BARBARA DE MEIJER 4850734 METROPOLITAN ECOLOGY OF PLACES SERIES

Pattern Booklet: Weaving Flax Fiber into the Territorial Fabric

A spatial design exploration on the potential role of flax in a circular biobased building sector in the Netherlands

Pattern Booklet MSc Architecture, Urbanism and Building Sciences-Track Urbanism Faculty of Architecture and the Built Environment Delft University of Technology

Title:

Weaving Flax Fiber into the Territorial Fabric

Sub title:

A Spatial Design Exploration on the Potential Role of Flax in a Circular Fiber Based Building Sector Graduation Lab: Metropolitan Ecology of Places

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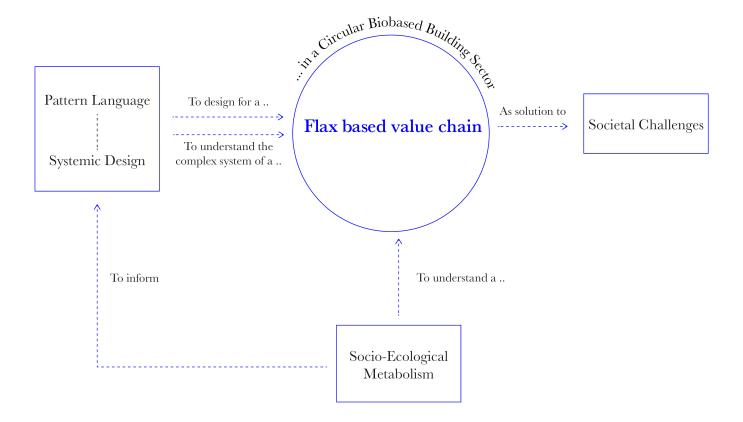


Pattern Booklet

This booklet shows an overview of the pattern language developed to understand the complex system of integrating a flax value chain, to modify the system and to translate the insights of the research into practical solutions. In 1977 Christopher Alexander developed an 'archetypical language', called 'pattern language'. It is a method to understand and possibly control complex systems in spatial design, but also to function as a design tool that can build something functionally and structurally coherent (Salingaros, 2008). This method acknowledges complexity, but breaks it down in comprehendible blocks of knowledge or solutions, called patterns, translatable to a wide range of conditions.

Whereas this booklet shows an overview of the patterns and how they are linked, the report shows how the patterns are applied on the case of Lelystad, Flevoland.

Conceptual Framework



Urban environments are complex systems, and spatially facilitating a circular flax value chain is a complex task, requiring knowledge from different sectors and technologies and on different scales. To achieve circularity, a pattern language is used as an instrument for interdisciplinary mediation (Hausleitner et al., 2020). Pattern language offers systemic design a structured approach for ideating solutions and organizing design principles and solutions. In this thesis, socio-ecological metabolism informs the development of pattern language by providing insights into the underlying ecological and social processes that shape design outcomes.

Pattern Field

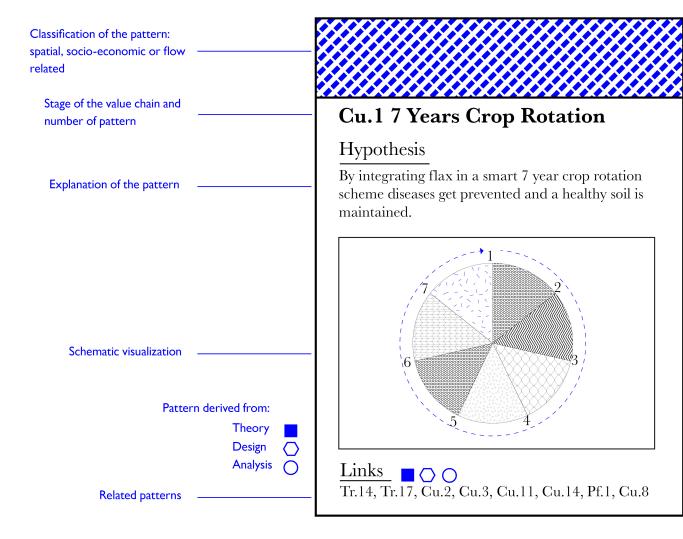
Socio - Economic

Socio Econol		
People skills Policies Employment		
Awareness Incentives	Education	
Technology Innovation	Networks Circularity	Sustainable Land Use
	Local Logistics Production	
Environmental Impacts		Space
??\\\(??\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	35502004502200505020045022055022	

Flows

The patterns are classified as socio-economic, spatial or flow related, or potentially a combination. Socio-economic patterns primarily address the social and economic aspects of the flax value chain system. Flow-related patterns focus on the movement, exchange, and transformation of resources, materials, information, or energy within the flax value chain and limiting environmental impact. Spatial patterns focus on geographical allocation of functions, interventions in the physical built environment and what qualities they bring.

Structure of Pattern



Theory

Flax can only be grown on the same plot once every 7 years in order to prevent the disease 'Verticilium Dahliae' and should therefore be included in a crop rotation scheme that keeps the soil healthy. When choosing the preceding crop, it is important to check the nitrogen supply. Preceding crops with a green manure crop and grass seed for example, are not suitable. After growing flax, it's possible to grow most other crops without risk (Vreeke et al., 1991).

Practical Implication

Oats, winter wheat, winter barley and spring barley are good crops to plant before flax. They generally give good flax quality and a low cultivation risk. After growing flax, crops that don't need a lot of nitrogen should be grown, but it's possible to grow most other crops without risk.

Theory underpinning the hypothesis

Practical or spatial implication

Organization of Patterns

The Patterns are organized along the value chain. By aligning patterns with the stages of the flax value chain, it provides a structured and systematic approach to understanding and modifying the system. It also ensures that all critical stages of the value chain are adressed and that interdependencies and connections between the different stages are clear. Eventually, it will also help to translate systemic changes to land-use changes.

