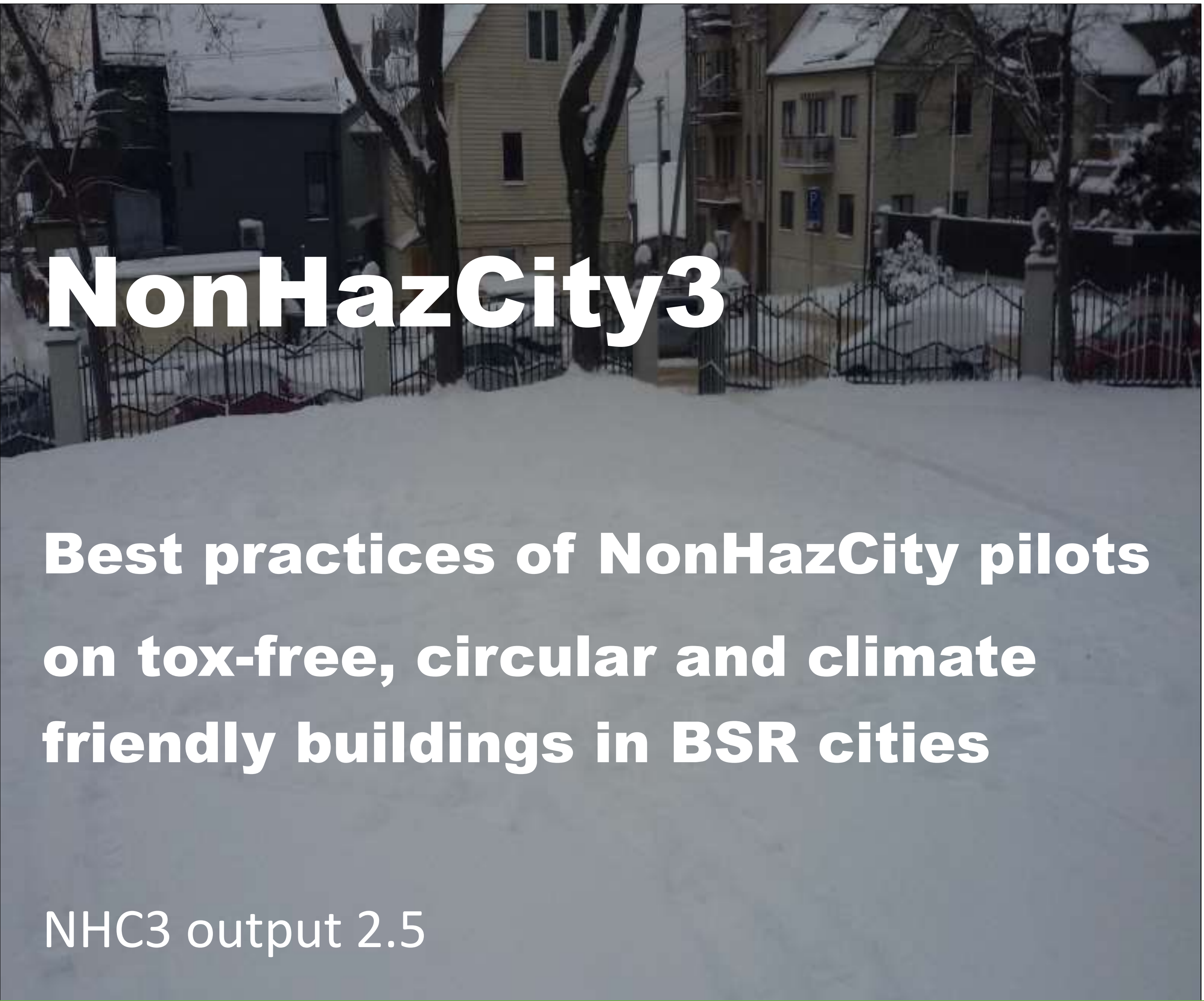

NonHazCity3

Best practices of NonHazCity pilots on tox-free, circular and climate friendly buildings in BSR cities

NHC3 output 2.5

Interreg Baltic Sea Region

Co-funded by the European Union

SUSTAINABLE WATERS

NonHazCity 3

NonHazCity

Best practices of NonHazCity pilots on tox-free, circular and climate friendly buildings in BSR cities

Authors: Jolita Kruopienė and Edgaras Stunžėnas from Kaunas University of Technology

Based on input and comments from: Riga City Council, City of Stockholm, City of Västerås, City of Helsinki, City of Tallinn, Auraplan Architects (Parish Maria Magdalenen, Hamburg), Holbaek municipality, Turku University of Applied Sciences, POMInnO Ltd, BVB Service AB, Baltic Environmental Forum Germany, Baltic Environmental Forum Estonia, Environmental Forum Latvia, Baltic Environmental Forum Lithuania, Ecodesign Competence Centre, NOMAD architects, professionals and private residents who tested the solutions.

NHC3 GoA2.5. Output O.2.5

June 2025

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Contents

Abbreviations

BVB:	the Byggvarubedömningen® database
DIY:	Do-it-Yourself
DGNB:	German Sustainable Building Council (Deutsche Gesellschaft für Nachhaltiges Bauen)
ED:	endocrine disruptors
GPP:	green public procurement
HS:	hazardous substances
IT:	information technologies
PFAS:	per- and polyfluoroalkyl substances
OPEs:	organophosphate esters
SDS:	safety data sheet
VOCs:	volatile organic compounds

Glossary

Interreg-specific:

Innovative **solutions and sub-solutions** can be procedures, instruments or tools (including physical objects, methods, concepts, or services, etc.). To lead to the desired results, solutions have to be tailored to the needs of final users, also considering the respective framework conditions. Solutions should ideally be deployed in the project's lifetime and taken up by a large number of institutions.

Pilot (pilot action) – a pilot action is an implementation-oriented activity which tests novel approaches and leads ultimately to the implementation of newly gathered knowledge and related solutions.

NonHazCity-specific:

Three-pillar approach – an approach that leads to non-toxic, circular and climate friendly buildings.

Tox-free – refers to a construction that avoids hazardous substances in building materials or finishes.

Circular – a closed-loop system for resources, materials and products, which maintain the value and utility of resources and products for as long as possible and minimizes waste and maximizes resource efficiency. It promotes recycling, reusing, refurbishing, and sharing, while prioritizing easy repair, upgradability, and disassembly. For the sake of environmental and health impacts, it is important to avoid hazardous substances in material cycles.

Climate friendly – involves application of products, components, technologies and construction practices which tend to have the least possible greenhouse gas emissions.

Introduction

This publication presents **assessment and evaluation of strategic and practical solutions** developed within the NonHazCity 3 (NHC3) project ("Reducing hazardous substances in construction to safeguard the aquatic environment, protect human health and achieve more sustainable buildings"). The developed solutions intend to contribute to making construction materials and building management circular, climate friendly and TOX-FREE (the so-called three-pillar approach), and this way to reduce emissions of hazardous substances (HS) from construction materials, buildings and construction sites and protect the (aquatic) environment and human health.

Solutions are published:

- Strategic solutions for managing procedures for construction materials and sites
- Step-by-step guide for the process management of toxfree construction at municipalities
- An introduction to Byggvarubedömningen® database - a tool for sustainable construction
- The NHC3 series of fact sheets for professionals involved in the construction business, highlighting the three pilar approach
- An introduction of an extension to the existing consumer app "Check(ED)"
- DIY Guide "Toxfree, circular and climate friendly renovation of my home"

Available at https://interreg-baltic.eu/project/nonhazcity-3/

Solutions have been tested by seven pilot actions:

- five of them involved mainly different municipalities from the Baltic Sea region countries,
- one involved construction sector professionals dealing with design and construction of tox-free, circular and climate friendly private houses,
- and one more involved inhabitant dealing with do-it-yourself (DIY) renovations.

Pilot actions and their achievements are summarized in publications:

- NonHazCity3 Strategic solution for managing hazardous substances in buildings, and construction materials: procurement, building certificates and restrictions
- The NonHazCity guide for design & construction of tox-free, circular & climate friendly municipal buildings
- Report from the pilots on private house design & construction and DIY renovations by inhabitants

Available at https://interreg-baltic.eu/project/nonhazcity-3/

Based on solutions testing, this publication summarizes (chapter 1) which alterations municipalities have made/ have to make to management processes to become best practice cases when implementing chemical smart approaches in construction processes, how helpful are all the proposed solutions in achieving tox-free, circular and climate friendly buildings, what works well and what are the challenges.

How to achieve best practice construction? Insights on conditions for applicability of the proposed solutions, transnational differences, and general advice on successful integration of the chemical-smart approach are presented in chapter 2.

Implications of adoption of best practices on receiving water quality are discussed in chapter 3.

Other project publications, relevant to achievement and assessment of best practices:

- Publication on the Occurrence of substances of concern in BSR buildings, construction materials and sites
- Building material catalogue for tox-free construction
- NonHazCityTraining Course on tox-free, circular and climate friendly building projects and renovation
- Tox-free building blueprint: chemical criteria for building certification and procurement draft

Available at https://interreg-baltic.eu/project/nonhazcity-3/

1 Evaluation of strategic and practical solutions leading to tox-free, circular and climate friendly construction

The evaluation aims to assess how effectively different solutions contribute to tox-free, circular, and climate friendly construction practices. It involves a combination of quantitative assessments and qualitative reflections provided by the implementers of pilot activities.

A diverse group of actors, including municipalities, private individuals, and construction professionals, tested strategic or practical solutions and sub-solutions developed within the NHC3 project.

To assess each tested solution, implementers of pilot actions completed structured templates and spreadsheets. The evaluation included a set of predefined, targeted questions addressing these key aspects:

- legal feasibility (except for DIY guide and consumer app "Check-ED"),
  (refers to whether existing laws, policies, or environmental commitments support or hinder the implementation of the solution),
- technical applicability
  (assesses whether limitations in technology, data availability, or materials restrict the solution's implementation),
- financial viability
  (evaluates whether the costs and funding constraints affect the affordability and economic viability of the solution),
- social acceptability
  (reflects the extent to which stakeholders, including the public and municipal staff, positively receive and support the solution),
- and potential for transferability, replicability, and scalability
  (measures how easily the solution can be adopted in different contexts, municipalities, or regions beyond the original project).

For each question, respondents selected "yes," "partially," or "no," and were encouraged to provide detailed comments based on their implementation experiences. These responses were then assigned scores, enabling a quantitative comparison of solution performance across the assessed aspects. Three questions were asked for each aspect, with a maximum score "2" for each question. Thus, the maximum possible score for each of the aspects is equal to "6".

