Reader manual

This document encompasses the developed questionnaire format tailored to the Boomveer innovation. For clarification, the typologies and typology clusters used to develop the question are presented in the same table as well, which align with the developed typology merged dataset. This dataset is used during the interview session with the company representative of the Boomveer innovation. However, due to sensitivity of the provided information, these results are only available on request. Furthermore, this tailored version is intended to be adaptable to other innovation, where typologies relevant to the new integrated technology should be used.

Economical					
Unique data entry	**Typology cluster**	**Question**	**High level answer**	**Detailed answer**	**Source**
Costs Embedded costs Investment costs Cost of capital Costs / m2 Ownership costs	Total Cost of Ownership (TCO)	What is the Total Cost of Ownership (TCO) over products entire life cycle? [euro / unit / year]			
Costs of implementation Installation costs Surcharge costs for installation	Implementation and installation costs	What are the total costs of installation of a product? [euro / unit]			
Management costs Running costs Operating costs Water costs Energy costs Maintenance costs per m2	Maintenance and Management Costs	What are the total costs of integral management of the tree? [euro / unit / year] Specify: - Water costs - Energy costs - Pruning costs - Labor costs - Other			
Product variation and Cost impact analysis Color/Grain Impact on Costs Cost Determinants	Cost Analysis and Optimization	What impacts the TCO of the product the most, and where lies chances for cost optimalization.			
Transportation Cost Analysis Transportation ease	Transportation Analysis	What are the costs of transportation? [euro / unit / year]			
Long-Term Savings Analysis Cost-Saving Measure Assessment Embedded costs VS returns Rate of return Payback time Economic productivity Cost recovery	Financial Sustainability Analysis	How much economical benefit is expected to be ‘generated’ by the innovation? [euro / unit / year]			
Product price Affordability	Product price	What is the price of the product? [euro / unit]			

<table>
<tr><td colspan="6">Market</td></tr>
<tr><td>Information aspect</td><td>Cluster</td><td>Question</td><td>High level answer</td><td>Detailed answer</td><td>source</td></tr>
<tr><td>Product alternatives

Comparative advantage over other alternatives

Comparison with water-permeable tiles

Effectiveness compared to alternatives

Technology parity

Carbon dioxide reduction (comparison to other technologies)

Innovation of the System</td><td>Comparative Assessment of Technology Alternatives</td><td>How does the innovation compare to other market available alternatives.

High level answer: use following format;

<table><tr><td>Aspect</td><td>Innovation</td><td colspan="3">Alternative</td></tr><tr><td></td><td></td><td>A</td><td>B</td><td>C</td></tr><tr><td>Heat mitigation</td><td>+++</td><td>+</td><td>++</td><td>+</td></tr><tr><td>Costs</td><td>+</td><td>++</td><td>+</td><td>+++</td></tr><tr><td>Maintenance</td><td>+</td><td>+</td><td>+</td><td>+</td></tr><tr><td>Sustainability</td><td></td><td></td><td></td><td></td></tr><tr><td>Innovative level</td><td></td><td></td><td></td><td></td></tr><tr><td>Life span</td><td></td><td></td><td></td><td></td></tr><tr><td>Synergy potential</td><td></td><td></td><td></td><td></td></tr></table>+ indicates low, +++ indicates high

Detailed answer: a detailed explanation can be given compared to other product alternatives.</td><td></td><td></td><td></td></tr>
<tr><td>Required parties for technology promotion</td><td>Required parties for technology promotion</td><td>What parties are needed for realization/promotion/implementation of innovation?</td><td></td><td></td><td></td></tr>
<tr><td>Risk of proactive approach</td><td>Risk of proactive approach</td><td>What is the major risk of investing in this innovation?</td><td></td><td></td><td></td></tr>
<tr><td>Likelihood of investment
Financial incentives
Green marketing
Investment horizon</td><td>Sustainable Investment Strategy (SIS)</td><td>What is the likelihood of investor interest in this innovation?

[are there already investors? And how is this expected for the future?]</td><td></td><td></td><td></td></tr>
<tr><td>Conflicts of economic interest</td><td>Conflicts of economic interest</td><td>Are there currently or expected conflicts of economic interest in the development and great scale implementation of this innovation?</td><td></td><td></td><td></td></tr>
<tr><td>Supply Chain readiness
Technology delivery time
Supply Chain Reorganization
Market conditions
Distribution network
Maximum Orderable Quantities</td><td>Supply Chain and Market Readiness</td><td>What is the level of readiness of the market for this innovation?