Trans



Cultivation

From Plant to Fibers

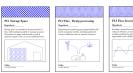
From Fiber to Product





Cultivation



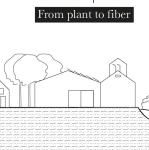














scalar



Construction Circular Building Hub

Textile









Textile sorting

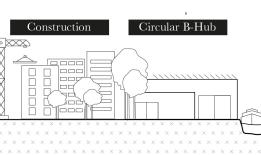


Recycling

Spinning

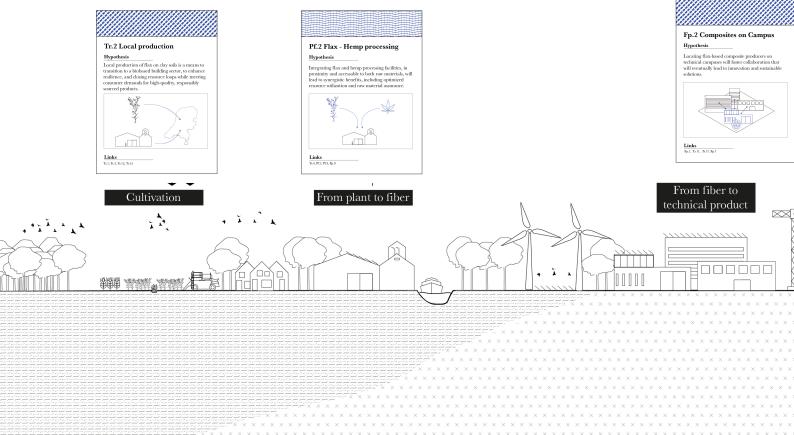
From shive / short

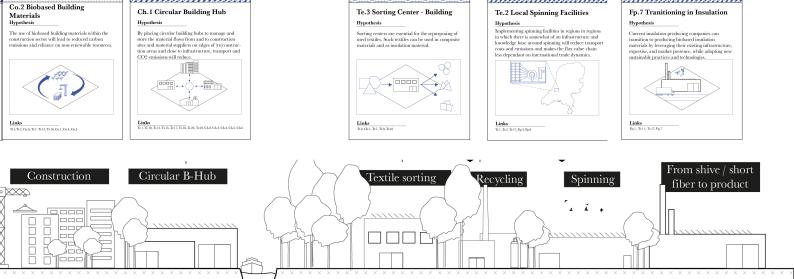
fiber to product



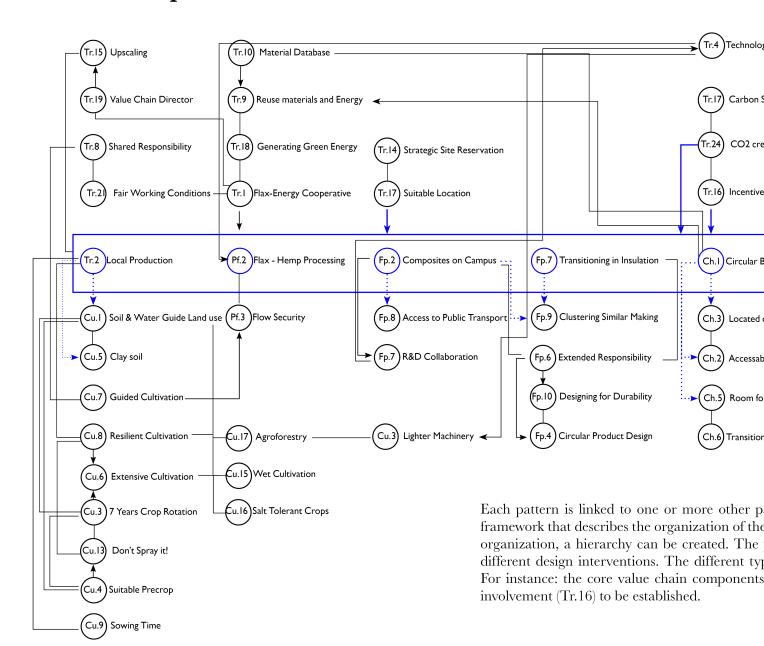
Core Patterns Value Chain

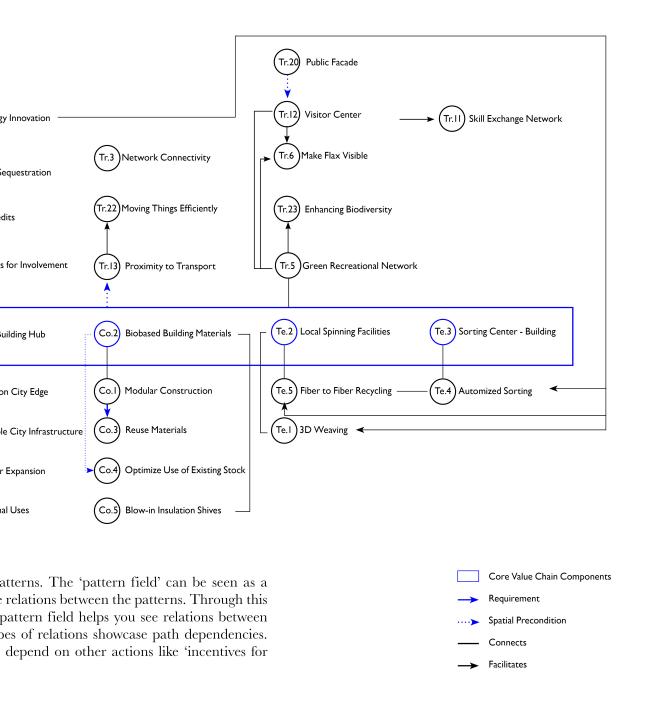
Some core patterns that are crucial for the establishment of a sustainable circular flax value chain can be recognized. They represent the required 'stages' of the value chain.





Path Dependencies

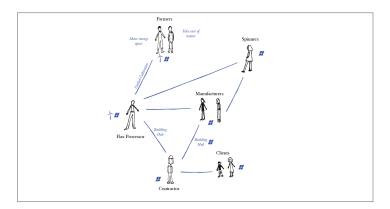




Tr.1 Flax-Energy Cooperative

Hypothesis

The integration of flax value chain activities with renewable energy resources within a cooperative framework will lead to increased sustainability and resilience.



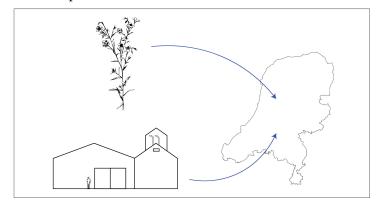
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 $Tr.2\ , Tr.3,\ Tr.6, Tr.8, Tr.9, Tr.11.\ Tr.13, Tr.16, Tr.17, Tr.18, Tr.23, Cu.7, Ch.1$

Tr.2 Local production

Hypothesis

Local production of flax on clay soils is a means to transition to a biobased building sector, to enhance resilience, and closing resource loops while meeting consumer demands for high-quality, responsibly sourced products.



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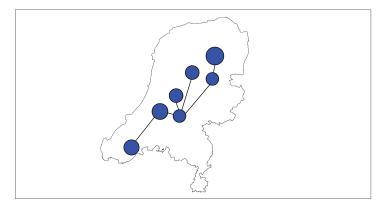
Tr.1, Tr.3, Tr.12, Tr.15



Tr.3 Network Connectivity

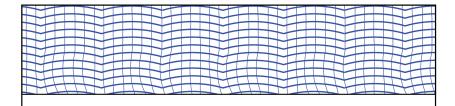
Hypothesis

Proximity and accessable connections between the different stations of the value chain will result in greater operational efficiency, reduced transaction costs, and enhanced collaboration



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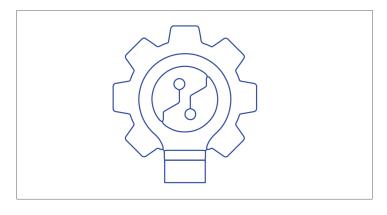
Tr.1, Tr.2, Tr.12, Tr.13, Tr.14, Tr.17, Tr.22



Tr.4 Technological Innovation

Hypothesis

Technological innovations are drivers of change, which will lead to enhanced resource efficiency, reduced environmental impact and more automatization.



