Interreg Danube Region

Co-funded by the European Union

Circular DigiBuild

The Study

Common assessment study for the preparedness and needs for innovations in construction industry in Danube area

The study was drafted by HSH PP4, A 2.1 Prof. Dr. Beatrix Weber; Dr. Iryna Rudnieva Hof University, and enrolled by 13 country partners.

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1. Task of study

Hof University (HSH) is working group leader of WGK 1 targeting the project specific objective to valorize existing knowledge and identifying applicable trailblazer innovations in CE-driven emerging digital technologies for construction and buildings in Danube area

The communication objective and target groups include to inform multiple circles of stakeholders from the quadruple helix across Danube region related to innovations for construction that could contribute to make the picture complete. Thus, the collection of existing knowledge shall go beyond the partnership and ensure larger coverage of possible solutions.

This involved a wide range of quadruple helix stakeholders — industry, academia, government, and civil society — and informing the about potential innovations that could enhance and complete the current understanding of sustainable construction practices. To meet this objective, a comprehensive assessment study was conducted to evaluate the current state of preparedness and the needs for innovation within the construction industry in the Danube region. This study ensures that the collection of existing knowledge extends beyond the immediate partnership, thereby ensuring a broader coverage of possible solutions. Through synergy and cooperation, the countries involved can increase the effectiveness of these efforts, promoting more sustainable and innovative development in the construction sector across the region.

Within this task, the activity A 2.1 was performed by PP04, HSH:

Common assessment study for the preparedness and needs for innovations in construction industry in Danube area (the study)

- All countries, supported by WKG1, performed studies.
- 2 online collaborative workshops with all partners to support the performance of studies were held by WGK1, PP04 HSH, in April and May 2024.
- A thematic open webinar to present the study "Preparedness and needs for innovations in construction industry in Danube area" was held by WKG,

PP04 HSH, in June 2024 (D.2.1.4).

- 2 regional multi-stakeholder meetings were held in all partner countries until end of July 2024 (D.2.1.5).
- This consolidated report will be approved by all partners at national level with their regional multi-stakeholder groups RMSG.

2. Performance of study and support for partners

2.1. Guidelines and Templates

For the targeted objective, HSH developed templates and guidelines for the study on assessing the preparedness of the building industry in 13 countries (including 18 partners) for increased circularity and the need for digitalization-led CE innovations during March and April 2024. All templates and guidelines were discussed with the partners in workshops and adapted to their needs (D.2.1.1).

The following documents were developed and delivered as templates as part of this task:

- Guideline for the Study
- Questionnaire and templates for the Circular DigiBuild Study
- Questionnaire evaluation template
- Documents and templates safeguarding the application of data protection rules:
  - Circular DigiBuild study information
  - Circular DigiBuild data protection information
  - Circular DigiBuild declaration of consent
  - Circular DigiBuild directory of data processing activities

2.2. Enrollment of studies and Data Protection Compliance

13 studies for the preparedness of the building industry (13 country-level Study for assessing the preparedness of the building industry for more circularity and needs for digitalization-led CE innovations) were performed in May and June 2024 in 13 countries coordinated by PP04, HSH (D.2.1.2)

All relevant documents (see above) were sent to the 13 participating partners.

The design of the study is compliant to the EU data protection law (General Data Protection Regulation). Guidelines have been provided by WGK 1 leader, HSH, and were to coordinate with the local data protection officer by each participating partner. Data protection compliance for the national studies as requiring necessary consent, documentation and deletion of personal data lies in the responsibility of each participating partner.

The selection of participants was driven by the quadruple-helix-approach. The national partners sent the questionnaire, and the data protection documents by e-mail to multiple quadruple helix stakeholders from the fields of business, academia, government, and civil society. Within the Working Knowledge Group1, it was concluded that the stakeholders were clustered as follows:

25 respondents in whole, including

- 10 from industry,
- 5 from academia,
- 5 from government and
- 5 from civil society.

Each of the 13 partners were as to deliver the raw data to PP04 HSH and to summarize the study results according to the questionnaire evaluation template in a national report as well as to submit the report to PP4 (HSH).

3. Problems while performing the studies

Engaging citizen stakeholders proved challenging, as identifying and involving them was particularly difficult. This issue was compounded by the varied levels of response across the 13 participating countries. Specifically, only 6 out of 13 countries managed to gather the targeted 25 responses. In several other countries, including many academic institutions, there was a noticeable reluctance to participate. The construction industry emerged as the most active sector in providing feedback, although Slovenia and Moldova were exceptions to this trend.

The disparity in response rates across countries led to potential distortions in the data, highlighting the need for careful re-analysis and qualitative assessment to

prevent incorrect conclusions. Additionally, the quality of the responses varied significantly, impacting the reliability of the data collected.

Identifying and representing citizen interests posed another significant challenge. Many countries struggled to determine who effectively represents citizens' concerns, complicating efforts to gain a comprehensive understanding of these interests.

4. Data Evaluation: A Qualitative Analysis of Survey Results

As described above, the data collection did not provide a consistent data base for data-driven evaluation for the moment being. Therefore, a qualitative assessment of the survey results from respondents was performed. Quadruple helix stakeholder distribution per participating country is presented in Figure 1 below.

Country	Industry	Academia	Government	Civil Society
Austria	x	x	x	-
Bosnia and Herzegovina	x	x	x	x
Bulgaria	x	x	x	x
Croatia	x	x	x	x
Czech Republic	x	x	x	x
Germany	x	x	x	x
Hungary	x	x	x	x
Moldova	x	x	x	x
Montenegro	x	x	x	x
Romania	x	x	x	x
Serbia	x	x	x	-
Slovakia	x	x	x	x

	Slovenija	x	x	x	x

Fig. 1: Quadruple helix stakeholder distribution per participating country

5 Cross-country comparisons and general findings by questions

5.1 Please describe your institution

5.1.1 How many employees work in your company?

Most countries, including Austria, Germany, Slovakia, Hungary, Romania, Bosnia and Herzegovina, Serbia, Montenegro, Croatia, Moldova, and Bulgaria, provided responses from all company sizes. However, in the Czech Republic and Slovenia, small enterprises were absent, differentiating them from the other countries with full representation.

5.1.2 Which sector does your institution belong to?

- The building/construction sector is represented in every country, indicating the significance of this sector in participating in circular economy-related projects.
- Circular Economy institutions are represented only in such country, like Germany, Slovakia, Hungary, Romania.
- Academic organizations are active in all countries.
- Government institutions are represented in all countries.
- The IT sector's contribution is absent in some countries, in particular Austria, Hungary, Romania, suggesting that the IT sector may be less engaged in circular economy projects in these regions.
- Non-governmental organizations (NGOs) are presented only in Germany, Hungary, Romania, Bosnia and Herzegovina, Montenegro, Moldova, and Bulgaria, indicating a strong role for civil society in promoting projects in these countries.
- In contrast, countries like Austria and Serbia have not involvement of civil society sector of Quad Helix Stakeholders, suggesting a difference in the level of civil society engagement.
- Associations are not presented across most countries (only in Germany, Slovakia, Romania, Croatia), indicating limited participation from this type of organization in the project.

- Many countries show participation from companies classified as “Other”.

5.1.3 What is your position in the Building/Construction industry?

- **Broad Representation**: Countries like Austria, Bosnia and Herzegovina, Germany, Romania, and Slovakia showed responses across most key sectors, including architects, engineers, building companies, property developers, and facility management. These countries exhibit a well-rounded participation across various construction-related roles.
- **Limited Representation**: Hungary and Moldova had the most limited range of responses, with Hungary only representing building companies, and Moldova including building companies, property developers, and recycling but lacking more traditional positions like architects or engineers.
- **Missing Sectors**: Some countries had notable gaps:
  - Bulgaria, Croatia, Czech Republic, and Montenegro lacked participation from certain key positions such as building companies or general subcontractors.
  - Slovenija had no responses from engineers, craftsmanship, or consultants, showing a more narrowly focused respondent base.
  - Serbia stood out with responses from academic and research positions like Assistant Professor and Senior Research Associate, rather than typical industry roles.
- Architects, engineers, and planners/consultants were consistently well-represented across most countries. However, craftsmanship responses were absent in many countries, indicating a potential gap in representation from the trades.

5.2 Please describe your position in your institution

5.2.1 Which department in the institution do you belong to?

- Austria, Bulgaria, and Romania have a strong presence of management roles (e.g., CEOs, Owners, and Managing Directors) and technical departments (e.g., Architectural Offices, R&D, and Project Management). Their responses highlight a mix of leadership and innovation roles, emphasizing strategic planning and digitalization.
- Bosnia and Herzegovina, Croatia, and Serbia show a broad institutional diversity, with departments ranging from administration and municipal

departments to environmental protection, engineering, and project management. These countries exhibit a balance between operational and government-focused roles.

- Germany and Hungary stand out for their emphasis on scientific research, technology, and digital innovation, with respondents from universities, R&D departments, and digitalization committees, reflecting a high level of focus on technological advancement in construction.
- Moldova, Montenegro, and Slovakia exhibit a mix of governmental, environmental, and strategic roles. Many respondents come from policy, regulation, and sustainable development departments, indicating a focus on aligning with broader sustainability and environmental goals.
- Czech Republic and Slovenia respondents often come from research and technical development roles, with a significant representation from environmental, civil engineering, and technology departments, suggesting a focus on sustainability and infrastructure development.

5.2.2 What is your position in the respective department?

- Austria, Germany, Hungary, Czech Republic: Responses from high-level positions (CEO, Owner, Head of Department) dominate, alongside key project roles (Project Manager, Research Associate). Germany and Hungary show diversity with additional positions like Vice President, Dean, and Strategy Head.
- Bulgaria, Bosnia and Herzegovina, Slovakia: Broadest range of roles, from technical specialists (Engineers, Architects) to leadership (CEO, Head of Departments) and specialized roles (Waste Expert in Bosnia, Senior Expert in Bulgaria, Senior Consultant in Slovakia). Bosnia stands out with more niche roles like Urban Planning Associate and Professional Associate for Planning.
- Croatia, Romania, Serbia: Mixed academic and managerial positions dominate, especially in Croatia and Serbia with numerous professors and research leads, while Romania had a more general mix of managers, specialists, and consultants.
- Moldova, Montenegro: More varied with fewer academic roles. Moldova features administrative and creative roles like State Secretary and Creative Director. Montenegro shows a balance between managerial roles and project leads.
- Slovenia: No responses.