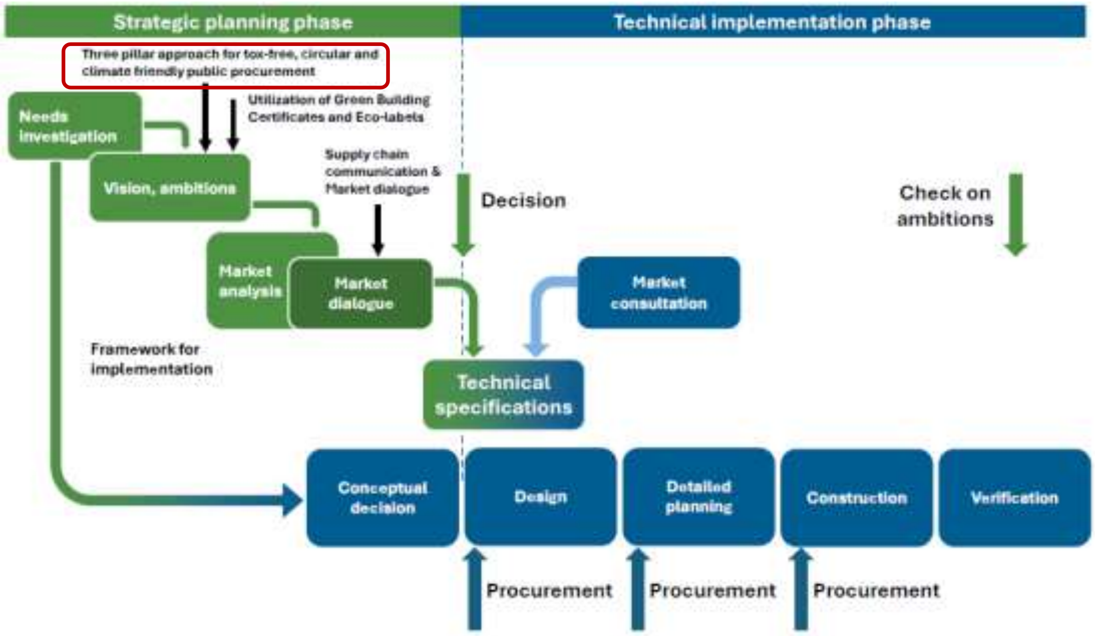
Beyond scoring, pilot implementers also responded to open-ended questions that captured observations, lessons learned, good practices, and challenges encountered during implementation. These reflections provided context and helped to highlight synergies and trade-offs among the solutions tested.

The collected data - both numeric and narrative - formed the basis of the evaluation results presented in this document. A full list of evaluation questions is included in the Annexes.

1.1 Evaluation of strategic solution

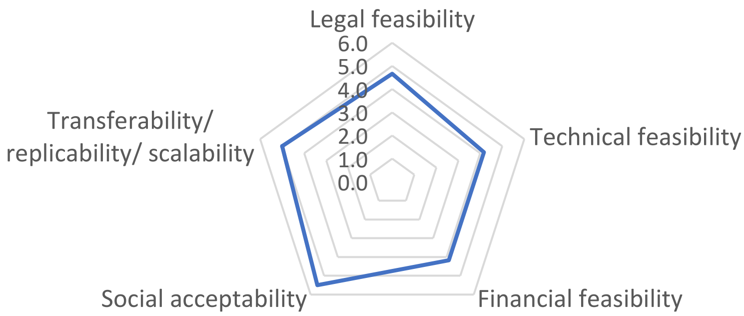
Strategic solutions on managing procedures for construction materials consists of three sub-solutions.

1.1.1 The three-pillar framework for tox-free, circular, and climate friendly public procurement of construction materials and buildings



The three-pillar framework for tox-free, circular, and climate friendly public procurement of construction materials and buildings shows significant promise, particularly excelling in social acceptability (5.5) and transferability/replicability/scalability (5.0). This high social acceptance stems from a positive public and internal perception of tox-free materials, enhancing occupant well-being and a city's reputation, while its transferability is aided by generally permissive national procurement laws, especially where local political will aligns. Legal feasibility (4.7) is also strong, with existing national frameworks largely accommodating such initiatives. Although technical (4.2) and financial (4.2) feasibility scores indicate areas for development, they are far from prohibitive, pointing to practical challenges like data availability and sourcing specific eco-labeled products, or the potential for higher upfront costs. The long-term financial benefits, such as reduced disposal expenses and improved building performance, underscore the solution's overall viability. Further national standardization and readily accessible material databases would undoubtedly bolster these aspects, accelerating the framework's broader adoption.

Quantitative assessment results of the solution: The three-pillar framework for tox-free, circular, and climate friendly public procurement of construction materials and buildings



Explanation of the assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations worth sharing
Legal Feasibility	
There are no direct legal constraints against implementing procurement criteria for avoiding HS. National procurement acts often encourage or allow the inclusion of environmental and social aspects criteria.	⇨ Some municipalities noted a lack of strong mandatory national-level requirements specifically targeting HS, making it reliant on the municipality's own initiative and expertise. ⇨Policy and political will at the local level (e.g., municipal environmental strategies, carbon neutrality goals) act as significant drivers for incorporating stricter environmental criteria, including those related to HS, and these are expected to persist beyond project timelines. ⇨ Upcoming elections or significant events can create windows of opportunity for introducing stricter environmental procedures.
Technical Feasibility	
No significant IT limitations were reported. However, the availability and access to reliable data on chemicals in construction materials posed a challenge across several municipalities.	⇨ The lack of unified national databases for chemical content in construction materials makes verification difficult, often relying on SDS that is potentially incomplete, and it is required only for some products. ⇨ Ensuring the availability and suitability of HS-free materials can be a concern, with some projects facing difficulties in sourcing specific eco-labeled or certified products. ⇨ The absence of dedicated software for managing HS information in public projects was noted by at least one municipality.
Financial Feasibility	
A potential increase in costs associated with eco-labeled or third-party verified sustainable materials (e.g., EPD) compared to conventional options was a recurring concern.	⇨ Financial resource constraints within municipal housing companies or general budget limitations can hinder the adoption of more expensive, environmentally preferable materials. ⇨ While upfront costs might be higher, some municipalities recognized the potential for long-term financial benefits through reduced disposal costs, improved building performance (e.g., energy efficiency), and increased property value due to certifications like DGNB. ⇨ Standardized procurement texts can streamline the procurement process over time, potentially reducing long-term financial costs for both the municipality and its partners.
Social Acceptability	
There is generally a positive perception of efforts to use tox-free construction materials, both within the municipality and among residents, contributing to the city's reputation and the well-being of occupants.	⇨ While the overall acceptance is positive, internal resistance from employees (e.g., project managers with traditional construction backgrounds) towards new, potentially time-consuming or knowledge-intensive requirements can occur. Ongoing education and clear communication of the benefits are crucial. ⇨ External stakeholders, like contractors, might initially resist stricter criteria if they perceive it as increasing their costs or reducing their chances of winning bids. Clear communication and demonstrating the long-term value are important. ⇨ Highlighting tangible social benefits, such as improved indoor air quality and reduced health risks, can strengthen public support.

Transferability/ replicability/ scalability	
The general consensus is that GPP criteria and related guidelines can be transferred and replicated to other municipalities, although local contexts and priorities need to be considered.	⇨ Smaller municipalities might find it easier to adopt innovations due to less complex organizational structures compared to larger cities, which often face more stringent bureaucratic processes and higher demands for justifying increased costs or non-standard procurement choices. ⇨ The level of existing knowledge and resources (financial and human) within a municipality significantly impacts its ability to implement and validate HS criteria effectively. ⇨ National-level standardization of regulations and the development of accessible databases on material content would greatly facilitate wider adoption across the Baltic Sea region. Prioritization and political will are key factors for successful expansion.

Summary of general observations regarding the use of the three-pillar framework for tox-free, circular, and climate friendly public procurement of construction materials and buildings:

- **Success Factors:** Start with pressing issues, foster collaboration, and demonstrate clear benefits (potentially linked to worker safety, water quality, etc.): this can drive successful implementation. Positive reinforcement and starting small are also recommended.
- **Challenges:** Overcoming organizational inertia in large entities, addressing data quality issues, justifying increased costs to funders, and managing conflicting goals are key challenges.
- **Impact of the sub-solution:** green public procurement (GPP) criteria and certifications like DGNB are seen as effective in reducing HS and promoting tox-free, circular, and climate friendly construction by guiding material choices and improving indoor environmental quality.
- **Synergies:** Integrating HS reduction with other sustainability goals (e.g., energy efficiency) and quality control processes can create positive synergies.
- **Suggestions for improvement:** Focus on measurable and verifiable criteria, advocate for stronger national legislation and databases, and provide adequate training and resources for municipal employees.

Quotes from piloting municipalities:

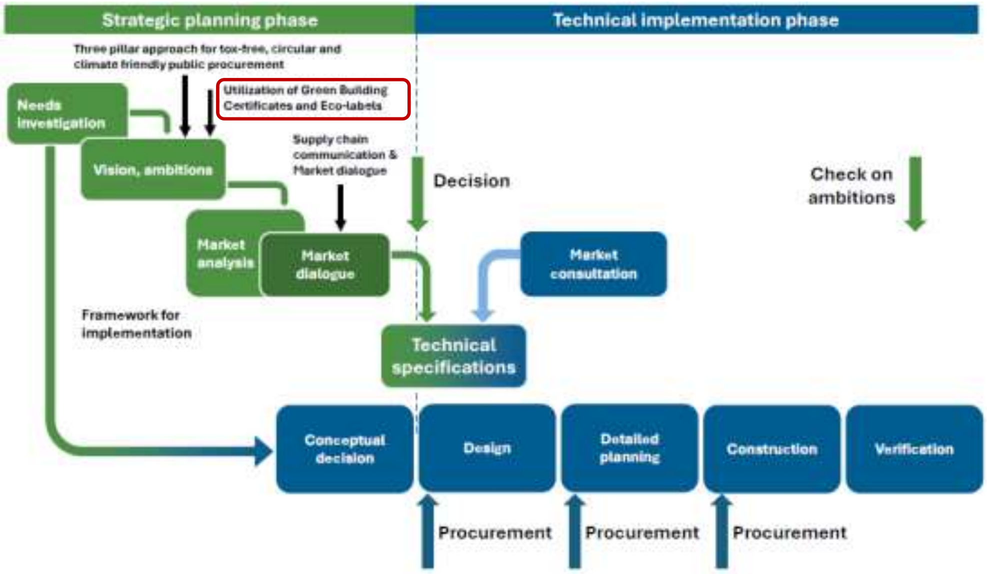
Helsinki: **"GPP criteria are now a normal tool - the key was incremental updates and aligning with city climate goals."**

Tallinn: **"Without measurable HS criteria and validation mechanisms, GPP remains aspirational."**

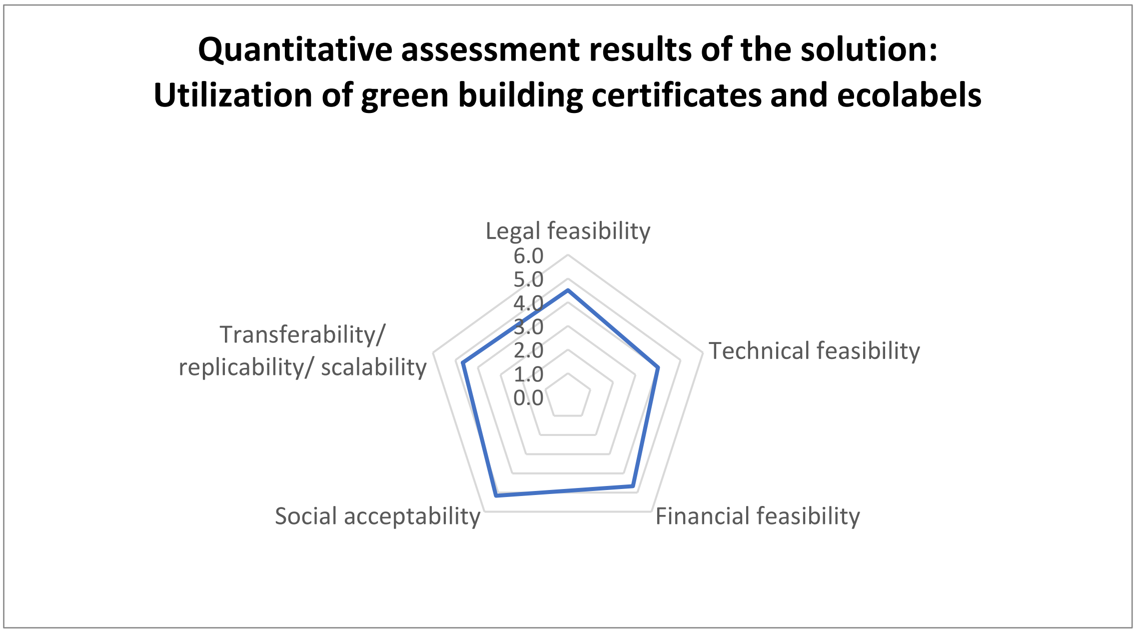
Stockholm: **"Sustainability people vs. construction people can be a real divide - internal education bridges this."**

Västerås: **"Higher costs triggered debates, but community pride in the project outweighed objections."**

1.1.2 Utilization of green building certificates and ecolabels



The "Utilization of green building certificates and ecolabels" demonstrates strong potential, with social acceptability scoring highest at 5.2, reflecting a positive reception for healthier buildings despite some practical resistance due to perceived workload and cost. Legal feasibility also scores well at 5.0, indicating existing frameworks can accommodate the solution, though the need for specific national mandates for HS and circularity is still apparent. While financial feasibility (4.7) presents challenges with upfront costs for certified materials, the long-term benefits are recognized. Transferability/replicability/scalability (4.7) is promising, emphasizing the need for national-level initiatives to facilitate broader adoption across varying municipal capacities. The main area for improvement lies in technical feasibility (4.0), primarily due to a lack of robust, accessible data on material content and circularity, which makes verification processes time-consuming for municipalities.