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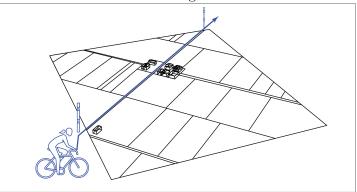
Pf.2, Fp.1, Fp.7, Fp.8, Fp.9, Fp.10



Tr.5 Green Recreational Route

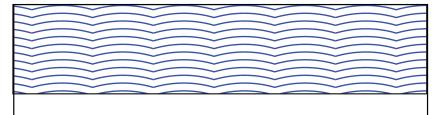
Hypothesis

A recreational route along the flax value chain, marked with signage poles that also function as beehotels will lead to increased awareness of the flax value chain. It is also expected to promote regional tourism and boost the ecological main structure.



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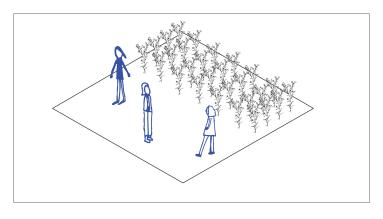
Tr.6, Tr.12, Tr.23



Tr.6 Making Flax Visible

Hypothesis

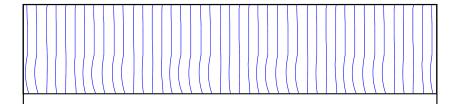
Activities along the flax value chain need to be made visible so the market picks up the products and the general public recognizes the importance.



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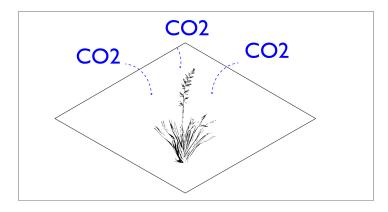
Tr.5, Tr.1, Tr.12, Tr.20, Cu.10



Tr.7 Carbon Sequestration

Hypothesis

Cultivation of fibre crops reduces environmental pressures by extracting CO2 from the atmosphere. Making circular and demountable materials from the crop extends the carbon storage time.



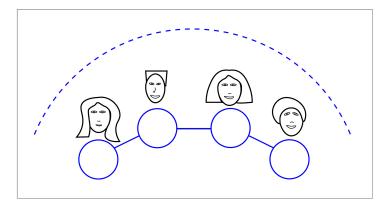
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Tr.1, Tr.8, Tr.24, Tr.23, Fp.4, Fp.10

Tr.8 Shared Responsibility

Hypothesis

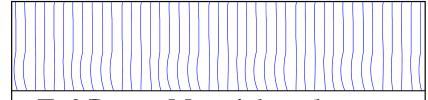
A shared responsibility approach along the flax value chain will lead to enhanced collaboration, transparency, and will foster fair distribution of risks and rewards among stakeholders.



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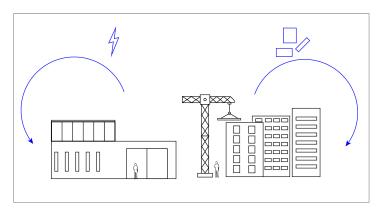


Tr.1, Tr.7, Tr.16, Cu.7



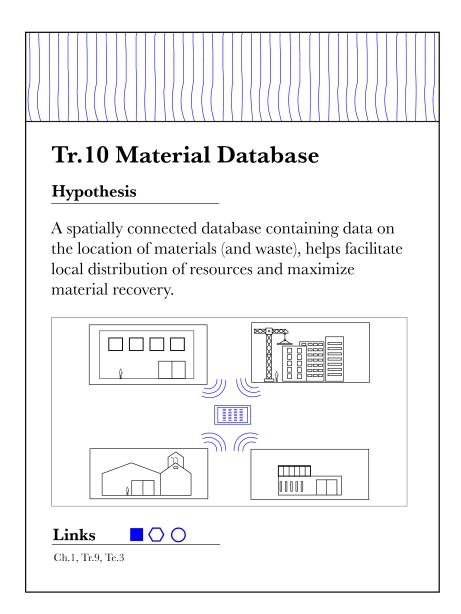
Tr.9 Re-use Materials and Energy Hypothesis

Reusing materials and energy will lead to a significant reduction in resource consumption and waste generation throughout the value chain, contributing to a circular economy.



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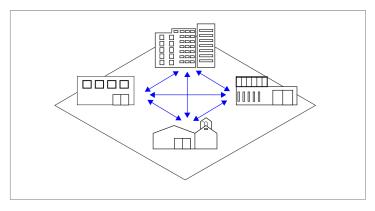
Tr.1, Tr.7, Tr.10, Tr.18, Co.1



Tr.11 Skill Exchange Networks

Hypothesis

Establishing skills exchange networks within the value chain, with a 'flax cafe' that is combined with a visitor center, will foster knowledge sharing and collaboration among stakeholders, resulting in improved efficiency, innovation, and more sustainable practices.



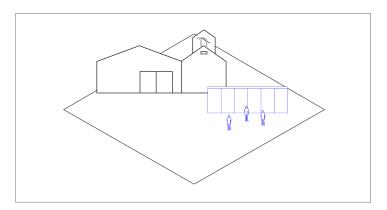
Links

Tr.1, Tr.4, Tr.12, Cu.7, Pf.2, Fp.1, Fp.2, Fp.3, Fp.7, Fp.9

Tr.12 Visitor Center

Hypothesis

Creating a visitor centre as a part of the recreational route to make the flax value chain visible will lead to increased awareness, and appreciation of flax and its potential applications.

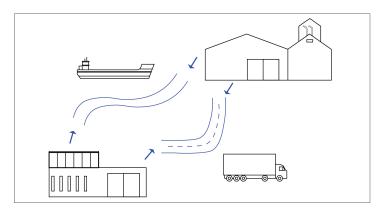




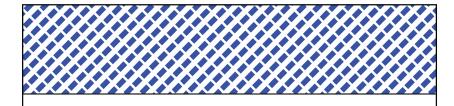
Tr.13 Proximity to Transport

Hypothesis

Activities along the flax value chain benefit from being in proximity and having access to relevant transport infrastructure.