5.3 Have you personally already gained knowledge about circular economy concepts?

- All countries show respondents with profound and superficial knowledge. At the same time, all countries have respondents with the opinion that it does not matter to the institution, suggesting the need for further awareness efforts.
- All countries have respondents with superficial knowledge of the concepts. And opinion that it is important to the institution and is not important to the institution. Only in Hungary no answers, that it is not important to the institution. This indicates that, while the topic is widespread, many people have not delved into its details.
- From all countries we have answers from respondents with information of profound knowledge of such concepts and the opinion that it is important to the institution.
- Countries such as Austria, Slovakia, Bosnia and Herzegovina, Serbia, Moldova, and Bulgaria did not indicate that they possess deep knowledge of these concepts while considering them unimportant for their institutions."
- In several countries, particularly Serbia, Montenegro, Bosnia, and Herzegovina, respondents indicated that these concepts are not important to their institutions. This may suggest barriers or a lack of understanding of the necessity of these concepts in these regions.

5.4 Definition of circular economy (EU definition)

- Respondents from all countries, except the Czech Republic, indicated 'Not at all' regarding their institution's engagement in circular economy concepts.
- Respondents from all countries demonstrate a limited understanding of the definition of the circular economy but express a strong interest in learning more to evaluate its potential for their institutions.
- All countries, except Bosnia and Herzegovina and Serbia, have respondents who master the concept and already apply it across their institutions. Additionally, all countries, except Serbia, have respondents who apply the concept across other institutions as well.

- All countries, except Bosnia and Herzegovina, have institution that already engaged in circular economy concepts to have some pilot projects in progress.
- Respondents from Germany, Slovakia, Romania, Serbia, Montenegro, Moldova, Croatia indicated "I don't know" regarding whether their institution already engaged in circular economy concepts.
- Thus, while some countries are actively engaging with circular economy practices, others still lag behind and may benefit from targeted programs or resources to boost engagement.

5.5 Have you personally already gained knowledge about digitalization in the construction sector?

- In all countries there are respondents who have profound knowledge of digitalization in the construction sector.
- Respondents from only two countries, Austria and Romania, indicated that they have a superficial knowledge of digitalization in the construction sector, while also expressing that, in their point of view, it is important for their institutions.
- In all countries, except Austria, there are respondents who have superficial knowledge of digitalization in the construction sector, while also expressing that, in their point of view, it is not important to the institution.
- In all countries, except Austria and Czech Republic, there are respondents who never heard about digitalization in the construction sector.

5.6 Is your institution already engaged in digitalizing products and processes with regards to the construction?

- In all countries except Austria, the Czech Republic, and Croatia, there were respondents who selected the answer "Not at all" regarding whether their institution is already engaged in digitalizing products and processes in the construction sector.
- Respondents from all countries, except Slovenia, indicated that their institutions are only superficially engaged in digitalizing products and processes with regards to the construction sector, but their want to know more to assess its potential for the institution.
- In all countries, except Bosnia and Herzegovina, respondents reported that their institutions enough engaged in digitalizing products and processes

with regards to the construction sector to have some pilot projects in progress.

- Except for Moldova and Bulgaria, respondents across all countries indicated that their institutions master the concept of digitalizing products and processes with regards to the construction sector and already apply it within their institution
- Respondents from all countries, except for Moldova, Bulgaria, Bosnia and Herzegovina, and Montenegro, fixed that their institutions master the concept of digitalizing products and processes with regards to the construction sector and already apply it across other institutions
- Only in Slovakia, Montenegro, Romania, and Moldova did respondents indicate "I don't know" when asked if their institution is already engaged in digitalizing products and processes in the construction sector.

5.7 Which digital applications do you already know in the building and construction sector?

- Respondents from all countries, except for Montenegro, indicated that they are familiar with digital application such as the Building Resource Passport (Fig. 4).
- Respondents from only one country, Bulgaria, indicated that they are not familiar with Digital Logbook (Fig. 4).
- In Serbia and Montenegro, survey respondents indicated that they are unfamiliar with digital application such as Digital Building Pass (Fig. 4).
- In every country, respondents indicated that they are familiar with Building Information Modeling (BIM) (Fig. 3).
- In four countries of the Danube region, namely Austria, Slovakia, Bosnia and Herzegovina, and Serbia, respondents indicated that they are unfamiliar with Optimization-based design and/or operation of the building and Artificial intelligence for decision support (Fig. 4).
- In Slovakia, Romania, Bosnia and Herzegovina, Serbia, Montenegro, Croatia, Bulgaria and Moldova, respondents reported being unfamiliar with any digital applications in the building and construction sector (Fig. 2).

Country	Industry	Academia	Government	Civil Society

Austria	-	-	-	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	-	-	-
Czech Republic	-			
Germany	-	-	-	-
Hungary	-	-	-	-
Moldova	x	x	x	-
Montenegro	x	x	x	-
Romania	x			
Serbia	x			
Slovakia	x	x	x	x
Slovenija	x			

Fig. 2: Familiarity with Digital Applications in the Building and Construction Sector. Answer None

Country	**Industry**	**Academia**	**Government**	**Civil Society**
Austria	x	x	x	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	x	x	x
Czech Republic	x			
Germany	x	x	x	x
Hungary	x	x	x	-
Moldova	x	x	x	x

Montenegro	x	-	-	x
Romania	x			
Serbia	x			
Slovakia	x	x	x	x
Slovenija	x			

Fig. 3: Familiarity with Building Information Modeling (BIM)

	Austria	Germany	Czech Republic	Slovakia	Slovenija	Hungary	Romania	Bosnia and Herzegovina	Serbia	Montenegro	Croatia	Moldova	Bulgaria
Building Resource Passport	x	x	x	x	x	x	x	x	x	-	x	x	x
Digital Logbook	x	x	x	x	x	x	x	x	x	x	x	x	-
Digital Building Pass	x	x	x	x	x	x	x	x	-	-	x	x	x
Building Information Modeling (BIM)	x	x	x	x	x	x	x	x	x	x	x	x	x
Optimization-based design and/or operation of the building and Artificial intelligence for decision support	-	x	x	-	x	x	x	-	-	x	x	x	x
Other	x	x	x	x	x	x	x	x	x	x	x	x	-
None				x			x	x	x	x	x	x	x

Fig. 4: Familiarity with Digital Applications in the Building and Construction Sector

	Austria	Germany	Czech Republic	Slovakia	Slovenija	Hungary	Romania	Bosnia and Herzegovina	Serbia	Montenegro	Croatia	Moldova	Bulgaria
Ecodesign Regulation for sustainable products	x	x	x	x	x	x	x	x	x	x	x	x	x
The Data Governance Act	x	x	x	x	x	x	x	x	x	x	x	x	x
European Data Act	x	x	x	x	x	x	x	x	x	-	x	x	x
EU General Data Protection Regulation	x	x	x	x	x	x	x	x	x	x	x	x	x
Artificial Intelligence Act (EU AI Act)	x	x	x	x	x	x	x	-	x	x	x	x	x
Regulation on the marketing of construction products	x	x	x	x	x	x	x	x	x	x	x	x	x
None			x	x							x		x

Fig. 5: Familiarity with EU legal framework of digitalization and circular economy

5.8 Did you ever hear of the EU legal framework of digitalization and circular economy?

- In all 13 countries surveyed, respondents indicated that they are familiar with such a EU legal framework of digitalization and circular economy, like the Ecodesign Regulation for sustainable products, The Data Governance Act, EU General Data Protection Regulation (Fig. 6) and Regulation on the marketing of construction products (Fig. 5).
- Of all the countries surveyed, only respondents from Montenegro, indicated that they are not familiar with European Data Act.
- Only in Bosnia and Herzegovina respondents indicated that they are not familiar with Artificial Intelligence Act (EU AI Act).
- In four country, namely Slovakia, Czech Republic, Croatia and Bulgaria, respondents reported that they are unfamiliar with any EU legal framework of digitalization and circular economy.
- In some countries, particularly Germany, there is a misalignment between existing regulatory frameworks (such as the HOAI and Procurement Regulations) and modern practices like Building Information Modeling (BIM). This gap necessitates a concerted effort to align regulatory frameworks with contemporary methodologies.

Country	Industry	Academia	Government	Civil Society
Austria	x	x	x	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	x	x	x
Czech Republic	x			
Germany	x	x	x	x
Hungary	x	x	x	x
Moldova	x	x	x	x
Montenegro	x	x	x	x

Romania	x			
Serbia	x			
Slovakia	x	x	x	-
Slovenija	x			

Fig. 6: Familiarity with EU General Data Protection Regulation

Country	Industry	Academia	Government	Civil Society
Austria	x	-	x	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	x	-	-
Czech Republic	x			
Germany	x	x	x	x
Hungary	x	x	x	x
Moldova	x	x	x	x
Montenegro	x	x	-	x
Romania	x			
Serbia	x			
Slovakia	x	x	x	-
Slovenija	x			

Fig. 7: Familiarity with Data Governance Act

Country	Industry	Academia	Government	Civil Society
Austria	x	-	x	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	-	x	x
Czech Republic	x			
Germany	x	x	-	x
Hungary	x	-	-	-

Moldova	x	x	x	x
Montenegro	-	x	-	-
Romania	x			
Serbia	x			
Slovakia	x	-	-	-
Slovenija	x			

Fig. 8: Familiarity with Regulation on the marketing of construction products

Country	**Industry**	**Academia**	**Government**	**Civil Society**
Austria	x	-	-	-
Bosnia and Herzegovina	x			
Bulgaria	x			
Croatia	x	x	-	x
Czech Republic	x			
Germany	x	x	x	x
Hungary	-	x	-	x
Moldova	x	x	x	x
Montenegro	x	-	-	-
Romania	x			
Serbia	x			
Slovakia	x	x	x	-
Slovenija	x			

Fig. 9: Familiarity with Artificial Intelligence Act (EU AI Act)

5.9 Do you have an idea about the impact of the following EU Legal Framework regulations on your institution?

5.9.1 Regulation on the marketing of construction products (CPR)

Countries like Germany, Austria, Croatia, and the Czech Republic show a strong familiarity with the CPR regulation, recognizing its significance for compliance, product safety, and integration with digital tools, and offering a variety of ideas. In contrast, Slovakia, highlighting barriers to sustainable practices, raises a specific concern that the CPR regulation might impede the circular economy by restricting the use of secondary materials in construction. This indicates that, while the regulation is known, its application may conflict with sustainability goals in some countries.

