Building circular supply chains for biobased building materials

1. The construction sector is the third most polluting industry globally, largely due to material choices. Biobased building materials appear to be a viable solution.
2. Interconnected barriers hinder the development of biobased supply chains. For example, regulatory issues can affect the ease with which biobased materials are adopted.
3. Impactful projects and enhanced collaboration among stakeholders can help overcome many of the barriers.

The construction sector is the third most polluting industry globally, accounting for around 39% of all energy-related CO2 emissions worldwide. A significant amount of the consumed energy is related to the extraction of raw materials, material production, high temperature treatment, transportation, and waste disposal. It is estimated that despite having residual value, more than 75% of all construction and demolition waste is neither being reused nor recycled. With a projected annual growth rate of 5.7%, the construction sector is on track to further increase its CO2 emissions, consumption of raw materials, and production of waste. As part of a closed-loop oriented economy, biobased building materials (BBMs) can play a crucial role in successfully reducing the environmental impact of the construction industry. Throughout their lifespan, these crops capture and bind large amounts of CO2, making it possible for BBMs to be carbon negative building materials. Additionally, BBMs also show great potential regarding reusability and recyclability. Recent years have witnessed significant advancements in the field of BBMs, with the introduction of numerous novel biobased alternatives, reflecting a dynamic landscape of innovation and diversification in sustainable construction materials. The region of Friesland, the Netherlands, is among the most ambitious regions in Europe regarding circularity, with a strong focus on establishing regional and circular supply chains for crops such as Hemp, Miscanthus, or Flax. To investigate potential barriers and enablers to building circular supply chains (CSCs) for BBMs, a small case study was carried out in collaboration with 'Vereniging Circulair Friesland' (VCF). The focus of this study was to find common problems that stakeholders of the supply chains for BBMs are facing and to find possible solution that can help them overcome these barriers.

The Study

To understand the challenges and enablers to building CSCs for BBMs, six semi-structured interviews were conducted with key individuals involved in the transition in Friesland, the Netherlands. These included farmers, producers, and other experts that are involved with coordinating and setting up the supply chains for BBMs in the region. This research mainly focussed on Miscanthus and Flax as biobased crops. The collected interviews were analyzed to identify common themes and important points.

This approach provided detailed and practical information about the current state and future potential of biobased building materials in the region.

Barriers

Based on the results from the interviews, the different stakeholders appear to face a range of barriers influencing their engagement with BBMs.

Technological barriers

Based on the participants' responses, technology seems to be a major barrier that keeps farmers from engaging in crops that are needed for BBMs, such as Miscanthus or Flax. This barrier covers both the inability to obtain the necessary technological appliances and the fact that necessary technological appliances do not yet exist. In response to the question of what barriers farmers would face the most, barriers connected to non-existing or hard-to-obtain technology were mentioned multiple times.