Explanation of the assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
There are no direct legal prohibitions against the utilization of green building certificates and ecolabels. However, national legislation lacks specific mandates for their utilization to integrate HS and circularity.	⇨ Existing building regulations and procurement laws can accommodate the inclusion of building certificates, provided they comply with general procurement principles. ⇨ A lack of binding national requirements for HS and circularity in construction makes mandatory utilization of these certificates challenging and hindering budget allocation. ⇨ Proactive municipal initiative (e.g., using DGNB) demonstrates that progress is achievable even without strict national mandates, highlighting the importance of internal will.
Technical Feasibility	
Access to comprehensive and reliable data on the chemical content and circularity potential of construction materials remains a key technical limitation.	⇨ Effective utilization of green building certificates and ecolabels relies on robust data management systems and accessible, standardized material databases, which are currently lacking. ⇨ In case of building certification, information verification is time-consuming for municipalities, sometimes exceeding their resources and expertise. Thus, external support might be needed. Municipalities may choose to build in-house competence, but this takes time.
Financial Feasibility	
Implementing stricter HS and circularity requirements can lead to increased upfront costs, particularly for certified or eco-labeled materials and the added workload of verification.	⇨ Financial constraints and a focus on lowest-bidder procurement can act as barriers to adopting more sustainable but potentially more expensive solutions. ⇨ The long-term financial benefits, such as reduced disposal costs, lower maintenance, and increased property value (due to certifications), are often recognized but not always prioritized in initial investment decisions. ⇨ Developing and testing new standards for HS and circularity can require significant employee time and resources.
Social Acceptability	
The concept of healthier and more sustainable buildings generally enjoys positive social acceptance. However, practical implementation of the utilization of green building certificates and ecolabels can face resistance from designers, contractors, and municipal employees due to added workload and cost concerns.	⇨ Ensuring tox-free materials adds workload for designers and contractors, potentially leading to some pushback. ⇨ Using established certification schemes can improve acceptance among project partners by providing a recognized framework. Public awareness of building certifications, however, may be limited. ⇨ Internal acceptance by municipality employees can vary, with potential resistance from those accustomed to traditional practices or concerned about increased workload and costs. Clear communication of benefits is crucial.
Transferability/ Replicability/ Scalability	
The solutions are generally considered transferable, but successful uptake depends on local contexts, resources, and national-level support.	⇨ Smaller municipalities might be more agile in implementing new approaches, while larger ones face more complex bureaucratic processes. ⇨ Financial and knowledge limitations in some municipalities can pose significant barriers. ⇨ National-level initiatives and regulations promoting circular and sustainable construction would greatly facilitate broader implementation across the Baltic Sea region. ⇨ The utilization of international/national standards significantly reduced the need to develop demands from scratch.

Summary of the general observations regarding utilization of green building certificates and ecolabels:

- **Success Factors:** The usage of certification schemes is able to proactively push the market towards new, higher standards, anticipating or even influencing national legislative changes.
- **Challenges:** Financial constraints were significant, as higher costs for tox-free and circular materials conflicted with "lowest bidder" procurement. Justifying increased **costs to** funders was a persistent problem.
- **Impact of the sub-solution:** Certification schemes are seen as effective tools for reducing HS and promoting sustainable construction, including tox-free, circular, and climate friendly practices. They serve as valuable communication tools with project partners and can confirm sufficiency for HS avoidance.
- **Synergies:** Certification schemes and ecolabels rarely address one single NHC3 project - focus pillar. Instead, they typically address multiple aspects, HS avoidance, circularity and climate neutrality among them.
- **Suggestions for improvement:** Address financial barriers by highlighting long-term benefits and prioritize circularity solutions with the largest measurable impact. Provide more education and guides for specialists, linking them with national regulations and e-construction platforms. Streamline validation processes which are currently difficult for municipalities.

Quotes from piloting municipalities:

Helsinki: **"Standards like Nordic Swan have become our baseline - the breakthrough came when we linked them to our Circular Economy Action Plan metrics."**

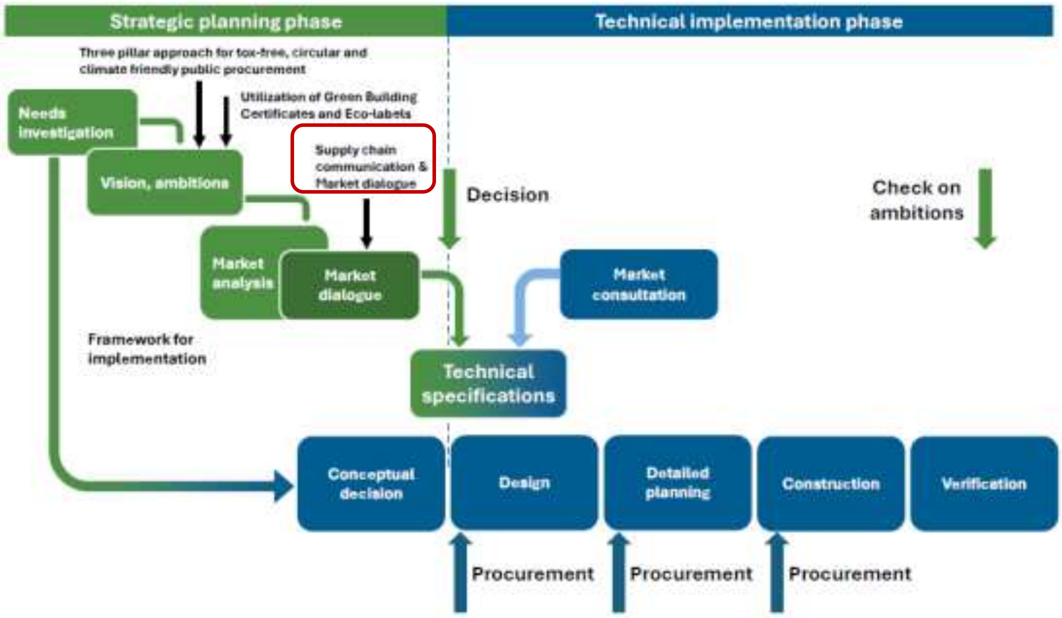
Holbaek: **"Making DGNB Gold certification a municipal requirement for new buildings over 1000 m^2 has successfully embedded sustainability into our standard practice."**

Tallinn: **"Until national regulations catch up, our HS-free material requirements remain vulnerable to budget-first decision making."**

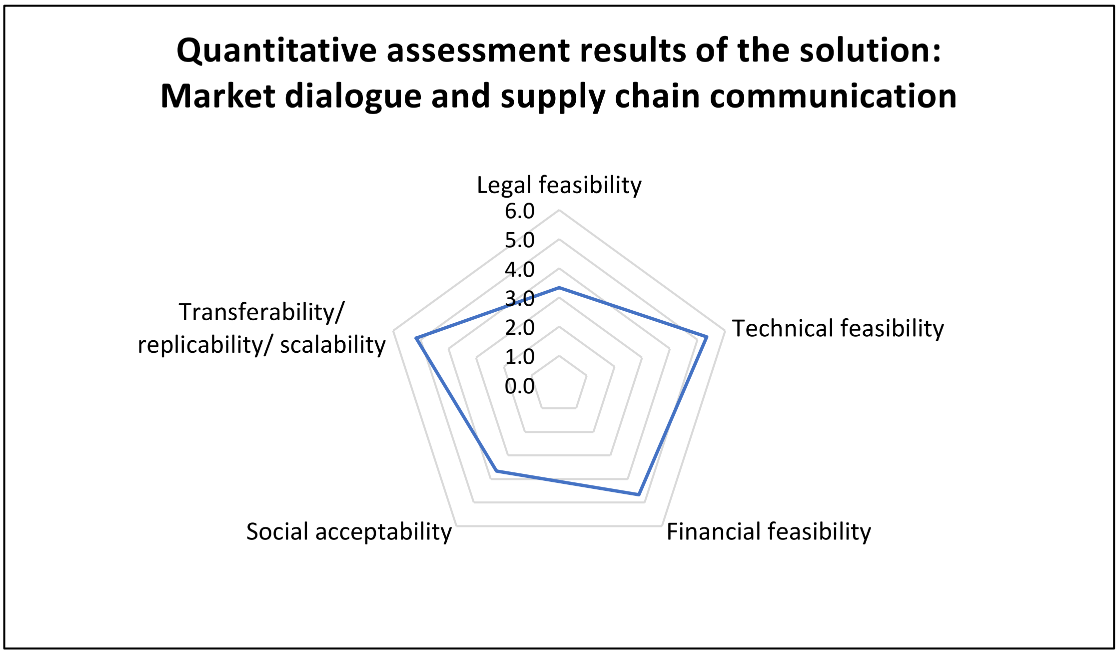
Stockholm: **"Miljöbyggnad certification turned political commitments into actionable specifications that even skeptical project partners could implement."**

Västerås: **"The requirements for Miljöbyggnad Silver was already met, but through this project we reached Gold, which can hopefully form the basis for a new standard in Västerås."**

1.1.3 Supply chain communication and market dialogue



The radar chart results for "Supply chain communication and market dialogue" indicate strong potential, particularly in technical feasibility and transferability, while legal and social acceptability present moderate challenges. Technical feasibility scored highly at 5.3, reflecting that the focus remains on effective information sharing and market insight gathering. Similarly, transferability and replicability achieved a robust 5.2, showing that the underlying principles are broadly applicable, yet success relies on establishing clear municipal procedures and motivating market participation. Financial feasibility, at 4.7, suggests that while direct costs aren't prohibitive, the primary constraint is often the necessary investment in employee time and resources. Legal feasibility (3.3) highlights ongoing challenges due to a lack of specific legal guidelines and the need to prevent preferential treatment within procurement processes. Social acceptability, with a score of 3.7, indicates that while stakeholders generally welcome dialogue, perceptions of unclear benefits or increased workload for municipal staff can hinder full acceptance.