Lack of idea was a common factor, particularly in countries like Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia and Romania. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact."

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the CPR regulations on their institution, the following key ideas and descriptions were identified:

1. **Product Standardization for BIM:** Standardizing building products is essential for integrating Building Information Modeling (BIM) and creating accurate as-built documentation, facilitating better project management and coordination.
2. **Environmental Information via Construction Software**: Providing environmental information on construction products through software promotes sustainability by making data on the environmental impact of materials easily accessible.
3. **Limited Influence of Construction Companies**: Construction companies have limited influence over their partners' plans and must operate within existing laws and regulations.
4. **Harmonization of Technical Requirements**: Harmonizing technical requirements, particularly those related to CE marking, ensures consistency and compliance across the industry.
5. **Increased Documentation and Proof Obligations**: There is a growing need for detailed documentation and proof to comply with legal and safety standards.

6. **Cross-Lifecycle Data Requirements**: Managing information throughout the lifecycle of construction products ensures traceability and compliance with stringent data requirements.
7. **Integration and Management of CE Markings in BIM**: The CPR requires integrating and managing CE markings and performance declarations in BIM systems, necessitating additional data fields, documentation, and automated verification processes.
8. **Digitalization Impact**: The impact of digitalization on construction companies varies, with some experiencing significant changes and others minimal.
9. **Permissibility and Neutrality in Tendering**: Ensuring the permissibility of construction products and maintaining neutrality in tendering processes are crucial for fair and transparent procurement practices.
10. **Technical Regulations**: Technical regulations are already available and are being discussed and reviewed to ensure compliance and enhance the construction process.
11. **Impact on Manufacturing and Documentation**: The CPR impacts the manufacturing process and documentation requirements, necessitating compliance with new standards and protocols.

These insights highlight the importance of standardization, sustainability, regulatory compliance, and digital integration in modernizing and improving the construction industry.

5.9.2 Ecodesign Regulation

In the analysis of the responses regarding the impact of the Ecodesign regulations on institutions across various countries, several themes emerged.

- **Lack of idea** was a common factor, particularly in countries like Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia and Romania. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact."
- **Environmental and energy efficiency** considerations were highlighted, especially in Germany and Slovakia, where respondents acknowledged the regulation's potential to influence sustainability and energy audits.
- There was a **focus on technical and regulatory applications**, seen in both Germany and Slovakia, where the regulations were linked to ongoing revisions and discussions.

- **Indirect influence** was reported in countries like Austria and Slovakia, where the regulations impacted advisory roles and broader industry standards.
- **Integration in education and research** was emphasized in Moldova, Hungary, and Slovakia, showing that some institutions were leveraging the regulation to enhance academic programs and develop future-focused approaches.

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the Ecodesign regulations on their institution, the following key ideas and descriptions were identified:

1. **Provision of Environmental Information via Construction Software**: Integrating environmental information on construction products through software is essential for promoting sustainability. This ensures that data regarding the environmental impact of materials is easily accessible and can be incorporated into project planning and execution.
2. **Environmentally Friendly Product Design**: Emphasis on designing products that are environmentally friendly aligns with the goals of the Ecodesign Directive. This approach supports the development of construction products that minimize environmental impact.
3. **Linked Data**: Utilizing linked data can enhance the management and accessibility of environmental information, making it easier to track and optimize the environmental performance of construction products.
4. **Indirect Influence on Planning and Advising**: Planners play a significant role in informing and advising clients about sustainable products and applications, indirectly supporting the objectives of the Ecodesign Directive. This involves educating clients on the benefits and availability of eco-friendly construction options.
5. **Integration of Energy Efficiency in BIM Systems**: The Ecodesign Directive requires integrating energy efficiency requirements into BIM systems. This includes managing and documenting energy consumption data, supporting energy audits and reports, and ensuring all energy-related products comply with established ecological standards. This integration improves the sustainability of construction projects and ensures compliance with the Directive.

These insights underscore the importance of digital tools, sustainable design, and the role of planners in advancing the goals of the Ecodesign Directive within the construction industry.

5.9.3 Data Governance Act

The overall trend suggests that while certain countries like Germany and Croatia demonstrate strong knowledge and implementation of the Data Governance Act and offering a variety of ideas. Many other countries are either unfamiliar with or still in the process of understanding its implications. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact." This varied awareness may stem from differences in data governance infrastructure, the digital maturity of sectors, or institutional engagement with EU regulations.

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the Data Governance Act on their institution, the following key ideas and descriptions were identified:

1. **Trust in Digital Data Exchange**: Strengthening trust in digital data exchange is crucial for enabling digital transformation. The DGA aims to create a secure and reliable framework for data sharing.
2. **Sustainable and Reliable Data Provision**: Establishing conditions for the sustainable and reliable provision and use of data is central to many organizational initiatives, promoting long-term data integrity and accessibility.
3. **Trustworthy and Secure Data Exchange**: Ensuring a trustworthy and secure exchange of data is essential for compliance with the DGA, which focuses on maintaining data integrity and security.
4. **Data Brokerage Services**: Considerations around data brokerage services are important, as they involve offering reliable and transparent data exchange solutions to customers.
5. **Separation of Data Storage and Services**: The separation of data storage (as managed by data trustees) from data-based services ensures enhanced security and trust in data handling.
6. **Robust Privacy and Data Management Practices**: Implementing robust privacy and data management practices is required by the DGA. This includes mechanisms for data integrity, access management, transparency

in data processing, and data protection measures such as anonymization and pseudonymization.

7. **Data Sovereignty in Large-Scale Projects**: Ensuring data sovereignty, particularly in large-scale projects, is necessary for compliance and the protection of sensitive information.

5.9.4 Data Act

The analysis of country responses to the EU Data Act reveals distinct trends across different regions. In Croatia and Germany, the focus was on specific benefits such as improved data access, standardization, and cloud management, reflecting a more developed engagement with the regulation. Hungary and Slovenia mentioned that the Data Act is acknowledged and applied in some organizations, but administrative challenges were also noted.

Countries like Slovakia, and Czech Republic had a significant portion of respondents who were either unaware or found it difficult to assess the Act's impact, indicating varying levels of familiarity with the legislation.

Lack of idea was a common factor, particularly in countries like Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia and Romania. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact."

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the Data Act on their institution, the following key ideas and descriptions were identified:

1. **Facilitating Data Use in Europe**: There is a recognized need to simplify data use within Europe to accelerate digital transformation. Discussions on data security, data protection, and data utilization are critical in shaping this process, albeit sometimes causing delays.
2. **Development of Data-Based Business Models**: Creating sustainable and effective concepts for data-based business models is a focal point for industry initiatives, particularly within the construction sector. This emphasis aims to leverage data to drive innovation and operational efficiency.
3. **Challenges for Cloud Providers**: Cloud providers face additional efforts to streamline cloud switching processes, reflecting the complexities involved

in ensuring seamless data transitions and compliance with regulatory frameworks.

4. **Fair Access and Use of Data**: Compliance with the Data Act requires platforms like Spartacus and N+P to ensure equitable access to and use of data. This involves implementing robust mechanisms for data sharing, managing access rights, and transparently handling data usage agreements. Such measures are crucial for enhancing collaboration among stakeholders and meeting regulatory obligations.

These points highlight the imperative of addressing data management challenges, fostering innovation in business models, and navigating regulatory requirements under the Data Act.

5.9.5 General Data Protection Regulation (GDPR)

The evaluation shows that Austria, Germany, and Slovenia stand out with the strongest familiarity, and highest impact, demonstrating comprehensive integration of GDPR into their business and institutional processes. Czech Republic, Croatia, and Slovakia display moderate familiarity, with noticeable but uneven application across sectors. Hungary and Serbia have partial awareness, but the impact is primarily administrative or limited in scope.

Lack of idea was a common factor, particularly in countries like Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia and Romania. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact."

This assessment highlights the varied levels of GDPR implementation across European countries, reflecting differences in regulatory awareness, business adaptation, and operational integration.

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the GDPR on their institution, the following key ideas and descriptions were identified:

1. **Secure Data Handling**: Ensuring secure handling of data, including implementing measures for anonymization and pseudonymization, is critical under GDPR. This involves managing data integrity, access control, and transparency in processing.
2. **Facilitation of Data Use**: There is a need to streamline the use of data within Europe, addressing issues related to data security, protection, and

utilization. Current discussions are shaping digital transformation efforts but may also lead to delays.

3. **Personal Data Protection**: GDPR compliance is essential in maintaining reliable protection of personal data within the construction industry, influencing how data is processed and managed.
4. **Regulatory Compliance**: Stakeholders are implementing GDPR regulations with the support of IT service providers to meet legal requirements and ensure data economy.
5. **Communication and PR Impact**: GDPR impacts communication strategies with members and other public relations aspects, requiring careful management of data sharing and consent.
6. **No Impact for Some**: For some institutions, particularly in the scientific field, GDPR primarily highlights new research areas and gaps without significant immediate impact.
7. **Cloud and Secure Platforms**: The use of cloud services and secure data platforms is emphasized to ensure compliance with GDPR.
8. **Administrative Effort**: Increased administrative effort is a common consequence of GDPR compliance.
9. **Rules for Processing Personal Data**: Establishing clear rules for processing personal data is necessary to comply with GDPR.
10. **Data Minimization**: Emphasizing data minimization to ensure that only necessary data is collected and processed.
11. **IT and Personnel Management**: GDPR impacts areas such as IT infrastructure and personnel management
12. **Consent Management**: Ensuring that certain information is not shared without explicit consent is a critical aspect of GDPR compliance.
13. **Indirect Impact**: In some cases, the impact is indirect, affecting specific departments rather than the entire institution.