Customer Behavior

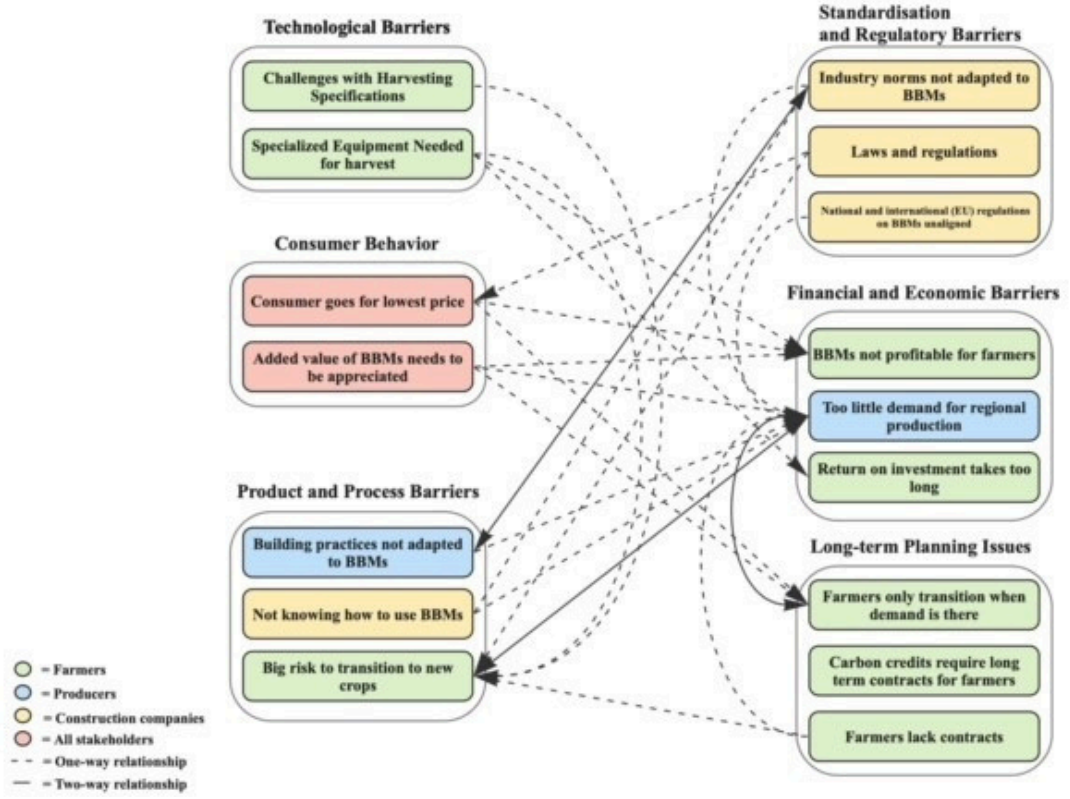
Customer behaviour' describes difficulties regarding the decision patterns of customers and perceptions of BBMs, especially in relation to non-BBMs. Throughout the interviews, we found that customers buy building materials based on availability and price. At the moment, non-BBMs are more broadly available and cheaper, which is why BBMs are often not perceived as the better choice, affecting the entire chain.

Product and process barriers

'Product and process barriers' outlines issues that stakeholders can face with novel products, specifically in the processing phase. Construction companies and producers of BBMs struggle with the processing of BBMs, while farmers struggle with the transitioning to the product itself.

Standardisation and regulatory barriers

Findings indicate that complicated certifications, industry standards and laws and regulations are hindering construction companies from engaging with BBMs. 'Standardisation and regulatory barriers' outline challenges that are related to (non) existing regulations and industry standards that hinder the application of BBMs. This barrier appears to be especially affecting construction companies.



Financial and economic barriers

Financial and economic aspects appear to be a major barrier for farmers and producers of BBMs. The fifth barrier, 'financial and economic barriers', covers challenges related to the financial and operational risk of engaging in BBMs. This barrier appears to affect mainly producers and farmers.

Long-term planning

Farmers struggle with a lack of contracts that provide them with security and enable them to plan with BBMs in the long run. The sixth and final barrier 'long-term planning' describes the challenges related to uncertainty stakeholders face in the long run when engaging in BBMs. Based on the participants' replies, this barrier appears to be affecting farmers the most.

Enablers

The interviews also show that there are possible ways for stakeholders to overcome the barriers they face.

Frontrunners and pilot projects

Positive examples of BBMs in practice appear to be important facilitators for convincing stakeholders to get involved with BBMs and showing them how to work with such materials. The first enabler identified consists of frontrunners and pilot projects showing stakeholders how to work with BBMs and what can already be achieved using such materials.

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Stakeholder collaboration

Collaborating more closely with other stakeholders can helpovercome several barriers that stakeholders face in theirtransition towards BBMs. 'Stakeholder collaboration' coverspossibilities to collaborate both within, and betweenstakeholder groups to overcome certain barriers to buildingCSCs. Such collaboration, is desperately needed to break withthe contemporary top-down approach from constructioncompanies who dictated processes to the rest of the supplychain. For BBMs, a participation model would be needed thatallows all stakeholders to work together to overcome barriersto overcome different barriers while building CSCs.