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
While the public procurement act generally permits market dialogue as a preparatory stage, it also imposes constraints to ensure fairness and prevent preferential treatment. Specific legal guidelines for conducting market dialogue in construction, particularly concerning HS and circularity, are often lacking.	⇨ Market dialogue should not confer any advantage in the subsequent procurement process. ⇨ Ensuring equal opportunity for all interested parties to participate, often through national procurement websites, is a legal requirement. ⇨ Municipalities cannot directly specify material producers in design projects, as all equivalent options must be considered.
Technical Feasibility	
IT tools are not necessarily a primary impediment, but the lack of established good practices and readily available, structured data for discussion can be a limitation.	⇨ Sharing information and gathering market insights on new options and market readiness are key technical aspects. ⇨ The quality and availability of data on chemicals and reused products, often provided by architects and contractors, can vary.
Financial Feasibility	
Conducting market dialogue primarily involves employee time and resources for planning and execution. Direct financial costs may not be substantial, but the overall impact on project costs (e.g., through the selection of more sustainable materials) needs consideration.	⇨ Lack of workforce to organize market dialogue events can be a constraint, especially for smaller municipalities. ⇨ Market dialogue itself does not inherently increase construction costs, but the information gathered might lead to the consideration of more environmentally friendly but potentially more expensive options. ⇨ Financial benefits might arise in the long term through a more informed market and the adoption of innovative, sustainable solutions.
Social Acceptability	
Market dialogue can be a positive tool for demonstrating openness to new solutions and increasing the municipality's reputation. However, its acceptance and impact can vary among stakeholders.	⇨ Stakeholders are generally willing to participate, especially if they see potential value or an upcoming procurement opportunity. ⇨ Resistance or lack of interest can occur if stakeholders perceive the process as time-consuming without clear benefits or if they disagree with the underlying policy goals. ⇨ Internal acceptance by municipality employees might be lower if it's seen as adding to their workload without clear necessity.
Transferability/ Replicability/ Scalability	
The principles of market dialogue are transferable, but successful implementation depends on the resources and specific context of each municipality and the engagement of the local market.	⇨ Lack of established procedures at the municipal level can be a barrier. ⇨ Motivating market participation, especially without offering direct advantages in procurement, can be challenging. ⇨ Smaller markets might have limited numbers of relevant producers. ⇨ Continuous dialogue and learning are essential for successful and scalable implementation.

Summary of general observations regarding market dialogue and supply chain communication:

- **Success Factors:** Market surveys proved valuable for gathering initial information and identifying market needs. Continuous dialogue within projects fosters incremental progress and can highlight the need for national guidance on specific issues (e.g., HS in construction).
- **Challenges:** Significant hurdles include a lack of market interest due to perceived low value, resistance from employees to new, time-consuming requirements, and skepticism about circularity benefits. The absence of national guidance and centralized data on HS is a major technical and legal barrier. Financial constraints can also halt initiatives.
- **Impact of the sub-solution:** Market dialogue primarily enhances knowledge of market readiness and informs the setting of sustainable criteria for HS reduction and circularity. It fosters communication and collaboration within the supply chain, contributing to more informed, sustainable material choices.
- **Synergies:** Market dialogue supports the development of updated procurement instructions and drives market development by communicating demand for sustainable solutions. Collective action across municipalities in making similar demands can also create significant leverage.
- **Suggestions for improvement:** Focus on motivating participants without violating procurement laws, expanding reach to wider audiences, and centralizing national data on materials. Practical, actionable guidance for conducting market dialogue and clear, measurable criteria are also essential for wider adoption.

Quotes from piloting municipalities:

Helsinki: **"Market dialogue ensures suppliers meet our criteria - it's now a standard tool for green procurement "**

Västerås: **"Byggvarubedömningen (BVB) is our main tool for market dialogue, as the material and circular information is included in the BVB assessment."**

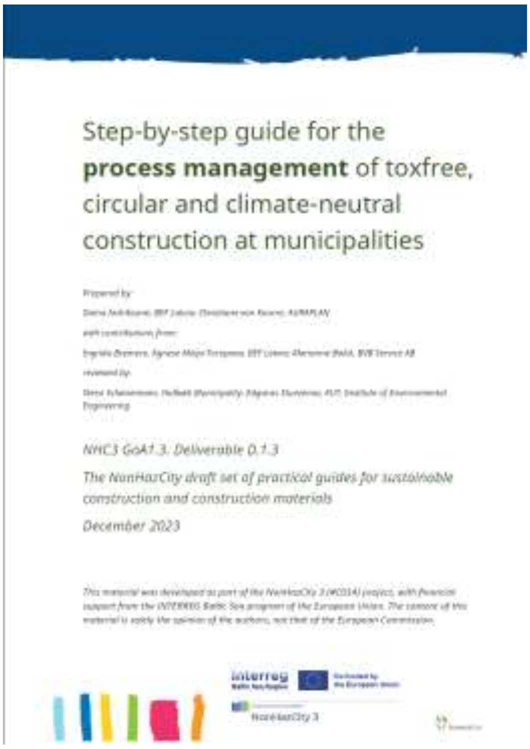
Tallinn: **"No registrations for our event showed market disinterest - dialogue needs tangible incentives."**

Stockholm: **"Big firms adapt to our circular demands; smaller ones struggle – this divide needs bridging."**

1.2 Evaluation of practical solutions

NHC3 project developed practical solutions, intended for municipalities, construction experts and inhabitants.

1.2.1 Step-by-step guide for the process management of tox-free, circular and climate friendly construction at municipalities


Step-by-step guide for the **process management** of toxfree, circular and climate-neutral construction at municipalities

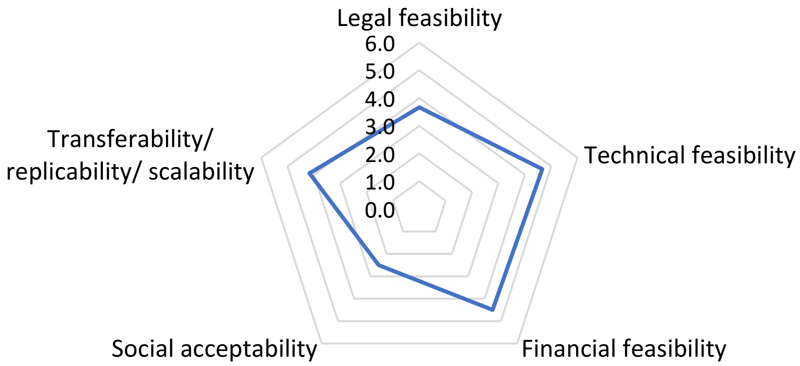
NHC3 GoA1.3. Deliverable D.1.3

The NonHazCity draft set of practical guides for sustainable construction and construction materials

December 2023

The "Step-by-step guide" demonstrates strong technical (4.7) and financial (4.5) feasibility, aligning with the synthesis noting no significant IT limitations for access and recognized long-term financial benefits despite potential upfront costs. Its transferability/replicability/scalability (4.2) is also high, indicating the guide's principles are broadly applicable, though adaptation to local contexts and national support will be crucial. However, legal feasibility (3.7), while not facing direct constraints, scores lower due to the lack of specific mandatory frameworks and reliance on internal pushes rather than legal mandates; some municipalities also felt their existing internal processes were sufficient. The most significant challenge lies in social acceptability (2.5), where the guide faces internal resistance from employees preferring traditional methods and uncertainty in acceptance from wider business stakeholders, highlighting the need for clear communication of benefits and integration into official processes.

Quantitative assessment results of "A step-by-step guide for the process management of toxfree, circular and climate-neutral construction at municipalities"



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
Generally, there were no direct legal constraints hindering the *existence* of such a guide. However, its *implementation* as a mandatory procedure faced limitations due to the lack of specific legal frameworks or integration into existing procurement regulations.	⇨ Some municipalities felt their existing internal processes were sufficient. ⇨ National regulations form the overarching legal framework, and the guide's principles should align with them. ⇨ Policy and political will at the local level (e.g., municipal environmental strategies, climate goals, chemical action plans, sustainability action plans) act as significant drivers for incorporating stricter environmental criteria, including those related to HS and circularity, and these are expected to persist beyond project timelines. The guide's principles can align with these broader commitments. ⇨ The absence of specific legal frameworks for the guide means that its "obligatory" status in some municipalities is more of a top-down internal push rather than a legal mandate, which can dilute its impact if not sufficiently supported. ⇨ External financial incentives (for example in Germany, KfW bank requires the QNG standard) and future EU Taxonomy considerations could introduce stronger legal and financial drivers.
Technical Feasibility	
No significant IT limitations were reported for accessing the guide itself. However, the availability and access to reliable data on chemicals in construction materials, and the need for internal process development, posed challenges.	⇨ The time required for municipal employees to thoroughly study and apply the guide could be a limitation. ⇨ Ensuring the availability and suitability of tox-free or circular materials can be a concern. Pilots noted difficulties in sourcing specific materials that are both environmentally sound and economically viable, sometimes leading to necessary design changes. ⇨ While accessing the guide itself had no IT limitations, several municipalities highlighted the need for developing internal procedures and potentially new software or integrated IT solutions to effectively manage and apply the guide's principles, especially for familiarizing entrepreneurs and for data-based decision-making.
Financial Feasibility	
The direct cost of accessing or being introduced to the guide was generally not a major constraint, especially if done within project frameworks. However, the *implications* of following the guide (e.g., for certifications, market dialogues, potentially more expensive materials) could have financial impacts	⇨ Financial resource constraints within municipalities, particularly a lack of dedicated staff positions for guide implementation and development, significantly limit the testing and wider adoption of the solution. ⇨ However, municipalities recognized the potential for long-term financial benefits through reduced operational costs (e.g., lower energy costs, reduced maintenance), longer material lifespans, and reduced risk of costly mistakes due to better process management. ⇨ Upfront costs might be higher due to factors such as certification processes, increased time for market dialogue, pre-feasibility studies, or the use of more expensive materials (e.g., wooden frames).

Social Acceptability	
The guide's potential to streamline processes and promote understanding among municipal employees was generally seen positively. However, acceptance beyond the project consortium and among the wider market was less clear.	⇨ While the guide is accepted as a method to facilitate and streamline work processes, internal resistance from employees (e.g., project managers who prefer traditional methods) towards new, potentially time-consuming or knowledge-intensive requirements can occur. Ongoing education and clear communication of the benefits are crucial. ⇨ Acceptance by business stakeholders might depend on the perceived impact on costs and workload. ⇨ Public awareness and acceptance were expected to grow as the benefits of sustainable construction become more evident.

Transferability/ Replicability/ Scalability	
The general principles of such a step-by-step guide were considered transferable, but successful uptake would require adaptation to local contexts, national regulations, and available resources.	⇨ Limited resources (especially staff time) in municipalities could be a significant barrier. ⇨ National-level support and potentially country-specific adaptations of the guide were seen as crucial for broader implementation within the Baltic Sea region. ⇨ Political will and decisions at the municipal level are necessary to prioritize and implement new processes.