These insights underscore the multifaceted impact of GDPR on the construction industry, emphasizing the need for secure data handling, regulatory compliance, and effective communication strategies to protect personal data and support digital transformation efforts.

5.9.6 Artificial Intelligence Act 2021/0106 (COD)

In general, most countries showed limited familiarity with the EU Artificial Intelligence Act, with respondents either unaware of its implications or recognizing no direct impact on their institutions. However, countries like Croatia,

Germany, and Hungary demonstrated a higher level of awareness, offering a variety of ideas and recognizing the Act's potential to influence AI development, ethical standards, and regulatory compliance. Despite growing awareness across several regions, the Act's concrete impact on institutions remains minimal or unclear for most at this stage.

After analyzing the answers from all stakeholders from 13 countries regarding the impact of the AI Act on their institution, the following key ideas and descriptions were identified:

1. **Reliable and Secure AI Framework**: Stakeholders emphasize the necessity of establishing reliable, legally secure, and sustainable framework conditions for the responsible deployment of AI. This is crucial for advancing digitalization within the construction sector while ensuring adherence to regulatory standards.
2. **Classification of AI Systems**: There is a need for clear classification of risk categories associated with AI systems intended for use in the construction industry. This classification framework aims to mitigate potential risks and ensure safe integration of AI technologies into construction processes.
3. **Legal Regulation of AI**: Discussions highlight the importance of developing a comprehensive legal framework to regulate artificial intelligence. This framework is essential for governing the ethical use, accountability, and transparency of AI applications within the construction sector.
4. **Initiative Status**: Currently, there are no specific initiatives undertaken by stakeholders in response to the Artificial Intelligence Act, indicating a need for future action and adaptation to emerging regulatory requirements.

Additional points of interest:

- **No Initiatives Yet**: Some organizations have not yet taken specific measures in response to the Ecodesign Regulation DGA, Data Act, General Data Protection Regulation, Artificial Intelligence Act, Regulation for the marketing of construction products.
- **Unclear Impact**: For some stakeholders, the impact of the EU Legal Framework regulations cannot be estimated at the present time.
- **Indirect Influence**: For certain departments, the influence of the EU Legal Framework regulations is indirect, with specific teams handling the compliance and integration details.

These insights underscore the critical role of establishing robust regulatory frameworks, classifying AI risks, and preparing for legal compliance to foster responsible AI adoption in construction.

5.10 Does your institution currently face the following challenges related to circular economy or the digital transformation?

5.10.1 Challenges Related to the circular economy

In all countries, respondents provided varied opinions—ranging from Strongly Agree, Agree, Disagree, to Unable to Evaluate—on the challenges associated with the circular economy. The key obstacles identified include insufficient financial resources and time for investments, as well as a lack of management commitment. Additionally, respondents highlighted gaps in knowledge about the latest solutions and the skills needed to implement digital tools for advancing the circular economy. Some respondents indicated the absence of a clear digital business model or strategy, and others noted difficulties in integrating circular economy solutions into existing organizational infrastructure. A few also believed that the impact of the circular economy on their organizations was either low or overestimated.

5.10.2 Challenges Related to Digital Transformation

Respondents across all countries expressed a wide range of opinions, from strong agreement to uncertainty, regarding the challenges of digital transformation. The obstacles highlighted were the lack of sufficient financial resources and time to invest in digitalization, as well as management's limited commitment to supporting these efforts. Additionally, respondents pointed out a lack of knowledge about the latest solutions and insufficiently skilled or qualified staff as key barriers. Other concerns included the absence of a clear digital business model or strategy, the difficulty of integrating digital solutions, and the perception of a low or overestimated impact of digitalization. These factors collectively represent the core challenges hindering the progress of digital transformation in the construction industry across the Danube region.

5.11 What do you think are the main advantages of a circular economy approach within the construction sector?

Based on the responses gathered from various countries regarding the advantages of a circular economy approach within the construction sector, we can

categorize them into several groups that reflect common themes among the responses.

Environmental Benefits: Many countries, including Austria, Germany, and Slovakia, emphasized the importance of reducing waste and CO_2 emissions as key advantages. The focus on resource conservation and the positive impact on the environment was prevalent, indicating a strong recognition of the ecological necessity for adopting circular practices.

Economic Advantages: Responses from Bosnia and Herzegovina, Bulgaria, and Romania highlighted the potential for cost savings and economic efficiency. The prospect of creating new jobs and companies within the circular economy framework was frequently mentioned, showcasing a shared understanding of the economic viability of this approach.

Sustainability and Resource Efficiency: Nations such as Croatia and Hungary stressed the role of the circular economy in promoting sustainability and improving resource efficiency. The idea that circular practices lead to longer-lasting materials and better resource management was a common theme, illustrating a commitment to sustainable development.

Innovation and Technology Development: Countries like Slovenia and the Czech Republic mentioned the opportunity for innovation and the development of new construction methods as significant advantages. The integration of new technologies and innovative practices into the construction sector was seen as a critical factor for advancing the circular economy.

Overall, the responses illustrate a collective recognition of the circular economy's multifaceted advantages, encompassing environmental, economic, and innovative aspects, while also underscoring the necessity for long-term sustainability in the construction sector.

5.12 What do you think could be gained by digital innovations in the construction sector?

In analyzing the responses regarding the potential gains from digital innovations in the construction sector, several common themes emerge across different countries, allowing us to categorize their perspectives into distinct groups.

Economic Benefits: Countries such as Austria, Germany, Bosnia and Herzegovina, Czech Republic, Hungary, and Croatia highlighted improvements in economic efficiency and cost reductions. These nations emphasized better planning, enhanced resource management, and the potential for improved profitability and competitiveness in the construction industry.

Efficiency and Process Optimization: Responses from Bulgaria, Slovakia, and Montenegro focused on increased efficiency and process optimization. They noted the significance of streamlined workflows, time savings, and improved project management, reflecting a consensus that digital innovations could facilitate quicker and more effective operations.

Sustainability and Environmental Impact: Countries like Germany, Austria, and Hungary acknowledged the importance of sustainability. They pointed out how digital technologies could contribute to resource efficiency, reduce waste, and improve overall environmental outcomes, suggesting that sustainability is a vital consideration in the implementation of digital solutions.

Digital Integration and Communication: Finally, several nations, including Serbia, Romania, and **Slovenia**, mentioned the role of digital innovations in enhancing communication and collaboration among stakeholders. Improved information sharing and connectivity were seen as essential for achieving better outcomes in construction projects, emphasizing that digital tools could bridge gaps between various actors in the sector.

Overall, these insights indicate a collective recognition of the transformative potential of digital innovations in the construction industry, with an emphasis on economic efficiency, process enhancement, sustainability, and improved collaboration.

5.13 Keeping in mind the topics in the questionnaire: How can cooperation within the construction sector, specifically regarding the Danube region, be enhanced in the context of circular economy?

Based on the responses from various countries regarding enhancing cooperation within the construction sector in the Danube region under the context of a circular economy, several common themes emerge that can be grouped by specific advantages.

Collaboration and Networking: Countries such as Austria, Bosnia and Herzegovina, Bulgaria, Croatia, and Hungary emphasized the importance of collaboration among stakeholders, including government ministries, educational institutions, and construction companies. They highlighted the need for joint projects, the establishment of networks, and the sharing of best practices to reduce waste and promote a circular economy.

Education and Awareness: Nations like Bosnia and Herzegovina, Croatia, and Montenegro noted the critical role of education and awareness-raising about circular economy principles. They mentioned initiatives such as workshops,

training programs, and the integration of circular economy topics into academic curricula to promote understanding among construction professionals and the public.

Financial and Economic Incentives: Countries like Romania, Hungary, and Serbia recognized the significance of financial support and incentives to motivate stakeholders to adopt circular practices. This includes funding for pilot projects and the establishment of public-private partnerships to facilitate collaborative efforts in the construction sector.

Technological Innovation and Data Management: Germany and Bulgaria highlighted the need for technological advancements and improved data management practices. They stressed the importance of digital tools for sharing information, managing resources, and ensuring a seamless integration of circular economy practices in construction processes.

Regulatory Framework and Legal Support: Respondents from Germany and Austria noted the necessity of establishing a clear regulatory framework to support the implementation of circular economy initiatives. They emphasized the need for harmonized rules and legal clarity to encourage cooperation among different stakeholders within the Danube region.

This evaluation shows that while there are diverse perspectives across countries, common threads of collaboration, education, financial incentives, technological innovation, and regulatory support reflect shared advantages that can facilitate a more integrated approach to circular economy practices in the construction sector.

5.14 In your opinion, how can collaboration within the Danube region construction industry, particularly in the relation to digitalization, be strengthened?

In assessing the responses from various countries regarding strengthening collaboration within the Danube region construction industry in relation to digitalization, we can identify several common factors and group them accordingly.

Austria, Germany, and Hungary emphasized the importance of **technological standards and data exchange**, highlighting the need for established standards to facilitate seamless communication and interoperability among stakeholders.

Bosnia and Herzegovina, Montenegro, and Romania focused on **collaboration and knowledge exchange**, mentioning the significance of joint

projects, networking opportunities, and the exchange of successful project experiences to promote digital transformation.

Croatia and Slovakia discussed the need for **education and training**, indicating that raising awareness and providing training on digital technologies are essential for facilitating adoption and collaboration within the sector.

Czech Republic and Slovakia brought attention to the necessity of **regulatory measures and standards**, suggesting that uniform regulations and supportive legal frameworks are vital for encouraging digital integration in construction processes.

Croatia and Austria expressed a desire for **collaboration models**, advocating for organized forums and partnerships with academic institutions to share best practices and foster innovation in digitalization efforts.

These groupings reflect the collective insights and perspectives shared by the respondents, underscoring the various dimensions of collaboration necessary for advancing digitalization in the construction sector across the Danube region.