Some barriers interact

After mapping the interations of the different barriers, it becameclear that many of them interact with each other, creating acomplex set of challenges (see figure 1). For example,technological issues make it ard to produce BBMs efficiently,which affects how easily these materials can be standardizedand produced on a large scale. This problem increasesproduction costs, leading to financial difficulties for businessestrying to invest in BBMs. The lack of supportive regulations addsto these issues. Without clear and favorable rules, companiesare less likely to invest in better technology or expand theirproduction, which keeps costs high and financial risks significant.These financial hurdles then make it difficult for, e.g. farmers, toplan for the long term and invest in the necessary infrastructureand market development. Customer behavior also plays a role.Low demand and limited awareness about BBMs discouragebusinesses from investing in these materials. If customers are notinterested or are unaware of BBMs, companies are less likely tospend money on improving technology or navigatingcomplicated regulations without a guarantee of returns. Thislack of market demand also makes it less likely thatpolicymakers will push for supportive regulations, as there is notenough public or market pressure. In summary, these barriersreinforce each other: technological limits raise costs, financialconstraints hinder investment, regulatory challenges slowprogress, and low market demand reduces incentives forchange. To overcome these issues, it is necessary to addressmultiple barriers at once, creating a more favorableenvironment for the adoption of BBMs.

Some barriers interact

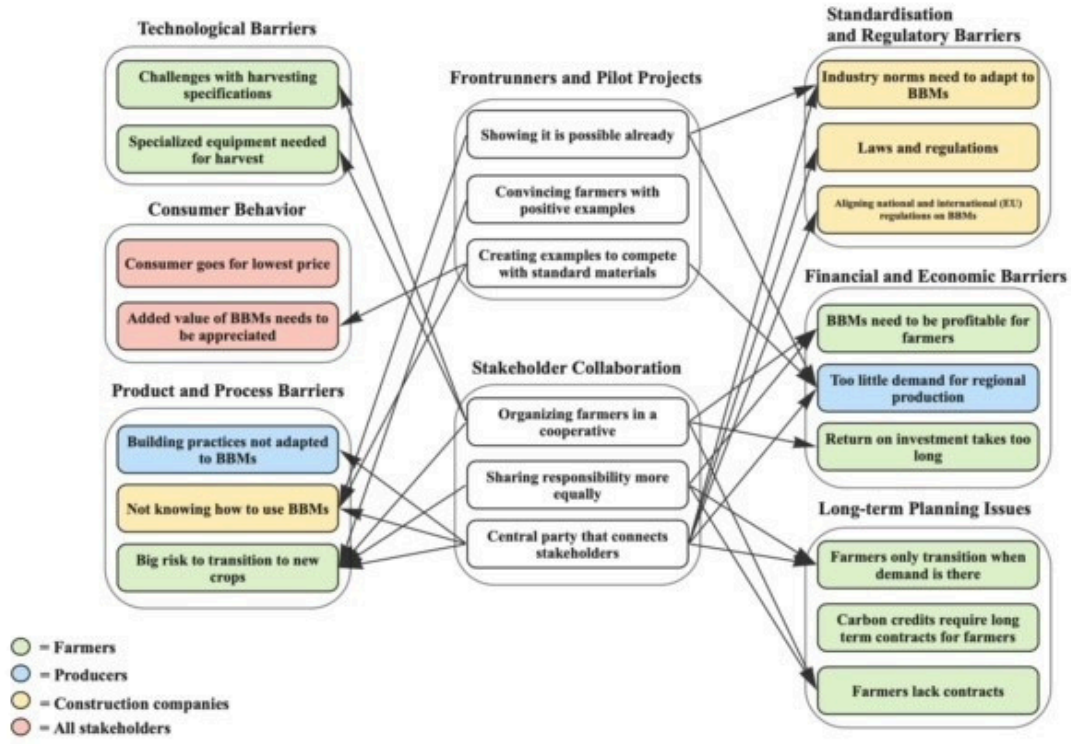
Despite the complex interplay of various barriers, there arestraightforward solutions to overcome them. Interviews suggest that increasing the number of frontrunners and pilot projects,along with fostering stronger collaboration betweenstakeholders, can effectively address many of the challengesstakeholders face (see figure 2).