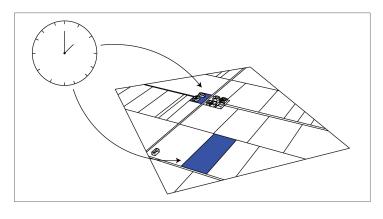
 $Tr.2,\ Tr.3,\ ,Tr.17,\ T4,\ Tr.17,\ Tr.22,\ Cu.12,\ Pf.1,\ Fp.5,\ Ch.1$



Tr.14 Strategic Site Reservation

Hypothesis

Strategic site reservation through time for flax cultivation and next stepts in the value chain will lead to optimized land use, enhanced supply chain resilience, and increased economic opportunities.



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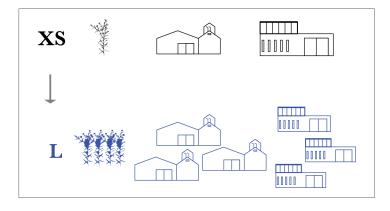


Tr.3, Cu.3 Tr.15, Tr.17, Ch.5

Tr.15 Upscaling

Hypothesis

Upscaling the flax value chain will lead to increased availability of sustainable raw materials, driving innovation and sustainable transitions in the construction and textile industry.



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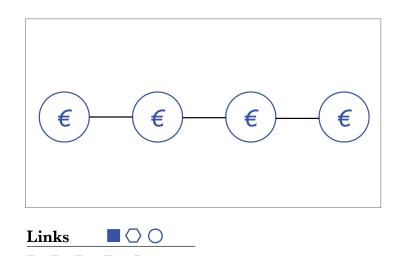
Tr.3, Tr.14, Tr.17



Tr.16 Incentives for Involvement

Hypothesis

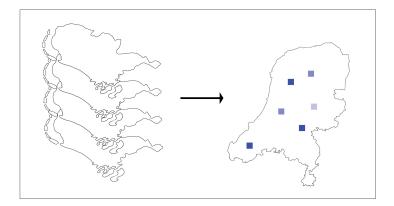
The upscaling of the value chain can be stimulated by the government through incentives as providing finance and space.



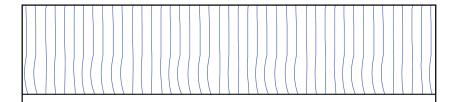


Hypothesis

Choosing certain geographical locations for specific functions based on their suitability enables more sustainable land use.



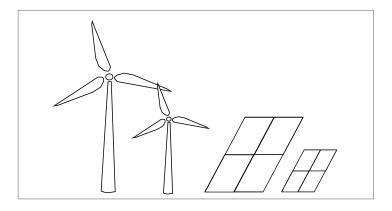
 $Tr.1,\,Tr.3,\,Tr.13,\,Tr.14,\,Tr.15,,\,Tr22,\,Cu.1,\,Cu.3,\,Cu.4,\,Cu.5,\,Fp.2,\,Ch.1,\,Ch.2,\,Ch.3,\,Ch.4,\,Ch.5$



Tr.18 Generating Green Energy

Hypothesis

Using renewable energy sources to provide energy along the flax value chain ultimately contributes to a more sustainable and resilient flax value chain.

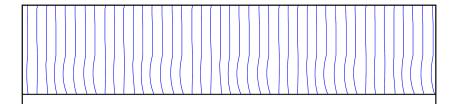


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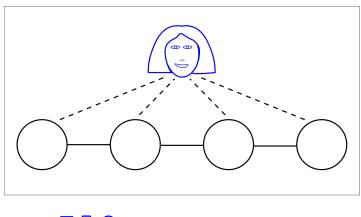
Tr.1, Tr.9, Ch.1



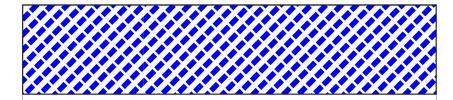
Tr.19 Value Chain Director

Hypothesis

Appointing a value chain director will lead to improved coordination, efficiency and space for innovation across the value chain.



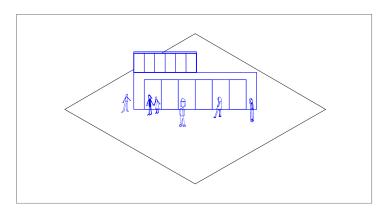
Links O



Tr.20 Public Facade

Hypothesis

Buildings with functions that aim to be visible or accessible to the public benefit from having an open and attractive facade, enhancing neighborhood integration.



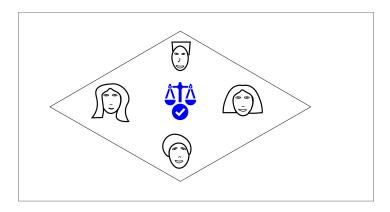
Links O

Tr.1, Tr.5, Tr.10, Tr.12



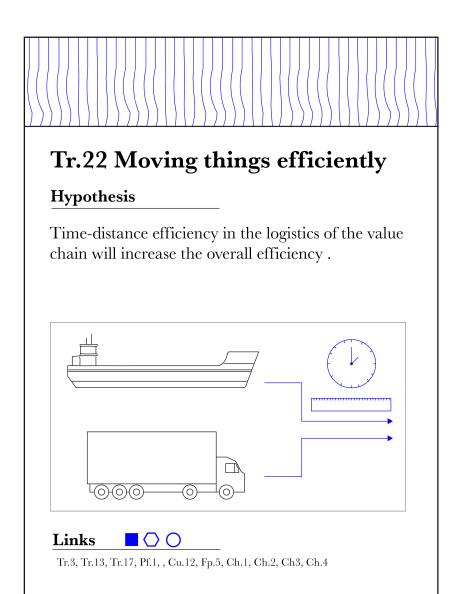
Hypothesis

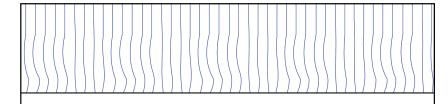
Fair working conditions are integral for providing good quality output, and a reliable and agile workforce.



Links O

Tr.1, Tr.16, Tr.24

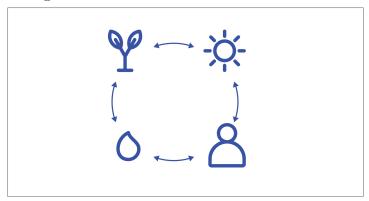




Tr.23 Enhancing Biodiversity

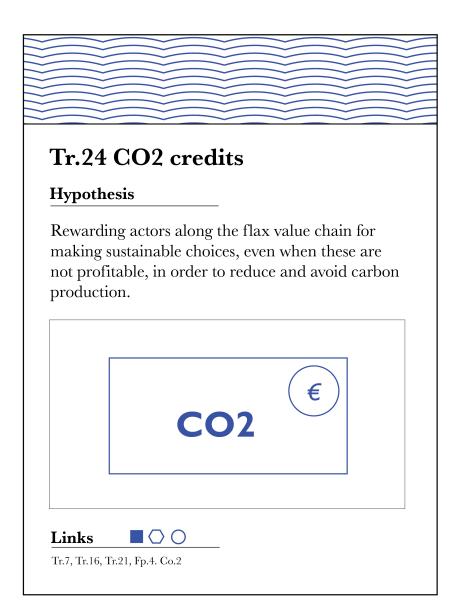
Hypothesis

Implementing biodiversity enhancement measures at each stage of the flax value chain and along the recreational route, using available edges, will positively impact local ecosystems and strengthen ecological networks.