Express in terms of:
- Production process
- Distribution process
- Installation process
- Upscaling
- Costumers</td><td></td><td></td><td></td></tr>
</table>

Market ecosystem					

Technological requirements					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Maintenance Maintenance provider Maintenance Labor Intensity Maintenance Knowledge Requirement Maintenance accessibility Maintenance Adaptation Technology element replacement and maintenance Maintenance requirements and Scheme Maintenance patterns	Maintenance & management	What are the maintenance and management requirements for this innovation? Boomveer specific: - Irrigation - Pruning - Leaves - Nutrients - Labor intensity - Required knowledge - Other element maintenance (frame) - Maintenance scheme/frequency	-		
Cooling Water requirements Irrigation requirements Water requirements Water demand Water usage Minimum Water Collection Size (requirement)	Water Resource Management	What are the requirements with respect to water? - How much water is required - What quality of water is required - Other?			
Pruning requirement	Pruning requirement	What are the requirements in terms of pruning?			
Energy demand	Energy demand	What are the requirements in terms of energy (electricity)? Expressed in [kwh / unit / day]			
Underlying Surface Requirements Soil Layer Requirement Ground implementation	Ground integration criteria	What are the requirements with respect to the ground or surface where the innovation is implemented?	-		

Requirements Soil layer requirement Soil (requirement) Installation depth Requirement					
Root Space Requirements Space	Space requirement	What is the minimal space required for the implementation of this technology?	-		
The amount of technology needed to get effect Thermal Impact Threshold Density	Technology Dosage				
Required slope and drainage systems	Slope and Drainage Requirements:	Is there a form of water drainage needed? for example via a slope?			

Functionality & effect					
Information aspect	**Cluster**	Question	High level answer	Detailed answer	source
Effectiveness	Heat Mitigation Effectiveness	What is the (hypothesized) effect of the innovation with respect to: - Air temperature - Surface temperature - Humidity Express these answers qualitatively (descriptive) and quantitative (with numbers) if possible.			
Effect on Heat stress					
Heat reduction per square meter					
Heat reduction (Qi et al 2022)					
Thermal Impact					
Heat Reducing Capacity					
UHI reduction (lucertini 2022)					
Urban cooling (Qi 2022)					
Nocturnal air temperature (de groot-reichwein et al)					
Land surface temperature (Qi 2020) Qi 2022, lucertini 2022					
Air temperature Qi 2022 Qi 2020					
Outdoor thermal comfort index (Qi 2022 & Qi 2020)					
Scale of effect (yamamoto 2016, lucertini 2022)					
Degree of effect (yamamoto 2016)					
Reliability (puig et al) (haselip et al)	Technological reliability and quality	How reliable is technology in terms of its intended effects?			
Technological					

quality Functional uncertainty (puig et al)					
Effect on other parameters involved in perception of heat	Comprehensive Heat Mitigation Effectiveness	Does the technology contribute to mitigation to other parameters that contribute to the human experience of heat.			
Shading effect	Shading effect	What is the shading effect of the technology? Express in terms of m2 shadow per unit.			
Albedo effect technology	Albedo effect	What is the albedo of the innovation? Express in value of 0 – 1			
Color-Surface Temperature Relationship	Color-Surface Temperature Relationship	What is the relation between the color of the surface of the innovation and its effect on the surrounding temperature.			
Time scale Optimal benefit period Period (yamamoto 2016)	Temporal effectiveness	How long does the intended effect last for? And when is innovation most effective ?			
Performance in freezing temperatures Slipperiness and need for salt	Cold weather performance	How is the functional performance of the innovation changed in cold temperatures.			
System Operation	System Operation	How does the innovation needs to be operated? Does it need operation apart from maintenance and management?			
Water Reuse from Crate	Water Reuse Capacity	Can water be reused for this product?			

Storage Potential to reuse water from roofs for maintenance Water Reuse Capacity		Can water that drains from this product be reused?			
Water capture rate Water storage capacity Water storage capacity (lucertini 2022)	Water capture and storage capacity	How much water can be captured and stored by the product? Express in m3/ unit Also indicate how long a certain volume can be stored			
Water purification steps	Water purification steps	- Not for boomveer -	-		
Evaporation Regulation	Evaporation Regulation	Can the evaporation rate be regulated?			
PM 2.5	Air pollution reduction	Does the product contribute to air pollution reduction? Express qualitatively (descriptive) and quantitative (numbers) if possible.			
Energy efficiency (puig et al) Energy savings (qi et al 2022), lucertinit 2022	Energy performance	-Not for boomveer-			

Design					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Context design 'different building types' How does if fit in larger scale urban planning & context	Urban context compatibility	How compatible is the product with the urban environment? - How easy is implementation into urban environment as we currently know it			
How well does it fit with underground soil structure Landscape Integration Site Orientation Site suitability Applicability on clay soil Technology placement	Landscape Integration and Technology Placement (LITP)	How well does it integrate with current landscape and are there requirements where this product needs to be implemented?			
Load bearing capacity Weight per square meter (kg/m2) Built area ratio Density Area to volume ratio	Structural Characteristics	What are the structural characteristics of the product? - Weight - Load bearing capacity - Volume - Area			
Dimensions Tree-canopy area Root depth	Dimensions	What are the dimension of the product? - Height - Width			

