisciplinary workshops, complemented by a unified communication strategy for disseminating project achievements. Active engagement with policymakers, industry partners, and end-users is crucial to demonstrate the practical applicability and benefits of circular solutions, thereby facilitating policy support and market adoption. Developing sustainable business models and conducting market analyses will be key to assessing commercial viability and ensuring the long-term impact of innovations. Additionally, documenting lessons learned and investing in training and educational initiatives can enhance knowledge transfer within the construction sector. Leveraging digital tools, such as product passports and material databases, will further support the optimization of resource use throughout the construction lifecycle. Focused efforts in these areas can significantly contribute to achieving SirkTRE's vision for a sustainable, circular timber-built environment, setting a precedent for future construction practices.

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