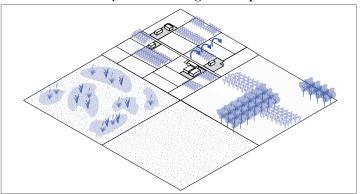
Links 🗌 🔷 🌑

Tr.5, Tr.1, Cu.13



Cu.1 Soil & Water Guide Land Use Hypothesis

Aligning land use decisions with the natural characteristics of the soil and water conditions in a given area, enhances agricultural productivity, mitigates environmental degradation, and promotes sustainable ecosystem management practices.



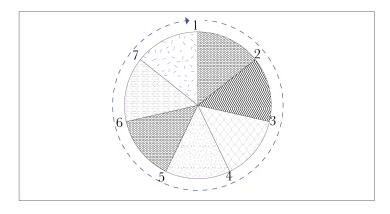
Links 🗆 🔾 🌑

Tr.17, Cu.5, Cu.3, Cu.6, Cu.15, Cu.16, Cu.17



Hypothesis

By integrating flax in a smart 7 year crop rotation scheme diseases get prevented and a healthy soil is maintained.

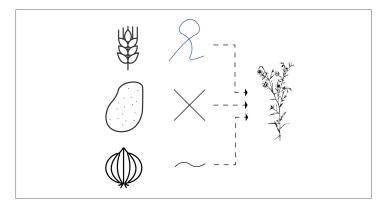




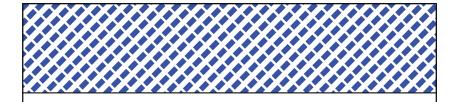
Cu.4 Suitable Precrop

Hypothesis

Cultivating a suitable precrop in rotation with flax improves soil health, reduces risk of diseases and enhances crop productivity.



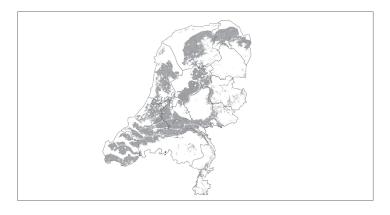
Links O O Cu.1, Cu.3, Cu.5, Cu.6, Cu.13,



Cu.5 Clay Soil

Hypothesis

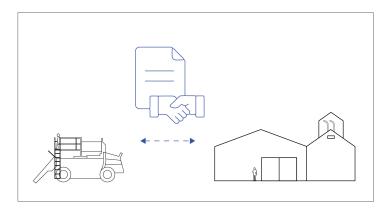
The highest yield is achieved when flax is grown on clay soil.



Cu.7 Guided Cultivation

Hypothesis

Implementing contracted and guided cultivation between farmers and processors, will lead to an increase in cultivation land, better quality and enhanced economic stability for both parties.



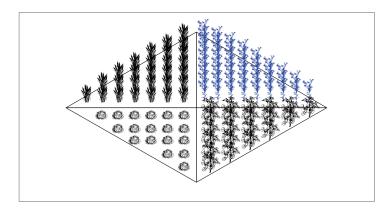
Links 🗌 🔷 🌑

Tr.1, Tr.8, Tr.11, Cu.8

Cu.8 Resilient Cultivation

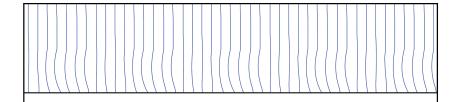
Hypothesis

In a resilient cultivation plan, flax only occupies a part of a farmers acreage and is part of a crop rotation, responding to a potential failed yield.



Links

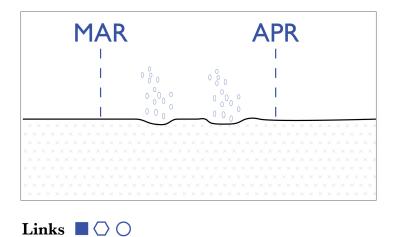
Cu.3, Cu.6, Cu.7



Cu.9 Sowing Time

Hypothesis

The best time to sow the flax seeds is between the end of March until mid-April. Sowing early generally ensures a higher yield.

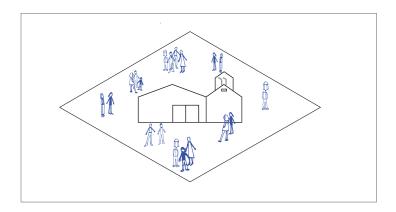


Cu.6, Cu.10

Cu.10 Harvesting Event

Hypothesis

Organizing a harvesting event will enhance community engagement, collaboration among stakeholders and appreciation for the flax industry.



Links





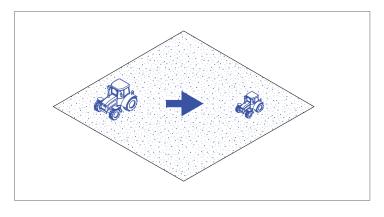
Tr.6, Cu.9



C.11 Lighter Machinery

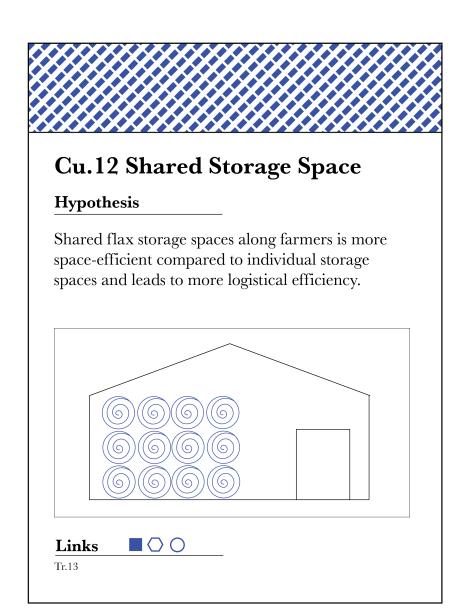
Hypothesis

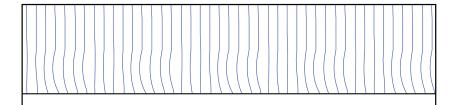
Technological innovation leading to lighter machines will reduce soil compaction.



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Tr.4, Cu.17

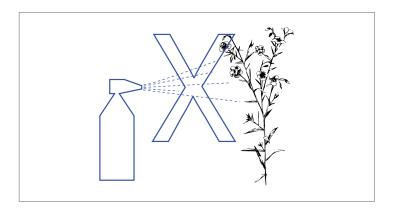




Cu.13 Don't Spray it!