6 Cross-country comparisons by Quadruple-Helix Groups and general findings by questions

The distribution of respondents' responses across the Quadruple-Helix Groups (Industry, Academia, Government, Civil Society) was provided by partners from only seven countries: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, and Slovakia. Consequently, the comparison of awareness and involvement of these groups in the concepts of circular economy and digitalization, as well as their preparedness and needs for innovation in the construction industry within the Danube region, is limited to these countries.

Question 1.1: Please describe your institution. How many employees work in your company?

Industry

Austria and Croatia provided industry responses across all company sizes except large enterprises, while Germany displayed the broadest range with responses from micro to large organizations. Hungary and Slovakia also contributed across most categories but omitted large and medium-sized enterprises, respectively. Moldova and Montenegro had more varied participation, with Moldova omitting large and small organizations, while Montenegro excluded large enterprises but covered micro to medium-sized ones.

Academia

In Austria and Slovakia, responses from academia were solely from large institutions. Germany exhibited a similar trend, with a focus on large entities and limited responses from small companies. In Hungary and Moldova, academia was represented by large enterprises, with Moldova also including medium-sized institutions. Croatia and Montenegro offered a more diverse view, spanning small to large institutions in Montenegro and all sizes except micro in Croatia.

Government

Government responses in Austria, Hungary, and Germany were exclusively from large enterprises, with Germany also contributing micro-company responses. Croatia and Moldova received input from large and medium-sized entities, while Montenegro and Slovakia achieved full representation across all categories. This diversity indicates a broader involvement from government institutions in Montenegro and Slovakia, covering all organizational sizes, while responses from other countries showed a preference for larger entities.

Civil Society

Civil society responses varied significantly by country. In Slovakia, responses were limited to micro enterprises. Germany and Montenegro presented a wider range with small and large organizations in Germany and micro, small, and medium-sized institutions in Montenegro. Croatia, Hungary, and Moldova emphasized smaller institutions, with Croatia and Moldova focusing on micro and small organizations, and Hungary reporting from micro and large entities only.

Question 3: Have you personally already gained knowledge about circular economy concepts?

Industry

- Austria, Croatia, Germany, Hungary, Moldova, Montenegro, and Slovakia show respondents with profound and superficial knowledge. In Austria, knowledge is viewed as important institutionally, whereas in Germany, some responses indicated it as less relevant. In Moldova, Germany, Hungary, Montenegro, Moldova, Slovakia respondents also never heard of such concepts.

- Countries such as Austria, Slovakia, Moldova, did not indicate that they possess deep knowledge of these concepts while considering them unimportant for their institutions.

Academia

- Austria, Germany, Croatia, Moldova, Montenegro and Hungary: Generally indicated profound knowledge of circular economy concepts, with consistent recognition of institutional importance.
- Moldova: Respondents also show no knowledge at all.
- Montenegro and Slovakia: Demonstrated superficial understanding, with importance and no importance to the institution.

Government

- Austria: Reported profound knowledge with importance attributed institutionally.
- Croatia, Germany and Moldova: Demonstrated both superficial and profound knowledge, with institutional importance considered significant.
- Hungary: Reported profound knowledge regarded as unimportant.
- Montenegro and Slovakia: Acknowledged both superficial and profound understanding, with varying institutional relevance.

Civil Society

- Germany: Demonstrated only superficial understanding and viewed as institutionally important.
- Croatia, Hungary, Moldova and Slovakia: Reported profound understanding, with institutional importance emphasized.
- Montenegro: Showed a range from no knowledge to superficial or profound understanding, with varying levels of institutional relevance.

Question 4: Definition of circular economy (EU definition). Is your institution already engaged in circular economy concepts?

Industry

- Austria, Germany, Croatia: In Austria, Hungary and Slovakia the industry sector showed varied levels of engagement, from a lack of familiarity to conducting pilot projects and mastery of the concept across institutions. German industries indicated either no engagement or a superficial interest

in exploring circular economy concepts, with some industries already implementing pilot projects. Croatia's industry sector reflected a mix of minimal and advanced engagement, with a desire for further knowledge.

- In Moldova and Slovakia some unsure of their status. Moldovan industries were at the superficial level but expressed interest in further involvement, with a subset applying circular economy concepts actively. Montenegrin industries reported either no engagement with circular economy concepts or a superficial interest, with the desire to explore its potential.
- Respondents from Germany, Slovakia, Moldova and Montenegro indicated "I don't know" regarding whether their institution already engaged in circular economy concepts.

Academia

- Austrian academia was involved enough to undertake pilot projects, with mastery evident in some institutions.
- In Croatia and Germany academia demonstrated a variety of engagement levels, from superficial to mastery across institutions.
- Hungary, Slovakia, Moldova, Montenegro: Hungarian academia indicated profound knowledge of these concepts and their institutional importance. In Slovakia and Moldova, engagement ranged from superficial to conducting pilot projects. Montenegrin academic responses spanned superficial to mastery.

Government

- Austria, Germany, Croatia: Croatia reported a superficial engagement in circular economy concept, enough engagement to implement pilot projects and a mastery of the concept applicable within their and across other institutions and answered that they don't know.

  Germany showed little or no government engagement, with only a superficial interest in some cases. Austria showed enough knowledge to have some pilot projects in progress.
- Hungary, Slovakia, Moldova, Montenegro: Hungarian government responses indicated minimal involvement. Slovakia's government responses ranged from no engagement to pilot projects, with several respondents unsure. Moldovan and Montenegrin governments showed limited engagement, primarily in pilot projects or basic knowledge with some mastery observed in Moldova.

Civil Society

- Germany, Croatia: In Germany, civil society reflected limited interest but showed a willingness to engage further. Croatian civil society exhibited minimal involvement, although there was interest in advancing knowledge.
- Hungary, Slovakia, Moldova, Montenegro: Civil society in Hungary and Slovakia demonstrated a basic engagement, often limited to pilot projects, superficial engagement or mastering the concepts across other institutions. Moldova's civil society indicated higher involvement, mastering and applying the concept widely. Montenegrin responses varied, from no engagement to a mix of pilot projects and mastery, with some organizations uncertain about their involvement.

Question 5: Have you personally already gained knowledge about digitalization in the construction sector?

Industry

- Austria: Respondents exhibited profound knowledge of digitalization in the construction sector, although some from the industry are not answered.
- Germany, Croatia, Hungary, Slovakia, Montenegro: A mix of profound knowledge and superficial understanding was observed, which they deemed unimportant. Industry respondents also reported either no knowledge or superficial insights.
- Moldova reported either having no knowledge of digitalization in the construction sector or a superficial understanding, which they do not consider important for their institutions.

Academia

- Austria and Germany display profound knowledge, with Germany and Croatia also showing superficial understanding, viewed as unimportant. Hungary and Slovakia show both profound and superficial knowledge. Moldova and Montenegro mainly lack knowledge, with some profound understanding. In Slovakia also answered that they have never heard of it.

Government

- Austria, Germany, and Croatia report profound knowledge, with Croatia also noting superficial knowledge, considered unimportant.
- Hungary and Slovakia indicate profound knowledge, while Moldova and Montenegro mostly lack awareness or only have a superficial understanding.

Civil Society

- Germany, Slovakia and Croatia demonstrate profound knowledge, though Croatia also includes superficial knowledge, viewed as unimportant. Hungary and Slovakia report both superficial knowledge. Moldova and Montenegro largely lack knowledge or see digitalization as unimportant.

Question 6: Definition of digitalization. Is your institution already engaged in digitalizing products and processes with regards to the construction sector?

Industry

In Austria, Croatia, Germany, Hungary, and Slovakia, industry respondents reported varying engagement levels in digitalizing products and processes, from superficial to mastery, with capability for pilot projects noted across most countries. While Moldovan and Montenegrin industries exhibited minimal engagement, often lacking understanding. In Slovakia, engagement ranged broadly, with some mastery within institutions.

Academia

Academia in Austria, Croatia, Germany, Hungary and Slovakia reported higher engagement levels, demonstrating readiness for pilot projects and mastery within their institutions. Germany and Slovakia also applies this concept across other institutions, while Moldovan and Montenegrin academia had limited knowledge and mostly superficial understanding, reflecting lower engagement with uncertainty regarding their involvement.

Government

Austrian government respondents displayed advanced engagement with digitalization. In contrast, the German and Slovakian government sectors showed mixed responses, from no to superficial engagement, with in Slovakia showing

capability for pilot projects and had respondents who don't know about their level of engagement. Moldovan and Montenegrin governments indicated limited engagement at all, while Montenegro has noted that digitalization concepts already applied within their institutions, or unsure of their status. Respondents in Hungary indicated only.

Civil Society

Civil society responses were largely minimal across countries. In Croatia, Hungary, Germany, Montenegro and Moldova, civil society respondents showed superficial engagement. In Montenegro and Germany civil society demonstrated enough engagement to have some pilot projects in progress. In Slovakia, Moldova, Montenegro and Hungary respondents reported no engagement at all. With in Slovakia and Croatia mastery the concept across other institutions.

Question 7: Which digital applications do you already know in the building and construction sector?