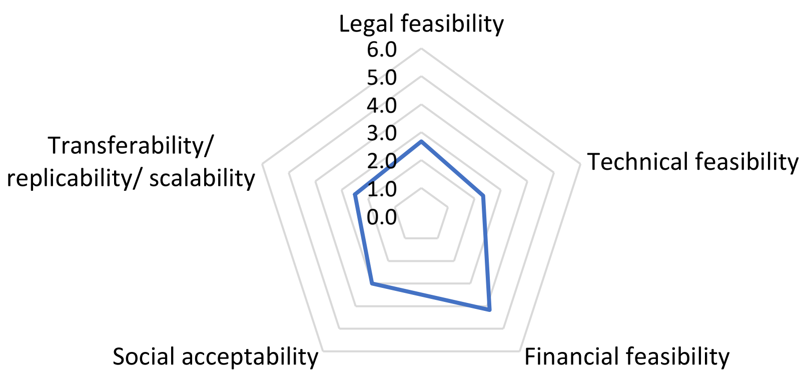
Summary of general observations regarding Step-by-Step guide**:**

- **Success Factors:** The development of any form of guidance was seen as a positive starting point for municipalities to tackle complex issues. Checklists were highlighted as a particularly useful aspect.
- **Challenges:** The need for dedicated personnel to implement such guides, the lack of standardized national data and verification methods, and potential resistance due to increased costs and workload were identified as key challenges. The diversity of national regulations and the need for country-specific adaptations were also noted.
- **Impact of Solutions:** The guide was expected to contribute to a more structured approach to integrating tox-free, circular, and climate friendly considerations into construction processes.
- **Synergies:** Step-by-step guide complements other solutions by providing a framework for implementation and decision-making.
- **Suggestions for Improvement:** Develop country-specific versions or annexes to account for national regulations and market conditions. Focus the guide on the most impactful, low-effort actions. Prioritize clear, measurable metrics for success. Consider the need for dedicated staff to support implementation and adaptation.

1.2.2 Data base system for construction product assessment based on the existing Swedish BVB system

The radar chart for the BVB-based database system highlights a mixed feasibility profile. Financial feasibility scores highest at 4.2, reflecting that while initial project costs were often covered, the long-term sustainability and significant investment required for national database development are key concerns. Technical feasibility (2.3) and transferability/ replicability/ scalability (2.5) are the lowest, primarily due to the system's strong Swedish-centric design, language barriers, and limited local product data, making direct adoption challenging. Legal feasibility scores 2.7, indicating significant hurdles with public procurement rules that hinder the mandatory implementation of a specific foreign database, suggesting a national equivalent might be more viable. Finally, social acceptability at 3.0, while moderate, faces challenges with resistance from construction professionals due to increased workload and low public awareness, despite the clear benefits of healthier buildings.

Quantitative assessment results of the solution: A data base system for construction product assessment based on the existing Swedish BVB system



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
Direct implementation of the Swedish BVB system as a mandatory tool in other countries faces legal hurdles, primarily due to public procurement regulations that require equal treatment and prevent favoring specific manufacturers or foreign databases.	⇨ Municipalities are often restricted from specifying particular materials or manufacturers to avoid corruption and market distortion, limiting the direct use of a specific database. ⇨ While BVB use might be part of internal processes in some cases, it's generally voluntary without national-level mandates. ⇨ Legal frameworks in some countries (like Germany with DGNB/QNG) endorse specific certification systems, potentially making the adoption of an external database like BVB less feasible without a clear legal incentive. ⇨ Developing a national equivalent database might be a more legally sound approach. ⇨ Some clearly expressed that while a direct transfer of the tool is problematic, the core principles of BVB are highly desired and should be expanded across the Baltic Sea region.
Technical Feasibility	
Technical limitations included restricted access to the BVB database, language barriers (as product titles often remained in Swedish), and the limited availability of local (non-Swedish) product data.	⇨ Access to BVB often requires registration and passwords, which can be a barrier for widespread use in pilot projects. ⇨ The Swedish-centric nature of the database, including product groupings based on Swedish norms, made it less directly applicable to other markets. ⇨ While some materials could be found by identifying Swedish equivalents, the data wasn't always machine-readable or easy to assess manually against BVB criteria. ⇨ The need for a user-friendly interface and better translation was highlighted.
Financial Feasibility	
The direct cost of initial access to BVB was sometimes covered by the project. However, broader implementation would involve subscription fees and the significant cost of developing and maintaining a comparable national or localized database.	⇨ Creating and managing a national database system requires substantial time, resources, and expertise, which might be beyond the capacity of individual municipalities. ⇨ Implementing a BVB-like system could lead to increased control activities and potentially higher construction costs if stricter criteria or certifications are mandated. ⇨ Long-term financial benefits might arise from better material tracking for reuse and lower maintenance, but these are not immediate. ⇨ Initial costs, such as subscription fees, were often covered by specific projects, but concerns arose about the system's long-term sustainability and ongoing costs after project completion, given its strong ties to the Swedish market.
Social Acceptability	
While the concept of a database for assessing HS has potential social benefits (assuring healthier buildings), the direct use of BVB faced challenges in acceptance beyond the project.	⇨ Construction professionals might resist new demands and the added workload of using a new database. ⇨ Public awareness of the benefits of such a system and the specific details of BVB was generally low outside the construction sector. ⇨ Material producers might not be motivated to list products primarily for smaller, non-Swedish markets. ⇨ Internal acceptance by municipality employees varied, with some seeing the potential while others were concerned about increased complexity and costs.

Transferability/ Replicability/ Scalability	
The BVB system itself, being very Swedish market-specific, had significant limitations for direct transferability. The underlying principles of a product assessment database, however, were seen as having potential if adapted to local contexts.	⇨ The lack of local product data and the Swedish-centric structure made direct replication difficult. ⇨ Creating national or regional databases tailored to local markets and regulations was considered a more viable path. ⇨ Scalability would depend on national-level initiatives and the willingness of material producers to participate. ⇨ Starting with a smaller scope and gradually expanding the database was suggested as a potential strategy.

Summary of general observations regarding Step-by-Step guide**:**

- **Success Factors:** The BVB traffic light system for quick assessment was seen as a highly valuable feature. Training provided by the project on using BVB was also appreciated.
- **Challenges:** The primary challenges were the strong ties of BVB to the Swedish market, the lack of local product data, language barriers, restricted access, and the complexity and cost of establishing a similar system in other countries. Legal constraints related to public procurement also posed a barrier.
- **Impact of Solutions:** While direct HS reduction from using BVB in pilot projects might have been limited due to its market focus, it increased awareness and provided a framework for better material documentation and selection.
- **Synergies:** Integrating a product database with procurement criteria and potentially linking it to building certification schemes were seen as beneficial synergies.
- **Suggestions for Improvement:** Focus on developing national or Baltic Sea region-specific databases. Ensure the database is user-friendly and includes comprehensive local product information. Consider starting with a minimum viable product approach for database development. Explore the possibility to automatically calculate and provide data on HS amount and CO_2 footprint for the whole building or 1m^2 of the building, based on material weight, presence of HS, and CO_2 data.

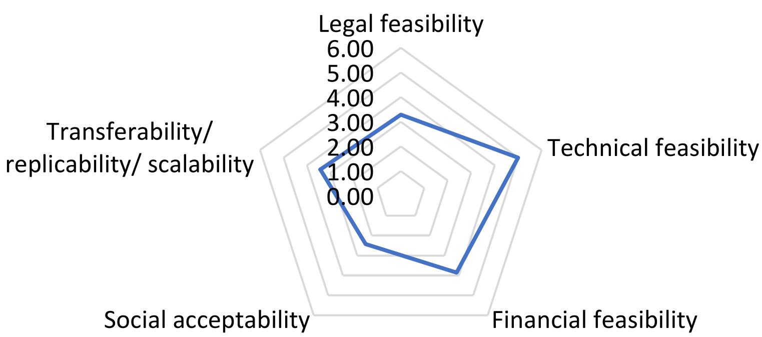
Quotes from piloting municipalities:

- **Västerås: "We log all products by weight in BVB, and aim towards 20% products assessed as *Recommended* in BVB and not more than 5% products assessed as *To be avoided*. With these goals we can reduce hazardous substances in our buildings."**
- **Stockholm: "BVB isn't optional for us - it's embedded in our workflows. The challenge isn't adoption, but ensuring every project complies."**
- **Stockholm: "Reused materials often lack data - BVB helps, but gaps force tough choices between sustainability and risk"**
- **Tallinn**: **"BVB can't be mandatory here - procurement laws demand equality, and most Estonian producers aren't in the system."**
- **Parish Maria Magdalenen**: **"The traffic-light system saved time, but without German-market alignment, BVB's utility is limited."**
- **Riga: "BVB is tailored for Sweden; we'd need our own database to make it viable."**

1.2.3 Fact Sheets for professionals

The NonHazCity fact sheets for construction professionals demonstrate strong technical feasibility (5.0), being easy to access, though their full potential is hindered by the lack of comprehensive national material databases and limited availability of eco-labelled products. Financial feasibility (3.9) is moderate; while the sheets themselves are cost-free, implementing their recommendations can incur expenses and offer long-term rather than immediate financial benefits. Legal feasibility (3.0) is average, as the sheets face no direct legal barriers but their utility is diminished where existing local processes are well-established or national legislation doesn't incentivize their use. Similarly, transferability/replicability/scalability (3.4) is inherent given their informational nature, but practical application requires significant adaptation to local contexts and resources. The lowest score in social acceptability (2.4) highlights challenges such as a perceived lack of specific, actionable guidance for procurement and a critical need for national adaptation to enhance their relevance and widespread adoption.

Quantitative Assessment Results of the solution tested during Pilot 6 activities: A series of NonHazCity fact sheets for professionals involved in the construction business



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
The fact sheets themselves generally did not encounter legal barriers. However, their utility was perceived as limited when existing local processes were already well-established or when national legal frameworks didn't specifically incentivize their use.	⇨ For entities with mature internal guidelines, the fact sheets sometimes presented overlapping information. ⇨ Alignment with national legislation was a prerequisite for their applicability. ⇨ In some contexts, there were no specific policy or legal drivers to adopt the recommendations in the fact sheets. ⇨ For professionals working within mandatory green building certification schemes, the baseline information in the fact sheets could be helpful for understanding the underlying principles.
Technical Feasibility	
Accessing the fact sheets was technically straightforward. However, their impact could be amplified by integration with digital tools and databases for material information.	⇨ The absence of robust, centralized national databases for construction materials, particularly regarding chemical content and circularity metrics, is a technical barrier to fully leveraging the fact sheets' information. ⇨ The real-world availability of eco-labeled products also presented a practical limitation.
Financial Feasibility	
The fact sheets themselves did not pose financial constraints. However, acting upon their recommendations could have cost implications related to material choices and implementation efforts.	⇨ The time investment required for professionals to understand and apply the information was a potential consideration, especially in resource-constrained environments. ⇨ The financial benefits of adopting more sustainable practices (as advocated by the fact sheets) were often seen as long-term and not immediately quantifiable.
Social Acceptability	
The fact sheets had the potential to facilitate knowledge sharing among construction professionals. Their acceptance depended on their perceived relevance, ease of use, and the clarity of the benefits they offered.	⇨ For future professionals (e.g., students), the fact sheets served as a valuable tool for raising awareness about sustainable construction practices.
Transferability/ Replicability/ Scalability	
As informational resources, the fact sheets were inherently transferable. However, their practical application required consideration of local contexts, existing knowledge, and available resources.	⇨ Entities with less experience in sustainable construction could find the basic information particularly useful. ⇨ Tailoring the information to specific stages of the construction process was seen as important for practical application.