Hypothesis

Implementing pesticide and insecticide-free agricultural practices will lead to enhanced biodiversity, improved soil health, and reduced environmental contaminations.



Links 🔳 🚫 🔘

Cu.3, Cu.4, Cu.6, Tr.23

Cu.14 Reed Edges

Hypothesis

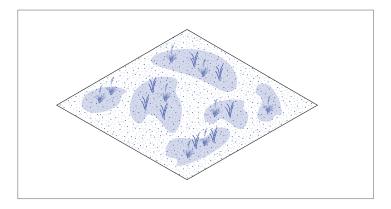
Reed can play a role in the erosion control, the water management, biodiversity conservation, carbon sequestration and biofiltration during the cultivation of flax and it can also be used as an insulation material.

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Hypothesis

Agricultural land that faces soil subsidence due to water pumping and clay ripening should shift to wet cultivation practices to prevent soil subsidence. This, in turn, prevents the oxidation of peat.



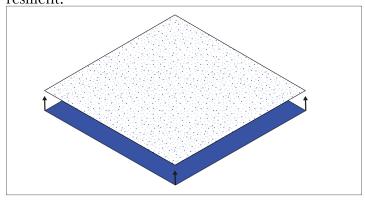
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Cu.1, Cu.5

Cu.16 Salt Tolerant Crops

Hypothesis

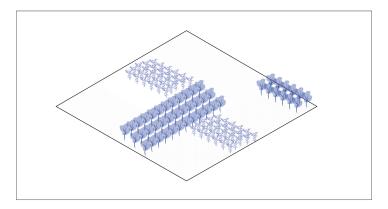
Due to sea level rise, groundwater in agricultural areas becomes increasingly more salt in certain areas. With these conditions, salt tolerant crops must be used to keep the landscape productive, yet resilient.





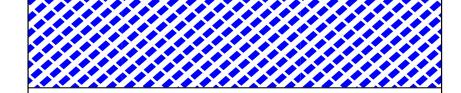
Hypothesis

To prevent or reduce soil compaction, trees could be planted which loosen the soil as a result from their root structure. They can, furthermore, be used to produce various biobased materials.



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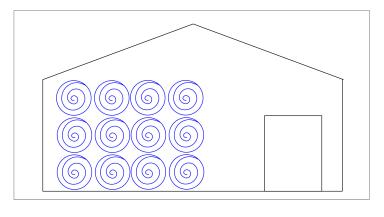
Cu.1, Cu.5, Cu.11



Pf.1 Storage Space

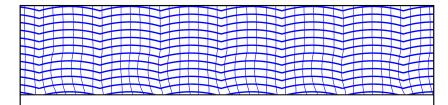
Hypothesis

Storage space on site is essential to manage seasonal fluctuations in supply and demand as well as to optimize logistics.



Links O

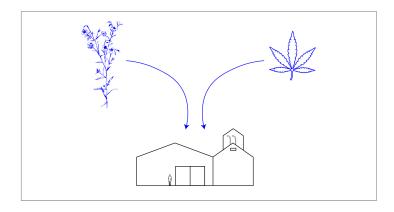
Tr.13, Tr.22, Pf.2, Pf.3

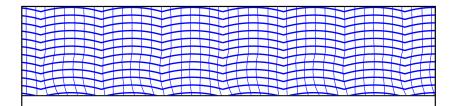


Pf.2 Flax - Hemp processing

Hypothesis

Integrating flax and hemp processing facilities, in proximity and accessable to both raw materials, will lead to synergistic benefits, including optimized resource utilization and raw material assurance.

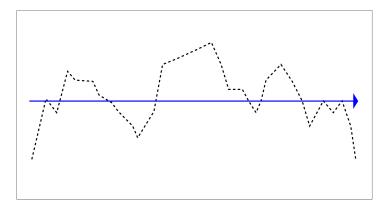




Pf.3 Flow Security

Hypothesis

Securing a steady flow within the flax value chain enhances efficiency, sustainability and fosters fair working conditions by providing stable employment opportunities and reliable income streams.



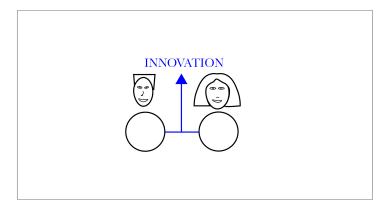
Links 🗌 🔘 🔵

Tr.21, Pf.1, Pf.2, Cu.7



Hypothesis

Establishing collaborations between industry and academia within the flax value chain will lead to accelerated innovation, knowledge transfer, and skill development.



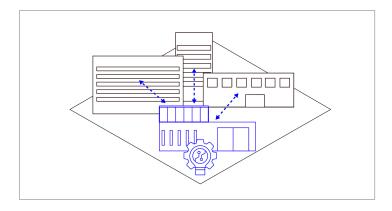
Links O

Fp.1, Fp.2, Fp.8, Fp.9, Fp.10, Tr.4, Tr.11 Tr.17, Pf.2

Fp.2 Composites on Campus

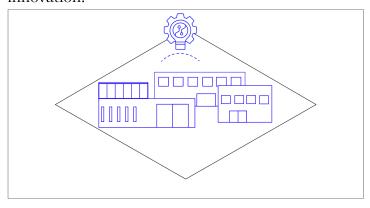
Hypothesis

Locating flax-based composite producers on technical campuses will foster collaboration that will eventually lead to innovation and sustainable solutions.



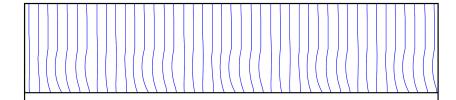
Fp.3 Mixing Complementary Making and Related Services Hypothesis

Mixing complementary manufacturing with related activities creates conditions for efficient work flows and provides opportunities for resource and knowledge synergies through cross-sectoral innovation.



Links O

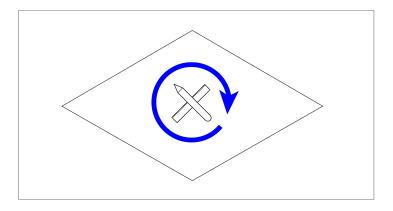
 $Fp.1,\ Tr.11,\ Tr.17, Fp.7, Fp.9, Te.2$



Fp.4 Circular product design

Hypothesis

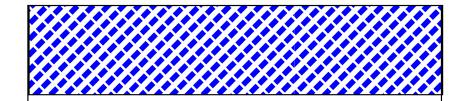
Circular product design minimizes waste, reduces environmental impact, and fosters a closed-loop system.