Industry

- **Building Resource Passport**
  - Familiarity: Austria, Germany, Croatia, Moldova, Slovakia
  - Not Familiar: Montenegro, Hungary (respondents noted no knowledge of applications)
- **Digital Logbook**
  - Familiarity: Austria, Germany, Croatia, Hungary, Slovakia, Montenegro, Moldova
- **Digital Building Pass**
  - Familiarity: Austria, Germany, Hungary, Moldova, Slovakia
  - Not Familiar: Croatia, Montenegro
- **Building Information Modeling (BIM)**
  - Familiarity: Austria, Germany, Croatia, Hungary, Moldova, Slovakia, Montenegro
- **Optimization-based Design/AI for Decision Support**
  - Familiarity: Germany, Croatia, Hungary, Moldova, Montenegro
  - Not Familiar: Austria, Slovakia
- **Other**
  - Noted by: Industry respondents in Germany
- **None** (respondents indicated no knowledge of digital applications)
  - Noted by: Industry respondents in Croatia, Montenegro and Slovakia

Academia

- **Building Resource Passport**
  - Familiarity: Germany, Croatia, Moldova, Slovakia
  - Not Familiar: Austria, Hungary and Montenegro (respondents noted no knowledge of applications)
- **Digital Logbook**
  - Familiarity: Germany, Croatia, Hungary, Slovakia, Moldova
  - Not Familiar: Austria, Montenegro (respondents noted no knowledge of applications)
- **Digital Building Pass**
  - Familiarity: Austria, Germany, Slovakia
  - Not Familiar: Croatia, Montenegro, Hungary, Moldova
- **Building Information Modeling (BIM)**
  - Familiarity: Austria, Germany, Croatia, Hungary, Moldova, Slovakia
  - Not Familiar: Montenegro
- **Optimization-based Design/AI for Decision Support**
  - Familiarity: Croatia, Germany, Hungary, Moldova, Montenegro
  - Not Familiar: Austria, Slovakia
- **None** (respondents indicated no knowledge of digital applications)
  - Noted by: Academia in Moldova, Montenegro and Slovakia

Government

- **Building Resource Passport**
  - Familiarity: Germany, Croatia, Hungary, Moldova
  - Not Familiar: Austria, Montenegro, Slovakia
- **Digital Logbook**
  - Familiarity: Croatia, Hungary, Moldova
  - Not Familiar: Austria, Germany, Montenegro, and Slovakia (respondents noted no knowledge of applications)
- **Digital Building Pass**
  - Familiarity: Germany, Croatia, Moldova, Slovakia
  - Not Familiar: Austria, Hungary, Montenegro
- **Building Information Modeling (BIM)**
  - Familiarity: Austria, Germany, Croatia, Hungary, Moldova, Slovakia
  - Not Familiar: Montenegro
- **Optimization-based Design/AI for Decision Support**
  - Familiarity: Croatia, Germany, Hungary, Moldova
  - Not Familiar: Austria, Slovakia, Montenegro

- **Other**
  - Noted by: Industry respondents in Germany
- **None** (indicated no knowledge of digital applications)
  - Noted by: Government sector in Montenegro, Moldova and Slovakia

Civil Society

- **Building Resource Passport**
  - Familiarity: Germany, Croatia, Moldova, Slovakia
  - Not Familiar: Hungary, Montenegro
- **Digital Logbook**
  - Familiarity: Germany, Croatia, Hungary, Montenegro, Moldova, Slovakia
  - Not Familiar:
- **Digital Building Pass**
  - Familiarity: Germany, Moldova, Slovakia
  - Not Familiar: Hungary, Croatia, Montenegro
- **Building Information Modeling (BIM)**
  - Familiarity: Germany, Croatia, Hungary, Montenegro, Moldova, Slovakia
  - Not Familiar: Hungary
- **Optimization-based Design/AI for Decision Support**
  - Familiarity: Germany, Croatia, Moldova, Hungary, Montenegro
  - Not Familiar: Slovakia
- **Other**
  - Noted by: Industry respondents in Slovakia, Montenegro
- **None** (indicated no knowledge of digital applications)
  - Noted by: Civil society in Montenegro and Slovakia

Question 8: Did you ever hear of the EU legal framework of digitalization and circular economy?

Industry

- **Ecodesign Regulation for Sustainable Products**
  - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, Slovakia
- **Data Governance Act**

    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, Slovakia
- **European Data Act**
    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Slovakia
    - Not Familiar: Montenegro
- **General Data Protection Regulation (GDPR)**
    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, Slovakia
- **Artificial Intelligence Act (AI Act)**
    - Familiarity: Austria, Croatia, Germany, Moldova, Slovakia
    - Not Familiar: Hungary, Montenegro
- **Regulation on the Marketing of Construction Products**
    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro
    - Not Familiar: Montenegro
- **None** (respondents indicated no knowledge of digital applications)
    - Noted by: Industry in Slovakia

Academia

- **Ecodesign Regulation for Sustainable Products**
    - Familiarity: Austria, Germany, Hungary, Moldova, Montenegro, Slovakia
    - Not Familiar: Croatia
- **Data Governance Act**
    - Familiarity: Croatia, Germany, Hungary, Moldova, Slovakia
    - Not Familiar: Austria, Montenegro
- **European Data Act**
    - Familiarity: Croatia, Germany, Hungary, Moldova, Slovakia
    - Not Familiar: Austria, Montenegro
- **General Data Protection Regulation (GDPR)**
    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, Slovakia
- **Artificial Intelligence Act (AI Act)**
    - Familiarity: Croatia, Germany, Hungary, Moldova, Slovakia
    - Not Familiar: Austria, Montenegro
- **Regulation on the Marketing of Construction Products**
    - Familiarity: Germany, Moldova, Montenegro
    - Not Familiar: Croatia, Austria, Hungary, Slovakia

- **None** (respondents indicated no knowledge of digital applications)
    - Noted by: Academia in Slovakia

Government

- **Ecodesign Regulation for Sustainable Products**
    - Familiarity: Croatia, Germany, Moldova, Montenegro, Slovakia
    - Not Familiar: Austria, Hungary
- **Data Governance Act**
    - Familiarity: Austria, Germany, Hungary, Moldova, Slovakia
    - Not Familiar: Croatia, Montenegro
- **European Data Act**
    - Familiarity: Germany, Hungary, Slovakia
    - Not Familiar: Austria, Croatia, Moldova, Montenegro
- **General Data Protection Regulation (GDPR)**
    - Familiarity: Austria, Croatia, Germany, Hungary, Moldova, Montenegro, Slovakia
- **Artificial Intelligence Act (AI Act)**
    - Familiarity: Germany, Moldova, Slovakia
    - Not Familiar: Austria, Croatia, Montenegro, Hungary
- **Regulation on the Marketing of Construction Products**
    - Familiarity: Austria, Croatia, Moldova,
    - Not Familiar: Germany, Hungary, Montenegro, Slovakia
- **None** (respondents indicated no answer or no knowledge of digital applications)
    - Noted by: Government in Germany

Civil Society

- **Ecodesign Regulation for Sustainable Products**
    - Familiarity: Germany, Moldova, Montenegro, Slovakia
    - Not Familiar: Croatia, Hungary
- **Data Governance Act**
    - Familiarity: Germany, Hungary, Moldova, Montenegro
    - Not Familiar: Croatia, Slovakia
- **European Data Act**
    - Familiarity: Germany, Moldova, Hungary, Montenegro, Slovakia
    - Not Familiar: Croatia
- **General Data Protection Regulation (GDPR)**
    - Familiarity: Croatia, Germany, Hungary, Moldova, Montenegro
    - Not Familiar: Slovakia

- **Artificial Intelligence Act (AI Act)**
    - Familiarity: Croatia, Germany, Hungary, Moldova
    - Not Familiar: Slovakia, Montenegro
- **Regulation on the Marketing of Construction Products**
    - Familiarity: Croatia, Germany, Moldova
    - Not Familiar: Hungary, Montenegro, Slovakia
- **None** (respondents indicated no knowledge of digital applications)
    - Noted by: Civil society in Hungary

Question 9: Do you have an idea about the impact of the following EU Legal Framework regulations on your institution?

Regulations for the marketing of construction products (CPR)

Industry:

Countries like **Austria**, **Croatia**, and **Germany** report a significant impact from the Construction Products Regulation (CPR), emphasizing its role in ensuring safety, compliance, and harmonized conditions for construction products. **Austria** highlights the basic requirements for building projects and its role in consulting for SMEs, while **Croatia** identifies a direct relationship as a producer of concrete. In contrast, **Hungary** and **Moldova** show a lack of familiarity with the regulation, with responses indicating uncertainty and minimal impact. **Slovakia** raises concerns that the CPR may hinder the circular economy due to strict regulations on secondary materials.

Academia:

Responses from **Germany** and **Slovakia** indicate that the CPR regulation is recognized for its potential to shape educational curricula, with implications for adapting teaching to align with industry needs. **Hungary** acknowledges a necessity to incorporate the regulation in education and research, emphasizing its role in ensuring uniform quality standards. However, in **Croatia**, there is a mixed response where some express a lack of opinion or familiarity, while others assert a strong connection to product development in compliance with the CPR.

Government:

In **Germany**, the government perspective indicates that product standardization is crucial for consistent documentation practices in Building Information Modeling (BIM). **Croatia** mentions that the regulation falls under the jurisdiction of the Construction Sector, showing awareness of its implications. Conversely, **Moldova**

shows varied responses, with some officials stating no impact while others acknowledge a high impact, suggesting inconsistency in understanding the regulation's significance. **Slovakia** largely sees no direct impact from the CPR, reflecting a limited engagement with construction product manufacturing.

Civil Society:

Responses from **Germany** indicate that civil society organizations have a limited direct impact from the CPR but recognize the regulation's role in promoting safety and compliance in the construction industry. **Croatia** outlines a detailed understanding of the regulation's effects on product safety and the CE marking, indicating a proactive approach to communicating these issues. However, in **Hungary**, **Montenegro**, and **Moldova**, civil society responses often reveal a lack of awareness or impact, with many indicating "no impact" or uncertainty about the regulation.

Ecodesign regulations: DIRECTIVE 2009/125/EC of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products:

Industry:

Countries such as **Austria** and **Germany** demonstrate moderate to high awareness of the Ecodesign regulations, with emphasis on product design for recyclability, energy efficiency, and environmental data management. **Austria** notes specific criteria like noise and efficiency for heating systems, while **Germany** mentions integrating energy efficiency standards into Building Information Modeling (BIM) systems. **Croatia** acknowledges the importance of the regulation in setting energy frameworks, though familiarity is limited. **Slovakia** sees potential for Ecodesign to drive broader eco-friendly functionalities in products, though it recognizes challenges for manufacturers adapting to future requirements. In **Hungary** and **Moldova**, industry responses reflect a lack of familiarity with the regulation, indicating limited engagement.