Bridge - Frontrunners and pilot projects

Having examples of BBMs in use could positively impact severalbarriers. First, it could help to overcome some product andprocess barriers. Pilot projects could inspire constructioncompanies, showing them how BBMs can be used in practice.Farmers who perceive the risk of transitioning towards crops likeMiscanthus or Flax as too high could be convinced by otherfarmers who successfully made that transition. By having morephysical examples of BBMs in use, customer behaviour couldalso be influenced by making the added value of BBMs morevisible. More frontrunners and pilot projects could also helpovercome standardisation and regulatory barriers. If morecompanies engage with BBMs and more pilot projects arelaunched, industry norms might adapt more quickly to BBMs.With regards to financial and economic barriers, morefrontrunners and pilot projects could help stimulate demandthat is needed by the producers of BBMs.

Bridge - Stakeholder collaboration

Stakeholder collaboration forms the second brideg to overcoming various barriers. A cooperative for farmers could facilitate knowledge exchange, equipment sharing, and negotiation on behalf of its members, helping to overcome technological, product, and process barriers. Knowledge sharing lowers the perceived risk of transitioning by providing support during and after the transition period. Economically, a cooperative could strengthen farmers' negotiating positions, helping in the development of profitable business odels and securing long-term contracts, reducing financial burdens and long-term planning issues. Besides a cooperative, moving from a top-down approach to a participation odel could further reduce financial burdens by sharing responsibility more equally among stakeholders. This shift could result in more profitable business models for farmers and secure long-term contracts, addressing planning issues and reducing transitoin risks. A central party connecting all stakeholders and acting as a mediator could also overcome several barriers. This intermediary could facilitate knowledge exchange, support members during transitions, and unite like-minded individuals and business. For the example of Friesland, vereniging Circulair Friesland was named as an example for how important such a connecting body can be to coordinate circular processes in the region. Accelerating the adaptation process for producers and construction companies to BBMs could lower farmers' transition risks. Additionally, a central party could address standardisation and regulatory barriers, align industry norms with BBMs, and adapt laws and regulations. By uniting BBM stakeholders, financial, economic, and long-term planning issues could be tackled, ultimately resolving demand-related problems.



Conclusion

BBMs hold immense potential for transforming the constructionindustry into a more circular and environmentally friendlysector. Although the adaptation of crops such as miscanthus orflax into CSCs is still facing some barriers, there appear to berelatively simple solutions to what initially might seem likecomplex problems. To successfully transition towards a more circular construction sector, stakeholders need positiveexamples that demonstrate how to work with BBMs.Additionally, stakeholders need to collaborate more closely toovercome the barriers they are facing.

This research was conducted in collaboration with the association Circular Friesland (VCF). With its more than 160 members from education, industry, and governmental institutions, VCF aims to make Friesland, the Netherlands, one of the most circular regions worldwide. One of the main objectives of this research was to contribute to the European project "Building Based on Biobased" (BBoBB). In the BBoBB project, 16 partners across five countries in the North Sea region work together to design, develop, and strengthen value chains for the use of biobased materials, something that VCF is deeply involved in. To accelerate the transition towards biobased materials in construction, VCF is taking various measures. As part of its program "Fryslân Builds Circular 2023-2026," VCF brings together supply and demand, supports forty biobased impact projects, and facilitates collaboration with regional stakeholders to overcome barriers in laws and regulations and develop biobased supply chains. To contribute to national goals as a region and to apply national knowledge locally, VCF also closely collaborates with Building Balance in the 'National Approach Biobased Building'. In the context of BBoBB, VCF places special emphasis on the design phase of biobased projects by involving architects with expertise in biobased building from an early stage.

Contact

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