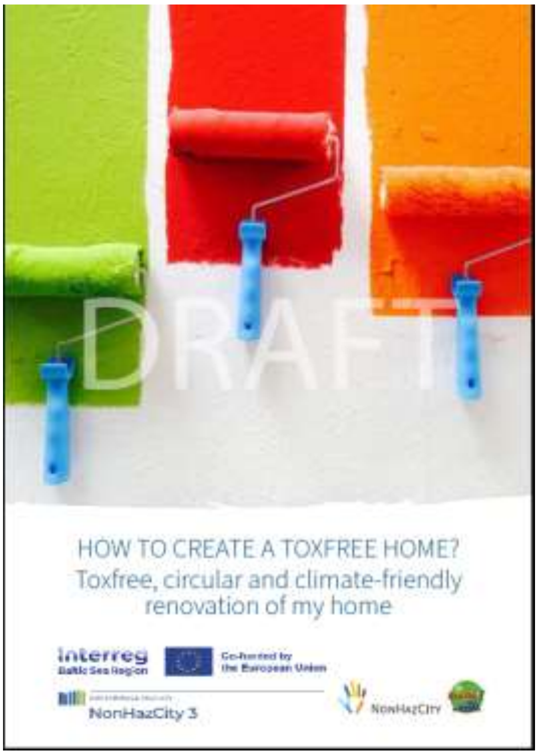
Summary of general observations regarding the Fact sheets:

- **Success Factors:** Providing a concise overview of key considerations and highlighting critical aspects were appreciated. The eco-label factsheet was specifically noted as helpful for understanding certification schemes.
- **Challenges:** The fact sheets were sometimes considered too general or lacking in specific, actionable guidance for procurement. The need for national adaptation and integration was a recurring point.
- **Impact of Solutions:** The fact sheets served as a good introductory resource, raising awareness about tox-free, circular, and climate friendly construction. However, their direct and measurable contribution to HS reduction was less evident.
- **Synergies:** Combining fact sheets with more detailed guidance documents was suggested for a more comprehensive approach. Fact sheets serve as an entry point of information that is then found in other project solutions and products in more details/depth/expanded knowledge.
- **Suggestions for Improvement:** Develop adaptable versions for different national contexts. Consider to include more detailed information on building certification schemes and provide clearer links to practical implementation. A web-based or modular format could enhance their usability.

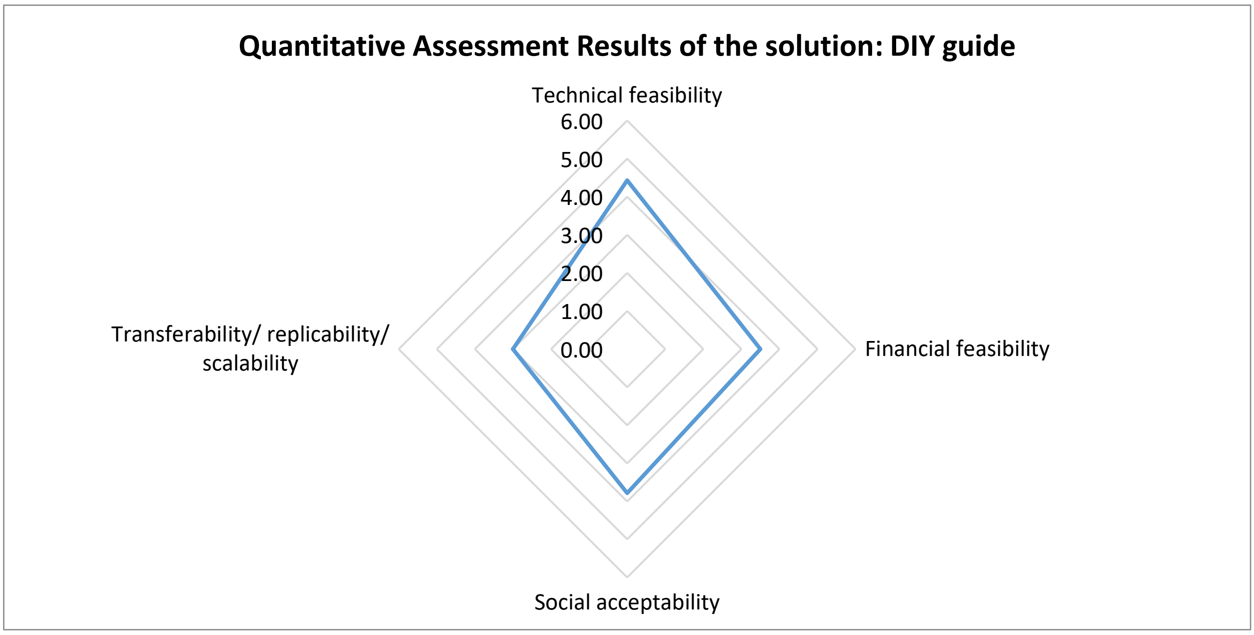
Quotes from those who piloting the Fact sheets:

- **Holbaek: "Fact sheets bridged knowledge gaps for subcontractors—simple formats work best for busy professionals."**
- **Student, Latvia: "Eco-label factsheets cut through greenwashing—now we know what to demand in practice."**
- **Auraplan**: **"The baseline info helped us reject cheap, toxic materials—but cost debates were tough. In the end, healthier spaces won parishioners' support."**
- **Architect, Lithuania: "The fact sheets are useful advice—but in practice, we can't apply everything 100%. We need more specifics on eco-certifications and realistic alternatives for local markets."**

1.2.4 Do-it-Yourself (DIY) Guide



The "Do-it-yourself guide" solution from the NonHazCity 3 project shows a solid performance in Technical feasibility (4.4), indicating its practical applicability, despite challenges like accessing comprehensive chemical data for DIYers. Social acceptability (3.8) is also strong, driven by personal values and project encouragement, although aesthetic preferences sometimes create conflicts. Conversely, Financial feasibility (3.5) faces hurdles due to the higher upfront costs of sustainable materials, even though long-term benefits are acknowledged. The lowest score is for Transferability/replicability/scalability (3.0), primarily due to cost barriers, limited awareness, and the availability of eco-labelled products. Overall, while the guide effectively raises awareness and offers practical tips, widespread adoption hinges on addressing financial constraints and improving access to detailed, localized product information.



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
Not relevant – not assessed	
Technical Feasibility	
Access to data and information on chemicals in construction materials was a significant technical challenge for DIYers. While eco-labels were helpful, comprehensive and easily understandable data was often lacking. Material availability and suitability also posed limitations.	⇨ Difficulty in obtaining clear and complete content declarations from manufacturers was a recurring issue. ⇨ Understanding chemical terminology and the implications of VOCs required a certain level of expertise. ⇨ Eco-labels were valued as a navigational tool but weren't always sufficient for detailed assessments. ⇨ Aesthetic preferences sometimes conflicted with the desire for more sustainable material choices (e.g., PVC flooring). ⇨ The suitability of certain materials for specific applications (e.g., moisture-prone areas) was a key technical consideration. ⇨ IT limitations were generally not a barrier to accessing the guide itself, but finding detailed product information online could be challenging, especially for non-English speakers.
Financial Feasibility	
Choosing more sustainable or less hazardous materials often led to increased upfront costs, which was a significant financial consideration for DIYers. However, potential long-term benefits and personal values sometimes outweighed these initial expenses.	⇨ The cost of eco-friendly alternatives was frequently higher than conventional options (e.g., wood fiber insulation vs. mineral wool, clay roof tiles vs. metal sheets, wooden windows vs. PVC). ⇨ DIY labor could offset some of the higher material costs. ⇨ Long-term financial benefits, such as energy savings or increased property value due to sustainable features, were anticipated by some. ⇨ For some DIYers, personal health and environmental concerns were prioritized over immediate cost savings. ⇨ Financial constraints sometimes necessitated compromises in material choices.
Social Acceptability	
Encouragement for safer and more environmentally conscious housing came from various sources, including personal values, social media, and project initiatives. Acceptance of DIY renovation results was generally positive, driven by health, practicality, aesthetics, and environmental considerations.	⇨ Personal conviction and prior experiences often motivated DIYers to seek sustainable solutions. ⇨ Project initiatives and specific social media channels provided encouragement and information. ⇨ Acceptance of renovated spaces was influenced by perceived improvements in health, ease of maintenance, visual appeal, and reduced environmental impact. ⇨ Sharing renovation experiences sometimes inspired others to consider similar approaches.

Transferability/ Replicability/ Scalability	
While the DIY guide itself was transferable, the actual implementation of its recommendations was influenced by factors like cost, availability of sustainable products, and the level of knowledge and interest among the broader public.	⇨ The DIY guide was seen as a helpful resource for individuals willing to invest time and effort in research. ⇨ Personal experiences and successful examples could inspire others. ⇨ Increased cost was identified as a potential barrier to widespread adoption. ⇨ Lack of awareness, limited access to information, and the absence of readily available specialists could hinder uptake. ⇨ The ease of finding eco-labeled products in local stores played a significant role in the feasibility of implementation.

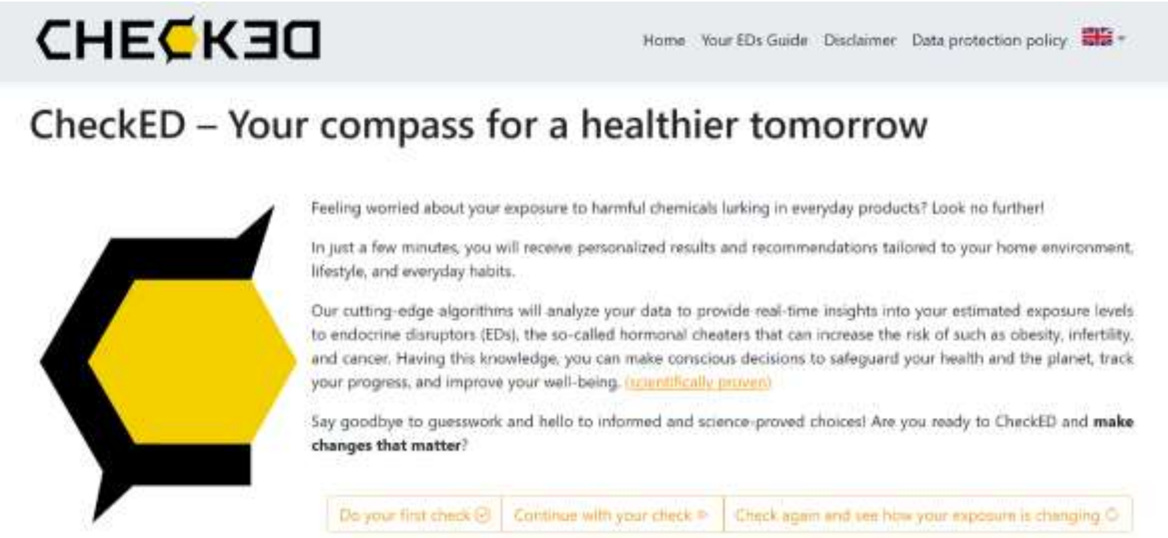
Summary of general observations regarding DIY guide:

- **Success Factors:** The DIY guide provided a useful introduction to sustainable building concepts, highlighted important considerations, and offered practical tips. The labeling lists and color-coded selection tables were particularly appreciated for their ease of use.
- **Challenges:** Finding detailed information on material composition, the lack of specific guidance on local product availability, and the need for more in-depth knowledge in certain areas were identified as challenges. The guide sometimes lacked specific advice for smaller-scale repairs or DIY-friendly installation information.
- **Impact of Solutions:** The DIY guide contributed to a greater awareness of hazardous substances and encouraged the selection of safer alternatives, although the extent of actual HS reduction varied. It also prompted consideration of the environmental impact of material choices.
- **Synergies:** The guide could be enhanced by providing links to more detailed resources and local product information.
- **Suggestions for Improvement:** Include more practical advice on where to find detailed product information, expand on specific material categories (e.g., cork flooring), improve the clarity of tables and prioritize advise (tips), consider adding a self-assessment tool, and provide more guidance on DIY-friendly installation methods and smaller-scale repairs.