Links



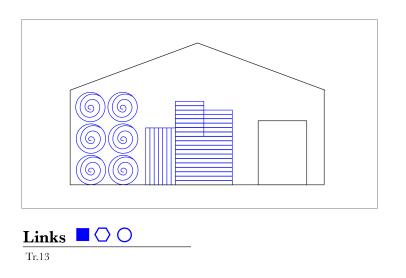
Tr.7, Fp.10, Fp.6, Co.1, Co.2

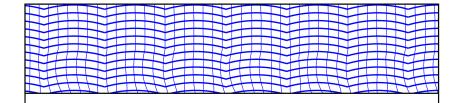


Fp.5 Storage Space

Hypothesis

Storage space on site is essential to manage fluctuations in supply and demand as well as to optimize logistics.

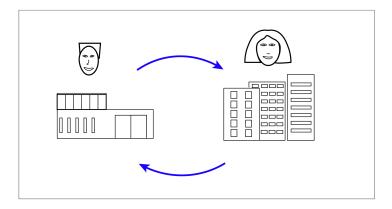




Fp.6 Extended Responsibilty

Hypothesis

If the producer's responsibility for a product is extended to the post-consumer stage, environmental considerations are taken into account already in the designing phase.



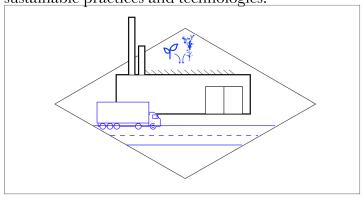
Links

Fp.4, Fp.10, Tr.7

Fp.7 Tranitioning in Insulation

Hypothesis

Current insulation-producing companies can transition to producing biobased insulation materials by leveraging their existing infrastructure, expertise, and market presence, while adopting new sustainable practices and technologies.



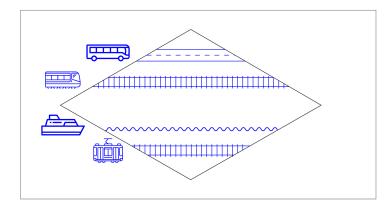


Fp.1, Tr.11, Tr.17, Fp.7

Fp.8 Access to Public Transport

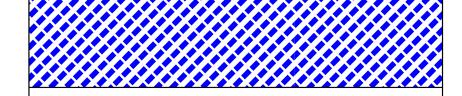
Hypothesis

Access to public transport will lead to improved mobility and accessability for workers, reduced commuting costs, and enhanced job satisfaction.



Links

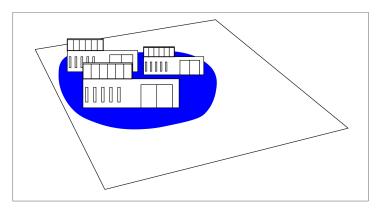
Fp.7, Tr.4



Fp.9 Clustering Similar Making

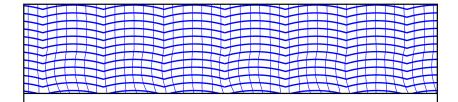
Hypothesis

Clustering similar types of manufacturing creates conditions for knowledge exchange, resource efficiency, collaboration, resulting in enhanced competitiveness and innovation.



Links O

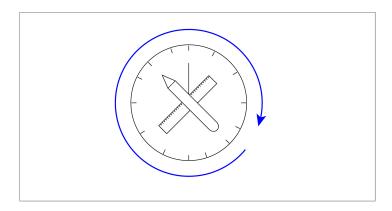
Tr.4, Fp.4, Fp.3



Fp.10 Design for durability

Hypothesis

When products are designed to be durable, resource use throughout the value chain gets reduced and the period CO2 is stored gets extended.



Links

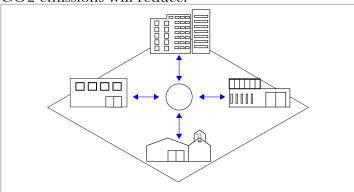


 $Tr.4,\,Tr.7,\,Tr.11,\,Fp.4,,\,Fp.6,\,Fp.7$

Ch.1 Circular Building Hub

Hypothesis

By placing circular building hubs to manage and store the material flows from and to construction sites and material suppliers on edges of (re)construction areas and close to infrastructure, transport and CO2 emissions will reduce.



Links 🗌 🔷 🔘

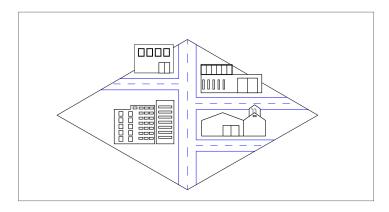
Tr.1. Tr.10, Tr.13, Tr.15, Tr.17, Tr.18, Tr.22, Tr.23, Ch.2, Ch.3, Ch.4, Ch.5, Ch.6

Ch.2 Accessable City

Infrastructure

Hypothesis

An accessible city infrastructure enables efficient transport from the circular building hub to the construction site.

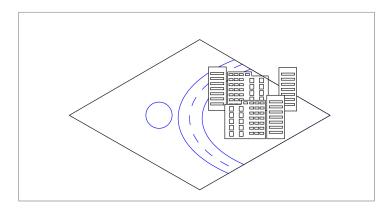




Ch.3 Located on City Edge

Hypothesis

Circular building hubs located on the edge of a city are in close proximity to constructions sites and are accessable to material suppliers outside the city.

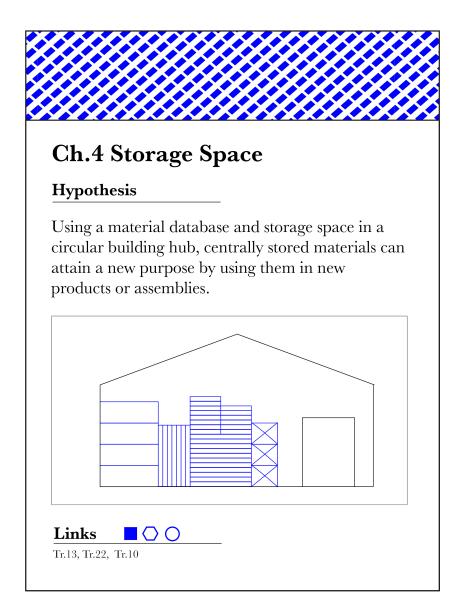


Links

Output

Outpu

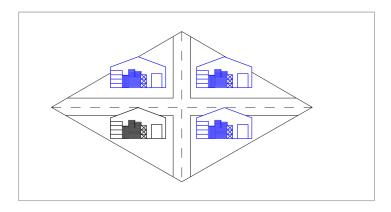
Ch.1, Ch.2, Ch.5





Hypothesis

Reserving room for expansion of the building hub accommodates adaptability to future growth and evolving needs.

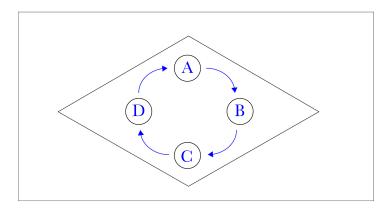


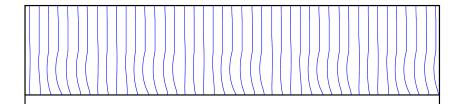
Ch.1, Ch.3, Tr.17, Ch.6

Ch.6 Transitional Uses

Hypothesis

Design and implementation of circular building hubs with adaptable infrastructure and modular configurations will enable transitions between different functions over time.