Vegetation height					
Aesthetics of design Colour variation Colour Shape Customization and Patterns Unpleasant appearance	Aesthetic Design Features	What are the variations in design in terms of: - Colour - Pattern - Shapes - Etc.	-		
Pre-installation adaptability Adaptability to Uneven Surfaces	Flexible Installation Design	How flexible is the installation of this product?			
Post-installation adaptability Tactical / removable Accessibility to Underground Infrastructure Modular Accessibility Replaceability	Flexible Maintenance Design	How flexible is the design after installation in terms of: - Replacement - Element replacement - Modifications - ETC.			
Seasonal adaptability	Seasonal adaptability	Does product change during seasonal changes? And what does this do to functionality?			
Height limitation	Height limitation	What are the minimum and maximum heights of the product?			
Time scale Lifespan Longevity Survival Time scale	Temporal Resilience	What is the lifespan of the product?			

implementation Durability					
Recyclability Material Reuse and Recycling Material Reusability Product reusability Circularity Circular economy considerations Disposal	Circular Material Management	What is the material circularity of the product components?	-		
Permeability Melting temperature Surface characteristics Material	Material characteristics	What are the material characteristics of the product in terms of: - Permeability - Fire resistance			
Material Flexibility Plant Diversity Vegetation species Technology versatility Tree compatibility	Material Design Flexibility	Range of flexibility in material usage, plant species diversity, etc.?			
Material biodegradability	Material biodegradability	Is the product fully biodegradable	-		
Sustainability production Degree of	Sustainable Manufacturing	Degree of sustainability of the production process.			

sustainable production process Sustainability material usage					
Sustainability transportation	Sustainability transportation	How is the product transported and how sustainable is this			
Natural Solutions	Natural Solutions	Can the product be changed to incorporate more natural elements?			
Vehicle Access Reinforcement	Vehicle Access Reinforcement	-not for boomveer-			
Growth potential in confined space	Growth potential in confined space	Is the growth potential of vegetation restricted by product?			
Walkability Inclusivity Path Integration	Pedestrian-Friendly Inclusive Design	-not for boomveer-			
Green surface area	Green surface area	-not for boomveer-			

Synergy					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Multifunctional Synergy Synergy potential Synergistic Technology Analysis	Synergistic Technology Integration	What are the synergy effects of the product and where lie future synergetic collaborations with other technologies?			
Can it function as water catchment area Integration with Drainage Solutions Sewage relief capacity	Water Integration Capacity	What is the water storage capacity of the product ? In terms of: - Quantity [m3/ unit] - Duration of storage			
Combination with green infrastructure Water buffer for irrigation Synergy – irrigation Synergy – vegetation compatibility Technology-Tree Synergy	Green Infrastructure Integration	Can it form synergy with other vegetation systems			
Recreational synergic potential Child-Friendly Design	Recreational Integration	Can product contribute to recreational purposes? For boomveer: - Can place at recreational site? - Can children climb in tree - Can frame be made for sitting? - Can tree used to hang a hammock			
Ecological benefit	Ecological benefit	What are the ecological benefits of this product ?			

Social					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Social impact Social Benefit Expression Social value Social 'user groups'	Societal Impact	What is the assumed impact of this product on society? Positive effects? Negative effects?			
Citizen participation on design Citizen participation on decision making process Resident co-management of technologies	Community Engagement	To what extend is the community engaged with this product? In tis design? In tis maintenance ? Is it user-friendly Can citizens also get product?			
Community engagement and communication Living lab communication Resident information communication	Community Information and Engagement	How is information regarding this product/technology transferred to the community (social) and how does this contribute to engagement, acceptance and participation?			
Citizen urgency Municipality urgency	Stakeholder urgency	What is the assumed urgency of this technology for different stakeholders? And how can urgency be increased?			
Recognition for work Motives for initiative	Recognition and Motivation	Why should someone advocate for the implementation of this specific technology?			
Contribution to awareness Community Sensitization on Greener Public Spaces with Low Investment Public acceptance Public awareness Public knowledge Socio-Technological Acceptance	Awareness and acceptance	How does this technology contribute to acceptance of these types of innovations, and the awareness of problems in the urban environment such as climate change, UHI effect,.			
distribution of	Equitable Technology	How is the implementation of this product			

technology benefits Social Sensitivity	Implementation (ETI)	distributed in society? Only rich or poor Who is most likely to benefit from products?			
Job creation	Job creation	Does this product contribute to new job creation?			