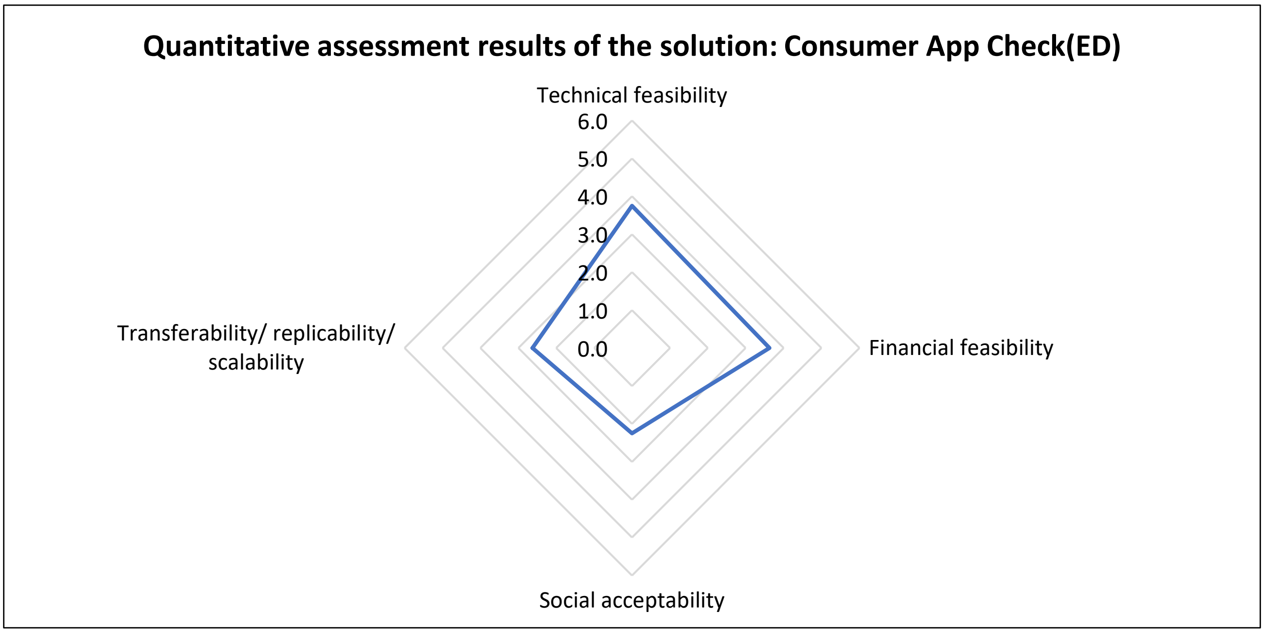
Quotes from those who piloted the DIY guide:

- **From Riga: "DIY guide showed various options and clear benefits of implementing the environment and health friendly solutions as well as possible risks. It is important that DIY renovator can read it on his own pace and return to the basic information if needed."**
- **From Riga: "Choosing natural materials for the roof has also triggered an interest in the possibilities of using natural materials indoors."**
- **From Hamburg: "The DIY Guide exposes toxic materials like PVC, but without legal backing, stores keep selling them."**
- **From Sweden: "Craftsmen tend to choose materials not based on their sustainability profile, but rather on how familiar and skilled they are to handle them."**
- **From Vilnius: "The DIY guide is a basic ABC of sustainable building."**

1.2.5 Consumer App "Check(ED)"



The Consumer App "Check(ED)" demonstrates solid performance in both Technical Feasibility (3.8) and Financial Feasibility (3.6). Technically, its reliance on predefined EDC concentrations addresses the challenge of limited direct chemical data, though the synthesis noted some user interface challenges and difficulties with older building materials. Financially, the app being free removes direct barriers to use, with acknowledged long-term benefits for healthier homes. Both Social Acceptability (2.3) and Transferability/Replicability/Scalability (2.6) scored lower. Despite raising awareness and fostering social engagement, the app's social acceptability might be limited by factors like the unintuitive interface mentioned in the technical section. Similarly, while inherently transferable as a digital tool, its widespread adoption is hindered by the time and effort required for users to input information, and the need for access to technology and specific home data.



Explanation of assessment results based on reflection and observations by the pilots:

Explanation of the assessment results	Observations Worth Sharing
Legal Feasibility	
Not relevant – not assessed	
Technical Feasibility	
The app's reliance on predefined EDC concentrations for building materials addressed the challenge of limited direct chemical data availability for consumers. However, the mobile version's user-friendliness was noted as a potential limitation. In some cases, identifying specific materials within older buildings posed a challenge for accurate app usage	⇨ The browser version of the app was considered more convenient than the mobile version by at least one user. ⇨ Uncertainty about the exact materials used in older homes could hinder accurate assessment using the app. ⇨ The user interface was described as unintuitive by one respondent, particularly concerning personal recommendations.
Financial Feasibility	
The Check(ED) app itself was free of charge, removing financial barriers to its use. While the app could identify materials that might warrant replacement with more expensive, less hazardous alternatives, the cost implications of such replacements were separate from the app's feasibility.	⇨ A user noted that the app's information could contribute to a healthier and more sustainable home, yielding long-term financial benefits for the individual and society.
Social Acceptability	
The app was generally well-received by the residents who used it. It increased awareness of potential health risks associated with common building materials. Sharing information and discussing the app with friends and family indicated a degree of social engagement with the solution.	⇨ The app raised awareness among residents about potential EDC exposure in their homes. ⇨ Users shared the app with interested individuals, suggesting a positive perception and willingness to recommend it. ⇨ Discussions about the app with friends indicated social engagement with the topic of safer housing.
Transferability/ Replicability/ Scalability	
As a digital tool, the Check(ED) app has inherent transferability and replicability. However, its effective application requires users to have the time, access to technology (computer or smartphone), and willingness to input the necessary information.	⇨ The app was considered user-friendly by some. ⇨ The time and effort required to use the app and input information were seen as potential barriers to widespread adoption by some residents. ⇨ The need for a computer and sufficient information about one's home environment could limit its accessibility for all inhabitants.

Summary of general observations regarding the implementation of the solution on “Consumer App Check(ED)”:

Success Factors: User-friendly interface. Effective at identifying potential EDC sources, raising health awareness. Provided some helpful tips for a healthier living environment.

Challenges: Mobile version less convenient. Unspecific material recommendations. Time-consuming data input. User interface could be more intuitive. Unclear terminology and unit presentation.

Impact of the solution: Increased awareness of potential EDC emitters. Motivated consideration of safer alternatives. Potential to influence future renovation decisions. Encouraged some users to reduce dust levels.

Synergies: Complements DIY guide by identifying risks addressed by safer alternatives. Highlights health impacts for more informed material choices.

Suggestions for improvement: Enhance mobile application. Improve material recommendation section. Streamline data input. Refine user interface. Clarify terminology and units. Consider the possibility of easier access to choices from previous assessments.

Quotes from those who the piloted CheckED app:

- **Ms. X (Lithuania): "I liked the app. It gave me insight into my EDC exposure and provided interesting tips."**
- **Ms. Y (Lithuania): "Check(ED) helps locate potential EDC emitters, and with this data, you can opt for HS-free alternatives."**
- **Mr. Z (Latvia): "User interface is unintuitive, especially for personal recommendations."**

2 How to achieve best practice construction?

Integrating a chemical-smart approach into construction projects is no longer a niche concern, but a critical imperative for ensuring healthier indoor and outdoor environments, fostering circular economy principles, and advancing climate neutrality. As demonstrated by diverse experiences across the Baltic Sea Region, this integration is a complex effort with many angles, influenced by prevailing legal landscapes, market dynamics, and municipal capabilities. A successful chemical-smart strategy is rarely a standalone solution, but rather a synergistic blend of policies, tools, and collaborative market engagement.

2.1 Conditions for applicability of solutions

The most successful integrations of a chemical-smart approach are rooted in several important conditions. Firstly, strong political will and clear municipal environmental commitments are required. Municipalities like Helsinki, Stockholm, and Västerås, with ambitious carbon neutrality targets and explicit public procurement strategies, demonstrate that high-level mandates translate into tangible action. These commitments create a demand signal that resonates through the supply chain. Secondly, a supportive legal and policy framework at the national level lowers risks and streamlines implementation. Where national acts on public procurement encourage (or even mandate) environmental and social aspects, as in Finland and Sweden, municipalities have a clearer path. Conversely, the absence of such mandates, as seen in Latvia and Estonia, forces municipalities to navigate legal ambiguities and justify increased costs, hindering broader adoption. Thirdly, dedicated resources and expertise are non-negotiable. Access to HS specialists, whether in-house or through external consultants, is crucial for setting precise, measurable, and verifiable criteria. Without this expertise, municipalities struggle to move beyond generic requirements to actionable, impact-driven procurement. Finally, data availability and verification mechanisms are the basis of any chemical-smart approach. Centralized databases (like Sweden's BVB) and reliable third-party certifications (like DGNB or Miljöbyggnad) provide the necessary information for material selection and ensure accountability.

2.2 The transnational approach

The aspiration for a unified chemical-smart approach across the Baltic Sea Region faces obstacles. The lack of harmonized legal and regulatory frameworks is a shortcoming. The disparity between countries with mandatory green public procurement and those where green procurement is merely recommended creates an uneven playing field. This legal fragmentation directly impacts market readiness; where demand for HS-free materials is sporadic rather than systemic, suppliers have less incentive to innovate or provide transparent data. Consequently, data scarcity and inconsistency become pervasive issues. Without national databases or standardized reporting, municipalities are left to collect the fragmented information by themselves, complicating material verification and hindering circularity. Furthermore, the financial implications present a constant hurdle. The perception that chemical-smart materials are inherently more expensive, coupled with procurement cultures that prioritize the lowest bid, often stifles progress. This is exacerbated by a lack of clear, quantifiable financial benefits from using tox-free materials in the short term. Lastly, internal capacity and market engagement challenges persist. Some municipalities lack the specialized knowledge or the time to effectively engage in market dialogue or to develop nuanced procurement criteria. Where market dialogue is not a conventional practice, suppliers may be unwilling to participate without clear incentives, perceiving it as an intrusive or unprofitable exercise.

2.3 General advice for integrating a chemical-smart approach

Successfully integrating a chemical-smart approach requires a strategic blend of the tested solutions, tailored to local contexts:

- Prioritize policy and mandates: Begin by advocating for and establishing strong, legally binding commitments at both national and municipal levels. This creates the essential "pull" for the market. Without this, efforts will remain voluntary and fragmented.
- Take advantage of green building certifications and ecolabels: These are effective tools. They provide a structured, third-party verified framework for addressing HS, circularity, and climate friendliness simultaneously. Instead of reinventing the wheel, municipalities should mandate the use of relevant national or international certifications (e.g., Miljöbyggnad, DGNB, Nordic Swan) in their construction projects. This simplifies criteria setting, reduces the burden of verification, and provides clear communication to the market.
- Invest in centralized data and expertise: Push for the development of national or regional material databases that include comprehensive HS information (e.g., mimicking BVB's traffic light system). Simultaneously, invest in training municipal employees or securing expert consultancy to navigate these databases and formulate precise, verifiable criteria. A chemical-smart approach is data-driven.
- Embrace strategic market dialogue: While challenging, market dialogue is crucial. It should not be a one-off event but an ongoing, strategic process to understand market capabilities, identify innovative solutions, and communicate future demands for tox-free and circular materials. Frame it as a collaborative effort to co-create sustainable solutions, not just a fact-finding mission. Focus on properties rather than specific products in dialogue to ensure fair competition.
- Pilot and scale incrementally: For municipalities just starting, begin with manageable pilot projects that focus on specific, high-impact areas (e.g., interior materials in kindergartens). Document successes and challenges thoroughly. As confidence and expertise grow, gradually expand the scope to other construction works and integrate the principles into broader procurement policies.
- Foster collaboration and knowledge exchange: Learn from leading municipalities like Helsinki, Stokholm, and Västerås. Participate in networks, share best practices, and advocate for common standards and tools across the Baltic Sea Region. The collective demand for chemical-smart materials will ultimately drive market transformation.