Academia:

In **Slovakia** and **Hungary**, academia recognizes that the Ecodesign regulations could shape educational content, particularly in energy efficiency, life-cycle impact, and sustainable building design. **Croatia** acknowledges familiarity with energy efficiency and labeling within academic projects but shows limited

understanding of the regulation as a whole. **Moldova** reports low to moderate impact, using aspects of Ecodesign information in teaching but lacking strong regulatory alignment. In **Germany**, academia shows minimal engagement, mentioning potential for new research areas without specific knowledge of the regulations.

Government:

Croatia and **Germany** identify the Ecodesign regulation as crucial for energy labeling and waste reduction initiatives, with government bodies actively involved in its implementation. **Slovakia** sees a partial impact, indicating the Ministry of Economics' role in coordinating with relevant institutions for national integration, and mentions a broader inclusion of non-energy-related products in future policy updates. **Hungary** and **Moldova** report limited familiarity, with some departments unaware of their role or minimal involvement.

Civil Society:

In **Germany**, civil society responses indicate an indirect impact, as associations inform members and support adaptation efforts within the industry. **Croatia** similarly shows an awareness of the regulation's environmental goals, though involvement remains limited to general awareness. **Slovakia** reports indirect effects, with some organizations promoting eco-friendly projects and bioeconomy initiatives in line with Ecodesign principles, despite uncertainty about specific impacts. In **Hungary** and **Montenegro**, civil society responses reveal limited to no engagement with the regulation, indicating a need for greater awareness and adaptation support.

Civil society across most countries indicates an indirect impact, primarily through informational roles and advocacy, though knowledge gaps are evident.

Data Governance Act

Industry:

Germany and **Hungary** recognize the administrative and compliance requirements imposed by the Data Governance Act, with a focus on data security and trustworthy data exchange. In **Germany**, this includes establishing robust data protection practices, data brokerage services, and ensuring data sovereignty in large projects. **Croatia** acknowledges the standardization of data collection and the alignment of digitizing sectors, although there remains uncertainty about

specific requirements. **Moldova** and **Montenegro** responses show a range of impacts from high to low, reflecting varying degrees of relevance to their organizations. **Slovakia** responses show limited understanding or familiarity with the act, indicating a need for further engagement with data governance principles.

Academia:

Hungary and **Slovakia** recognize the relevance of data governance, emphasizing the necessity of adapting educational frameworks to align with new data protection standards. **Hungary** additionally highlights the European Data Protection Regulation's role in ensuring secure data handling. Responses from **Croatia** and **Germany** reflect minimal familiarity with the act, while **Moldova** integrates it into specific areas of teaching, albeit with limited depth. **Montenegro** shows a spectrum of responses ranging from acknowledgment to unfamiliarity, illustrating varied engagement levels within academia.

Government:

Germany and **Slovakia** emphasize the role of the Data Governance Act in bolstering trust in digital data exchange, noting its importance in digital transformation efforts. **Croatia** and **Hungary** acknowledge its application, with **Croatia** specifically highlighting its relevance for research and consulting. **Moldova** and **Montenegro** exhibit a range of responses from low to high impact, showing inconsistency in perceived relevance. **Slovakia** identifies certain practical applications, such as publicly accessible data portals, though overall familiarity remains limited.

Civil Society:

In **Germany** and **Croatia**, civil society responses show some familiarity, with **Germany** actively informing members and engaging in political discourse on data governance. **Hungary** reports limited impact, though there is awareness of the act's requirements. **Moldova** and **Montenegro** indicate diverse levels of understanding, with impacts ranging from high to no impact. Responses from **Slovakia** and **Montenegro** reflect minimal engagement, showing a gap in familiarity and relevance to this stakeholder group.

Data Act

Industry:

Responses from **Germany** and **Croatia** indicate that the Data Act's primary effect lies in establishing fair data access and use, with German industries specifically noting the administrative demands for cloud providers and integration platforms to facilitate data sharing. **Hungary** and **Moldova** report a more moderate impact, focusing mainly on administrative and operational tasks, while **Austria** and **Montenegro** reflect uncertainty or lack of awareness about the Data Act's potential impact. **Slovakia** has mixed responses, with some indicating awareness and engagement with the Data Act while others remain uninformed.

Academia:

In **Germany** and **Hungary**, academic institutions recognize the Data Act's role in supporting research through enhanced data-sharing mechanisms, suggesting it could open new research fields. **Slovakia** expresses limited direct relevance, highlighting that the Data Act's focus on business-to-consumer data may not significantly affect academic functions. **Croatia** and **Moldova** report superficial or minimal understanding of the Act, with responses showing little detailed engagement with its implications.

Government:

Germany and **Hungary** see the Data Act as a critical element for promoting secure, streamlined data usage and data protection within digital transformation initiatives, though they note ongoing discussions and delays. **Croatia** reports minimal familiarity, indicating its application without further detail. In **Moldova** and **Montenegro**, responses vary from moderate impact to lack of knowledge, reflecting a less consistent understanding of the Data Act's influence on government data management practices. **Slovakia** mentions application of the Act primarily for publicly available resources like geoportals, indicating localized usage rather than comprehensive adoption.

Civil Society:

In **Germany**, civil society stakeholders report an active role in informing members and facilitating adaptation to the Data Act's requirements, with anticipated benefits for real-time monitoring and predictive maintenance. **Croatia** and **Hungary** indicate an understanding of the regulation's importance, though specific impacts remain generally undefined. **Moldova** and **Montenegro** responses range from low to high impact, but overall, civil society displays limited

engagement, with many respondents either uninformed or uncertain about the Act's relevance. **Slovakia** largely reflects minimal awareness, with scattered knowledge of the Data Act's objectives.

While there is an understanding of the Act's goals, there are gaps in engagement, especially regarding civil society and academic responses. Overall, the responses indicate that while the Data Act is seen as instrumental for fair data access and digital transformation, its practical impact and understanding vary widely among sectors and regions.

General Data Protection Regulation (GDPR):

Industry:

Countries such as **Austria**, **Croatia**, and **Germany** report a high level of familiarity with GDPR, with **Austria** and **Germany** mentioning the regulation's importance for protecting data privacy and its administrative impact, especially in IT and personnel management. **Croatia** emphasizes data protection for individuals, while **Hungary** primarily perceives GDPR as an added administrative task. **Slovakia** and **Moldova** report varied impacts, from moderate to low, highlighting the requirement to protect employee and customer data without fully understanding its implications.

Academia:

In **Germany** and **Slovakia**, GDPR prompts a shift toward increased transparency and accountability in handling personal data, suggesting a move to adjust educational and research practices to ensure compliance. **Hungary** acknowledges that GDPR aligns with organizational regulations and emphasizes data management transparency. However, **Croatia** displays minimal engagement, with some responses indicating unfamiliarity with GDPR requirements. **Moldova** references the use of GDPR knowledge mainly in teaching but cites low awareness of the full regulatory scope.

Government:

Responses from **Germany** show significant engagement with GDPR, highlighting its role in the broader digital transformation and data security discussions that delay digitalization. **Croatia** and **Slovakia** note active GDPR application in administrative and public service contexts, indicating awareness of its necessity

for processing personal data. In contrast, **Moldova** and **Montenegro** report mixed impacts, with some government sectors noting no significant effect.

Civil Society:

In **Germany** civil society organizations observe increased administrative responsibilities to ensure GDPR compliance, particularly regarding member data handling and political advocacy. **Croatia** reports minimal operational impact from GDPR, suggesting pre-existing data protection measures already aligned with GDPR principles. **Hungary** and **Moldova** acknowledge awareness and application of GDPR but often reflect limited impact, mainly administrative, on civil society functions.

Artificial Intelligence Act 2021/0106 (COD):

Industry:

Countries like **Austria**, **Germany**, and **Croatia** show some understanding of the AI Act's relevance, noting its role in establishing fair, reliable frameworks for AI use, with **Germany** emphasizing risk classification and compliance in construction. **Croatia** and **Germany** mention data protection compliance and the need for responsible use of AI for digital transformation. **Hungary** and **Moldova** demonstrate mixed awareness, with some sectors expressing familiarity while others report minimal or uncertain impact. **Montenegro** and **Slovakia** primarily indicate low familiarity or relevance, highlighting potential gaps in understanding of the AI Act's requirements.

Academia:

Responses from **Germany** and **Slovakia** suggest minimal perceived impact in research, with a focus on potential fields of study rather than direct application. **Hungary** sees the AI Act as a guide for ensuring compliance and ethical standards in AI education, while **Croatia** reports only superficial awareness. **Moldova** and **Montenegro** show diverse responses, from moderate to low impact, indicating that while some institutions are integrating AI Act insights into teaching, others see little immediate effect.

Government:

Germany highlights the need for standardized frameworks that support sustainable AI applications, while **Croatia** acknowledges awareness but lacks

direct application of the AI Act. **Hungary** and **Moldova** display mixed responses, with some government sectors unengaged or unfamiliar with the Act's implications. **Slovakia** foresees an eventual increase in AI use in the public sector, although current impact remains low. **Montenegro** responses vary widely, indicating limited consistency in understanding or relevance across governmental sectors.

Civil Society:
Croatia and **Germany** reflect an awareness of the AI Act's role in fostering safe, reliable AI, with **Germany** indicating a moderate impact due to minimal high-risk AI use. **Hungary** and **Moldova** acknowledge that the Act may affect civil society organizations, though specific impacts remain in progress. **Slovakia** and **Montenegro** display a lower level of familiarity or influence, with responses indicating mixed or partial awareness. These varied responses highlight differing levels of engagement and preparedness across civil society sectors concerning AI regulation.

Question 10: Does your institution currently face the following challenges related to circular economy or the digital transformation?

In all countries we received feedback related to the circular economy on every response option from industry, academia, civil society and government sector. Only in Austria civil society did not provide any responses.

In all countries we received feedback related to digitalization on every response option from industry, academia, civil society and government sector. Only in Austria civil society did not provide any responses.

Question 11; What do you think are the main advantages of a circular economy approach within the construction sector?

Industry
Austria, Germany, Croatia: Recognize the circular economy's role in reducing CO_2 emissions, enhancing resource efficiency, lowering costs, and prolonging building lifespans. Local job creation, waste reduction, and regionalization of resources are mentioned, aligning with goals of environmental stewardship and operational sustainability.