Governmental					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Compliance with public space consultation regulations Public space handbook compatibility Compliance to standards Legislations Legal framework Bureaucracy Legal considerations Legal feasibility Procedural time Administrative considerations Regulatory Landscape Technology placement and regulations Arboricultural Permit	Regulatory compliance and permitting	What are current regulations and laws that have impact on this technology and its implementation? (these can be national laws, municipality guidelines, etc.) - Needed permits for implementations - Height limitations - Places not allows for installation - Types of trees not allowed - Etc. And; what is the likelihood that future regulations might impact this technology			
Contribution to municipal policies Regulatory Advocacy	Contribution to municipal policies	To what extend does this technology/product comply with municipal guidelines ?			
Funding support Subsidies potential	Funding support	Are there funding programs that support this product in any way? - Development - Implementation - Can people get funding for implementation in garden for example. - Can project developers get funding for implementation in their projects. - Etc.			
Actor	Actor involvement	How involved are different actors with the			

involvement		development and implementation of this product?			
Property ownership Ownership	Property ownership	Who is the owner of this product over its life cycle? And what about after its functional life cycle? Who is responsible?			
Presence of product warranty Technology warranty	Legal product performance assurance	Is there a product warranty that legally assures the product performance over a certain extend of time?			
Legislative Mandate	Legislative Mandate	Are there known legislative mandates to promote this technology/product?			
Political commitment to technology Policy support Political acceptance	Political Technology Endorsement (PTE)	To what extend is this product supported by policy?			
Management capacity Available resources Resistance to change Monitoring capacity	Organizational Technology Competence (OTC)	To what extend are government agencies open, able and motivated for the implementation of this technology? - Do they have management capacity - Do they have the required knowledge - Is there a resistance to this product			
Conflicts of interest	Conflicts of interest	Are there any conflicts of interest regarding the implementation of this technology/product in terms of policy?			

Impact & vulnerability					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Functionality impact Disturbance of inplace function What to do with replace material Replacement of in place structure Installation impact Impact on building facades	Integration and Replacement Impact	How is the site of implementation affected by the installation of the technology: - Is there permanent damage? - Does installation requires removing of inplace material (such as removal of inplace tiles etc.)			
Water pollution Leaf litter impact	Water Quality Impact of Technology	Does the technology/product negatively impact quality of water of: - Runoff - Due to leaf litter impact - Water draining from product			
Potential soil contamination Soil drought Soil Organisms' Reactions to the Technology Soil Impact on Performance	Soil-Environment Relationship	-not for boomveer-			
No Groundwater Recharge Groundwater Level Impact on Performance	Hydrogeological Interaction	-not for boomveer-			
Potential negative effects	Technology’s dual impact	What are potential negative effects of this technology/product?			

Trade-off effect					
Vulnerability to damage Wear resistance Vulnerability to misuse Vulnerability to neglect Vulnerability Environmental sensitivity Vulnerability to removal	Technology Resilience and Robustness	How vulnerable is this technology/product to: - Misuse - Neglecting - Misuse - Mis management - Vandalism - Etc.			
Technology Vulnerability to Weather Wind displacement considerations Seasonal effects Slip hazard Dry Period Maintenance Drought Resilience Peak rainfall response	Climate Resilience of Technology	How resilient is this technology to changing weather conditions: - Wind - Rain - Drought - Solar intensity - Freezing - Peak rainfall events			
Impact on biodiversity Ecological response Environmental impact Technological	Ecological Impact	Is there an impact of this technology/product on surrounding ecology? - Negative ? - Positive?			

Impact on Ecological Connectivity					
Root Impact on Path Material	Vegetation-technology Interaction	-not for boomveer-			
Plant Growth Through Material					
Fire Resistance	Fire Resistance	How resistant is this technology/product to fire?			
Pest and Pathogen Management in Water Buffer Technology	Pest and Pathogen Management	Is there a risk on pest and pathogens for this technology / product; - Is it vulnerable to them - Does it facilitate them			
Mosquito Infestation					
Shoe Cleanliness	End User Impact	--not for boomveer-			
Public health	Public Health impact	Can this technology/product have an impact on public health?			
Mortality and morbidity					

Implementation & Installation					
Information aspect	Cluster	Question	High level answer	Detailed answer	source
Application possibilities of technology Applicability in market or event settings Location of deployment Possible application beyond parking lots Roof-based Implementation Versatility of use Multi-functional compatibility	Versatile Application	How versatile can it be applied roofs parks streets markets			
Previous technology deployment Technology Performance Studies	Technology Deployment History	Is this technology already deployed and proved to work.			
Context readiness for implementation	Context readiness for implementation	How ready is the context of implementation acceptance how much to people want product is production ready			
Installation responsibility	Installation responsibility	Who is responsible of installation			