In conclusion, a chemical-smart approach to construction is not merely about avoiding HS; it's about fundamentally rethinking how we build. It integrates with circularity and climate goals, creating healthier, more resilient, and sustainable built environments. While challenges remain, particularly in achieving transnational consistency and overcoming financial inertia, the path forward involves a concerted effort to strengthen policies, utilize proven tools, foster robust market engagement, and continuously learn and adapt. The municipalities that embrace this holistic approach will undoubtedly lead the way in shaping the future of construction.

3 Implications of adoption of best practices on receiving water quality

Occurrence of HS in construction materials poses an environmental challenge, impacting the quality of receiving water bodies, including the sensitive Baltic Sea. The "Occurrence of Substances of Concern in Baltic Sea Region Buildings, Construction Materials and Sites" (Screening Report) provides empirical data on the presence of substances like phthalates, PFAS, biocides, organophosphate esters (OPEs), and metals in construction materials, and on their pathways into stormwater and wastewater. The proactive adoption of best practices, guided by conscious decisions about the purchase, use, management, and disposal of building materials, directly reduces these contamination flows.

Implications from adoption of strategic solution:

It all starts with setting vision and ambition for tox-free construction and implementing high environmental standards for procurement. The reduced leaching of HS from outdoor surfaces and release from building components is achieved by mandating their exclusion or setting strict limits for the HS within the technical specifications for procurement, thereby eliminating a primary source of aquatic contamination. This is further reinforced by the utilization of green building certificates (Miljöbyggnad, DGNB or others) and ecolabels (Nordic Swan, EU Flower and others). Certification schemes can provide a clear pathway to select materials that inherently contain fewer or none of the targeted HS, while ecolabels themselves are the easily identifiable assurances of environmental performance of construction materials. These tools help to significantly minimize HS emissions and runoff from construction sites and buildings into stormwater and wastewater, also air emissions. Finally, supply chain communication and market dialogue serve to actively inform manufacturers and suppliers about the risks posed by the proven contaminants. This dialogue can reveal the availability of safer alternatives and encourage manufacturers to reformulate products. As a result, it fosters a market shift toward innovative, safer alternatives and ultimately could lead to a systemic reduction of the hazardous chemicals entering the Baltic Sea Region's water environment.

Implications from adoption of practical solutions:

The "Step-by-step guide" contributes to improving receiving water quality by offering a preventative framework to manage HS in construction. By emphasizing early conceptual decisions, the guide empowers municipalities to proactively minimize the introduction of HS into buildings. Furthermore, its focus on diligent on-site management, responsible waste handling, and selective demolition mitigates the release of HS from construction sites and materials.

BVB provides transparent information on the environmental and health properties of building products. Municipalities making purchasing decisions based on BVB assessments can actively select products rated green, indicating lower HS content. This directly reduces the use of materials containing substances like high concentrations of phthalates (e.g., in PVC flooring, cables, roofing membranes) or certain biocides, OPEs or others, thereby minimizing their leaching into stormwater and wastewater. When more municipalities and construction companies demand products listed in databases like BVB, it incentivizes manufacturers to develop and offer safer alternatives. This systemic shift would lead to a cleaner market and, consequently, fewer HS entering the aquatic environment across the Baltic Sea Region.

By promoting practices such as selecting eco-labelled products with low or zero volatile organic compounds (VOCs), opting for natural alternatives like clay or lime-based paints, avoiding materials containing plasticizers (e.g., vinyl wallpapers), and ensuring proper disposal of hazardous waste, the DIY Guide leads to minimized release of hazardous chemicals such as VOCs, formaldehyde, heavy metals, flame retardants, plasticizers, bisphenols, and biocides. This reduction in emissions and leaching from building materials directly leads to an improved receiving water quality in the Baltic Sea Region by decreasing the overall chemical load entering groundwater, rivers, and lakes via sewage, dust, air, and runoff from roofs and facades, thereby mitigating environmental pollution and protecting aquatic ecosystems.

The implemented solutions help prevent releases of HS during the building's operational life, as well as during future maintenance, renovation, and demolition, material reuse and recycling, thereby protecting water quality over the long term.

ANNEX I

Questions for evaluation of strategic and practical solutions implementation at municipalities:

Feasibility: legal
Were there any policy or legal constraints that limited implementation of the solution?
Were there any policy or legal incentives to use the solution?
Are there environmental commitments of your municipality that encourage usage of solutions, even after NHC3 project ends?
Feasibility: technical
Were there any technical limitations related to IT (availability & access of specialized software, portals, etc.) that impeded implementation of the solution?
Were there any limitations related to data/ information availability (e.g., data on chemicals in construction materials) that impeded implementation of the solution?
Were there any limitations, related to construction materials (e.g., availability and/ or suitability of HS free materials) that impeded implementation of the solution?
Feasibility: financial
Were there any financial resource constraints that limited the testing of the solution?
Was there a substantial increase in the construction costs (*please indicate: what is substantial for you?*), when implementing the solution compared to the usual practice? (*More expensive construction materials; hiring new employees; access to information sources; certification costs, etc.*)
Are there some financial benefits to implementing the solution?
Social acceptability
Do you see some social benefits because of the solution implementation?
Was there a positive acceptance of the solution beyond the project consortium (acceptance by business stakeholders, the society, reflections in media)?
Was the solution accepted and easily up-taken by the municipality's employees?
Transferability/ replicability/ scalability
Are there any limitations for the solution to be applied for all construction works organized by the municipality?
From the perspective of your municipality, would it be difficult to uptake the solution for another municipality, which did not participate in the NHC3 project?
From the perspective of your municipality, can the solution be expanded within the Baltic Sea region countries?

	General questions
1.	Successes and positive lessons (what work(s)ed well)
2.	Problems, challenges, barriers identified (what didn't work so well/ was missing in the solution/ tool):
3.	Was the solution helpful to meet the objectives defined?
a)	Describe how application of the solution contributed to reduction of HS (present your judgement on extent, if possible)
b)	Describe whether & how the solution has contributed to tox-free, circular, and climate friendly construction. If observed, please indicate also conflicts between tox-free, circularity and climate aspects
c)	If several solutions were used, which of them contributed more to HS reduction?
d)	What synergies have been observed between the solutions your municipality has tested?
4.	Suggestions for revision of the solution
5.	Feedback on the materials developed about the solution within the project
a)	The most useful aspects
b)	Aspects that could be further clarified, added
c)	Other remarks, which you would like to present about the materials

ANNEX II

Questions for evaluation of practical solutions by professionals:

Feasibility: legal
Were there any policy or legal constraints that limited implementation of the solution?
Were there any policy or legal incentives (including financial incentives) to use the solution?
Are there environmental commitments at municipality that encourage usage of the solutions?
Feasibility: technical
Were there any limitations, related to data/ information availability (e.g. data on chemicals in construction materials) that impeded implementation of the solution?
Were there any limitations, related to construction materials that impeded implementation of the solution?
Were there any technical limitations, related to IT that impeded implementation of the solution?
Feasibility: financial
Was there a substantial increase in the construction costs (*please indicate: what is substantial for you?*) when implementing the solution compared to the usual practice? (*More expensive construction materials; consultation with external experts; access to information sources; etc.*)
Were there any financial resource constraints that limited the testing of the solution?
Are there some financial benefits of implementing the solution?
Social acceptability
Have you already received encouragement from the social media, television, public or press to invest in safer housing in terms of health and the environment? How have these solutions contributed in achieving CCC housing?
Was there a positive acceptance of the solution by professionals involved in the renovation process (consultants from building supply stores, designers, hired craftsmen, project managers, etc.)?
Has the client and his family members, relatives, friends, neighbours or apartment complex community (to your knowledge) accepted the results (renovated housing) of the solution application and by what aspects (health, practicality, aesthetics, environmental impact, etc.)?
Transferability/ replicability/ scalability
Were there cases when construction sector professionals after seeing the renovation results became inspired to use these solutions for their own projects?
Are there any limitations, in your opinion, for the solution to be applied by all relevant professionals?
Would it be difficult to uptake the solution without NHC3 project expert consultations?

	General questions
1.	Successes and positive lessons (what work(s)ed well)
2.	Problems, challenges, barriers identified (what didn't work so well/ was missing in the solution/ tool)
3.	Was the solution helpful to meet the objectives defined?
a)	Describe how application of the solution contributed to reduction of HS (present your judgement on extent, if possible)
b)	Describe how application of the solution contributed to circularity (present your judgement on extent, if possible)
c)	Describe how application of the solution contributed to climate neutrality (present your judgement on extent, if possible)
d)	Describe whether & how the solution has contributed to nontoxic, circular, and climate friendly construction *(If observed, please indicate conflicts between tox-free, circularity and climate aspects)*
e)	If both solutions were used, which of them contributed more to HS reduction?
f)	What synergies have been observed between the solutions you have tested?
4.	Suggestions for revision of the solution (Was the solution essentially useful?)

ANNEX III

Questions for evaluation of practical solutions for DIY renovations:

Feasibility: legal
Not relevant, not assessed
Feasibility: technical
Were there any limitations, related to data/ information availability (e.g. data on chemicals in construction materials) that impeded implementation of the solution?
Were there any limitations, related to construction materials that impeded implementation of the solution?
Were there any technical limitations, related to IT that impeded implementation of the solution?
Feasibility: financial
Was there a substantial increase in the construction costs (*please indicate: what is substantial for you?*) when implementing the solution compared to the usual practice? (*More expensive construction materials; consultation with external experts; access to information sources; etc.*)
Were there any financial resource constraints that limited the testing of the solution?
Are there some financial benefits of implementing the solution?
Social acceptability
Have you already received encouragement from the social media, television, public or press to invest in safer housing in terms of health and the environment? How have these solutions contributed in achieving CCC housing?
Was there a positive acceptance of the solution by people involved in renovation process (consultants from building supply stores, designers, hired craftsmen, recruited handy relatives, friends or neighbours, etc.)?
Have family members, relatives, friends, neighbours, apartment complex community and even you accepted the results (renovated housing) of solutions application and by what aspects (health, practicality, aesthetics, environmental impact, etc.)?
Transferability/ replicability/ scalability
Were there cases when construction sector professionals, relatives, friends, neighbours, or the apartment complex community after seeing your renovation results became inspired to use these solutions for their own projects?
Are there any limitations, in your opinion, for the solution to be applied by all inhabitants?
Would it be difficult to uptake the solution without NHC3 project expert consultations?

	General questions
1.	Successes and positive lessons (what work(s)ed well):
2.	Problems, challenges, barriers identified (what didn't work so well/ was missing in the solution/ tool):
3.	Was the solution helpful to meet the objectives defined?
a)	Describe how application of the solution contributed to reduction of HS (present your judgement on extent, if possible):
b)	Describe how application of the solution contributed to circularity (present your judgement on extent, if possible):
c)	Describe how application of the solution contributed to climate neutrality (present your judgement on extent, if possible):
d)	Describe whether & how the solution has contributed to tox-free, circular, and climate friendly construction *(If observed, please indicate conflicts between tox-free, circularity and climate aspects)*:
e)	If both solutions were used, which of them contributed more to HS reduction?
f)	What synergies have been observed between the solutions you have tested?
4.	Suggestions for revision of the solution (was the solution essentially useful?):