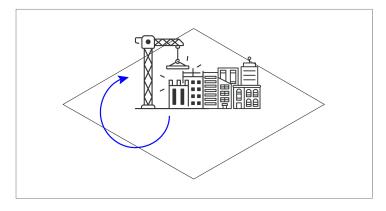




Co.1 Modular Construction

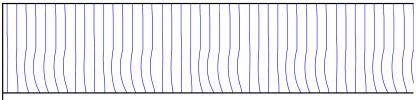
Hypothesis

Keeping the materials (de)constructable in a modular way assures that materials can be used multiples cycles and in multiple ways.



Links O

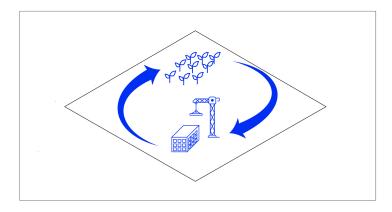
 $Co.1,\,Co.2,\,Fp.4,\,Tr.7,\,Tr.7,\,Tr.9$



Co.2 Biobased Building Materials

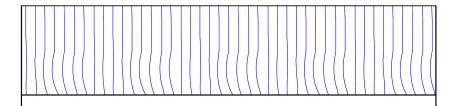
Hypothesis

The use of biobased building materials within the construction sector will lead to reduced carbon emissions and reliance on non-renewable resources.



Links O

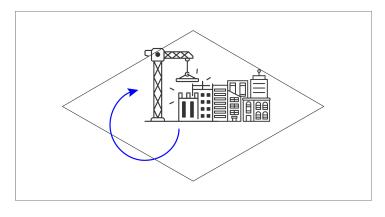
 $Tr.1, Tr.2, \, Cu.6, \, Tr.7, \, Tr.15, \, Tr.16, \, Co.1, \, Co.4, \, Co.5$



Co.3 Re-use materials

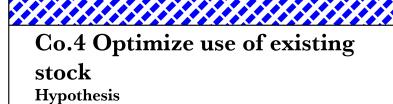
Hypothesis

With high-quality reuse of building materials, resource consumption along the value chain gets reduced and CO2 gets stored for a longer period of time.

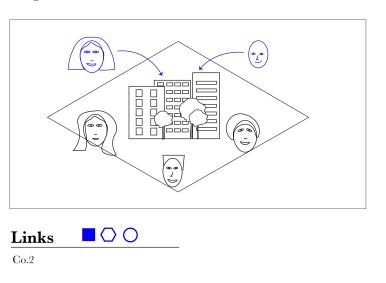


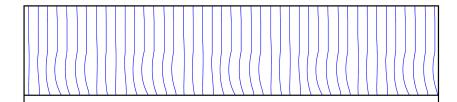
Links O

Co.1, Tr.9



By better utilizing the existing housing stock - through f.i. home sharing - the number of needed new houses decreases, thereby reducing materials usage and CO2 emissions.

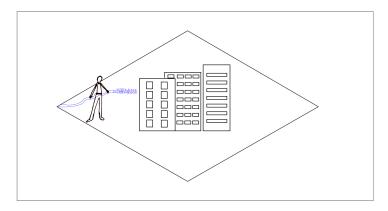




Co.5 Blow-in insulation shives

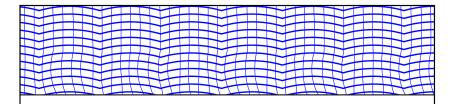
Hypothesis

Adopting blow-in insulation techniques and using flax shives for this amongst other materials will require less processing and result in improved construction efficiency.



Links O

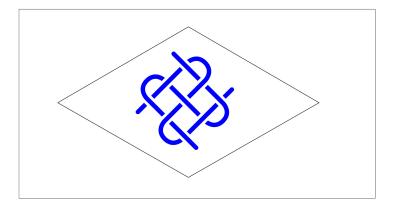
Co.2



Te.1 3D weaving

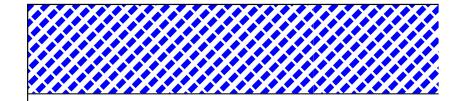
Hypothesis

Technology innovation in the field of 3D weaving can greatly reduce material demand and waste production in the textile value chain.



Links 🗌 🔾 🔵

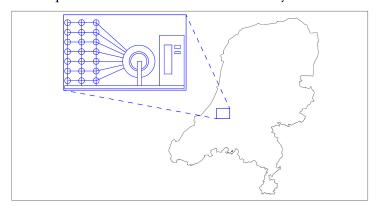
Tr.4, Tr.15, Te.2



Te.2 Local Spinning Facilities

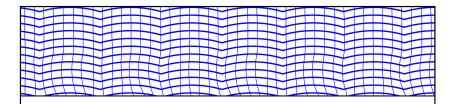
Hypothesis

Implementing spinning facilities in regions in regions in which there is somewhat of an infrastructure and knowledge base around spinning will reduce transport costs and emissions and makes the flax value chain less dependant on international trade dynamics.



Links O

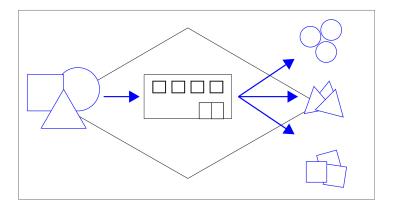
Tr.1, Tr.2, Tr.17, Fp.3, Fp.8



Te.3 Sorting Center - Building

Hypothesis

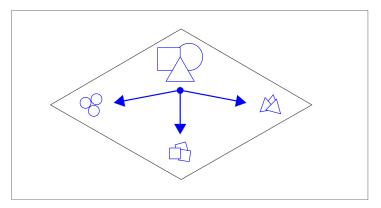
Sorting centers are essential for the repurposing of used textiles. Such textiles can be used in composite materials and as insulation material.



Te.4 Automized sorting

Hypothesis

Automized sorting of textile will result in increased efficiency. Technology innovation may enable the possibility to distinguish different material types and conditions, enhancing the potential synergy between the building and textile sectors.



Links



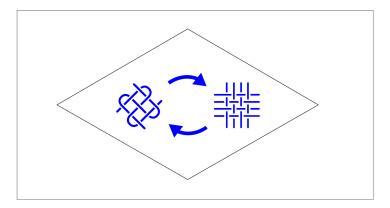


Tr.4, Tr.9, Te.3, Te.5



Hypothesis

Recycling textile to fibers again makes it possible for resources to be inserted into the flax value chain again. As such, the chain becomes a circular chain and resource consumption gets reduced.



Links 🗆 🔾 🔸

Tr.4