Slovakia: Emphasizes local material sourcing, waste reduction, and closed-loop models, with potential economic benefits like stable market responses to fluctuating resource availability.
Hungary: Notes environmental protection, waste reduction, and cost savings as important benefits, though responses suggest early-stage engagement.
Moldova, Montenegro: Highlight waste reduction and cost savings, but demonstrate a focus on general economic benefits rather than specific applications.

Academia
Austria, Croatia: Stresses the potential of circular economy models for CO_2 reduction and sustainable growth, with contributions toward reduced material use and long-term ecological benefits. Opportunities for innovation, such as developing new materials, are also mentioned.
Germany, Slovakia: Academics view the circular economy as essential for reusing materials, reducing environmental impacts, and fostering sustainable construction education.
Hungary: Supports green solutions and sustainable development, emphasizing the importance of recycling and lower environmental impact, though with limited detailed application.
Montenegro: Focuses on recycling, secondary raw materials, and minimizing ecological footprints, with a focus on sustainable resource consumption and environmental protection.

Government
Austria, Croatia: Governments promote waste reduction, efficient resource use, and environmental sustainability as essential circular economy benefits, supporting long-term societal goals like climate resilience.
Germany: Acknowledges circular practices as a future requirement, emphasizing cost reduction, sustainability, and efficient building design for CO_2 mitigation.
Slovakia: Views circular practices as means to minimize primary material use and foster resource efficiency, while creating jobs and advancing sustainable regional growth.
Hungary, Montenegro: Value waste reduction, resource efficiency, and environmental protection, though with a need for stronger systemic support to integrate these policies effectively.

Civil Society

Germany, Croatia: Civil society groups advocate for resource conservation, waste reduction, and local material reuse, highlighting positive environmental and social impacts of circular practices on community and lifestyle.

Slovakia: Expresses support for cross-sector collaboration in circular approaches, viewing resource efficiency and waste reduction as vital components of sustainable growth.

Hungary: Shows an understanding of cost reduction through material reuse and lower CO_2 emissions but lacks in-depth operational knowledge.

Moldova, Montenegro: While endorsing environmental benefits, these responses tend to emphasize basic conservation principles rather than detailed circular economy strategies, indicating an early stage in circular adoption.

Moldova, Montenegro, and Hungary: Reveal an awareness of circular economy benefits but signal a need for systemic support to operationalize these principles broadly.

Question 12: What do you think could be gained by digital innovations in the construction sector?

Industry

Austria, Germany, Croatia: Emphasize efficiency gains and significant cost reductions through digital innovations. They highlight quality improvement, enhanced communication among project stakeholders, and increased transparency in processes.

Hungary, Moldova, Montenegro, Slovakia: Focus on time savings and minimizing pollution, while also noting the need for better resource management and streamlined processes.

Overall Insight: Digital innovations in the construction sector enhance efficiency, reduce costs, improve quality, and promote sustainable practices across various countries.

Academia

Austria, Germany, Croatia: Highlight the role of digital tools in improving sustainability practices, tracking resource usage, and fostering research on circular economy impacts.

Hungary, Slovakia: Mention the importance of studying efficiency, quality improvements, and the integration of digital solutions in educational curricula.

Overall Insight: Academia is focused on understanding the implications of digitalization in construction, particularly regarding sustainability and efficiency enhancements.

Government

Austria, Croatia, Germany, Montenegro: Recognize the potential for digital innovations to streamline administrative processes, reduce bureaucracy, and enhance planning and decision-making. Governments in these countries see digital technologies as vital for improving operational efficiencies and expediting construction project approvals.

Civil Society

Croatia, Germany, Slovakia: Emphasize the benefits of digital innovations for environmental protection, resource efficiency, and improved project outcomes that positively impact communities. Civil society groups in these countries advocate for increased transparency and accessibility through digitalization, fostering public trust in the construction sector.

Question 13: Keeping in mind the aforementioned topics in the questionnaire: How can cooperation within the construction sector, specifically regarding the Danube region, be enhanced in the context of a circular economy?

Industry

Austria, Germany, Croatia: Emphasize the importance of joint projects and partnerships to foster collaboration in the construction sector. There is a focus on creating common normative foundations, sharing resources, and promoting innovative practices.

Hungary: Highlights the need to utilize demolition waste and calls for leadership commitment to strengthen cooperation.

Montenegro: Points to the significance of knowledge exchange and adopting new technologies as vital for improvement.

Moldova: Stresses the creation of public-private partnerships and financial incentives for collaborative projects.

Academia

Austria, Croatia, Germany, Montenegro: Advocate for networking and the establishment of round tables to facilitate knowledge sharing and the

dissemination of best practices. The need for standardized interfaces and education on circular economy principles is highlighted.
Hungary: Calls for the organization of training courses and the development of partnerships to support research and innovation.
Slovakia: Suggests that shared challenges within the Danube region can lead to successful application of innovations.

Government
Austria, Germany, Hungary, Montenegro: Emphasize the need for pilot projects, regulations, and financial incentives to promote cooperation within the construction sector. There is a focus on aligning legislation with EU standards to facilitate collaboration.
Croatia: Identifies digitization as a key pathway to improved cooperation, while Moldova highlights the importance of resource management and partnerships.

Civil Society
Croatia, Hungary, Montenegro: Highlight the necessity of public engagement and awareness-building efforts to promote circular economy practices. Establishing recycling facilities and encouraging community participation in recycling efforts are common themes.
Moldova: Advocates for a stronger legal framework to support the circular economy, along with ongoing professional dialogue among stakeholders.
Slovakia: Stresses the importance of building regional networks, sharing good practices, and involving associations in joint projects.

Overall Insight:
Industry: Calls for collaborative initiatives, resource sharing, and innovative practices to drive the circular economy forward.
Academia: Emphasizes networking, education, and the importance of standardization to facilitate cooperation across borders.
Government: Advocates for regulatory frameworks, pilot projects, and financial incentives to support collaboration and resource management.
Civil Society: Highlights the need for public engagement and awareness initiatives to foster a supportive environment for circular economy practices.

Question 14: In your opinion, how can collaboration within the Danube region construction industry, particularly in relation to digitalisation, be strengthened?

Industry

Austria, Germany, Croatia: Emphasize the importance of standardization in digital interfaces and tools like BIM, promoting cross-border compatibility to streamline communication and data exchange. Collaboration is further strengthened through transparency in practices and incentives for companies to adopt digitalization, with Austria and Germany also suggesting partnerships with academia and tech partners to bridge the digital knowledge gap.

Hungary, Montenegro, Slovakia: Focus on training and financial support to aid companies, especially small and medium enterprises (SMEs), in adopting digital tools. They stress leadership involvement and the development of a digital culture within organizations, with Hungary highlighting regulatory support as an essential enabler.

Academia

Austria, Croatia, Germany: Promote knowledge exchange programs and collaborative development of user-friendly digital tools in partnership with industry. They emphasize the role of education and roundtable discussions to facilitate digitalization within the construction sector, suggesting academic involvement in standardization efforts to foster cohesive approaches to digital adoption.

Hungary, Montenegro, Moldova: Advocate for the creation of shared digital platforms, training programs, and joint research projects to connect academia with industry. Standardization and best practice sharing are seen as ways to support broader regional goals for digital integration and promote a unified approach to digital knowledge-building.

Government

Croatia, Germany, Montenegro: Stress the creation of centralized databases, digital standards, and incentives to foster digital adoption. They advocate for education programs related to digital tools like BIM, with Croatia and Montenegro suggesting inclusion of experts from academia and industry to create actionable, sector-specific digital policies.

Hungary, Moldova, Slovakia: Emphasize the need for financial support and regulatory frameworks to promote digital adoption, with Hungary highlighting grant funding and generational training as essential. Moldova and Slovakia support collaborative approaches like the Quadruple Helix model to ensure cross-sector cooperation and long-term sustainability in digitalization efforts.

Civil Society

Croatia, Germany, Montenegro: Focus on the practical adoption of digital tools for everyday use across all industry roles, with a particular focus on standardized data formats and ease of use to encourage broad adoption. Croatia highlights EU-subsidized vouchers for SMEs, while Germany and Montenegro suggest networking and knowledge-sharing to foster community-based digital growth.

Hungary, Moldova, Slovakia: Highlight accessible digital solutions, awareness programs, and best practice sharing to build capacity within the industry. They suggest workshops and platforms for civil society involvement in digitalization and stress the need for solutions that accommodate limited resources among smaller companies and individuals.

7 General conclusions from the study

The analysis reveals varying levels of engagement with circular economy concepts, digitalization in construction, and knowledge of EU legal frameworks across countries. There are noticeable differences between countries that are actively engaged and those where awareness or implementation is lagging. The building/construction sector is prominent across all countries, highlighting its importance in driving circular economy initiatives. However, some sectors, like IT and NGOs, show uneven participation across regions, indicating varying levels of stakeholder involvement. Identifying and engaging civil stakeholders was challenging in many countries

- The study shows that in most countries, including Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Moldova, Montenegro, Romania, Slovakia and Slovenia, stakeholders from all sectors are involved: industry, academia, government and civil society. Industry sector, Government institutions and Academic organizations are represented in all countries. In Serbia and Austria, there is a lack of civil society participation.

- The building and construction sector is crucial for engaging in circular economy projects across all countries, although circular economy institutions are limited to Germany, Slovakia, Hungary, and Romania. Academic organizations are active in all countries. Government institutions are represented in all countries except Austria, and the IT sector is absent in Austria, Hungary, and Romania. Non-governmental organizations (NGOs) are present only in Germany, Hungary, Romania, Bosnia and Herzegovina, Montenegro, Moldova, and Bulgaria. Associations are limited to Germany, Slovakia, Romania, and Croatia, while participation from companies classified as “Other” is noted in many countries.
- The most creative countries that are leaders in providing ideas are Croatia, Czech Republic, Germany and Slovakia. Lack of idea was a common factor, particularly in countries like Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia and Romania. Responses from these regions limited to general assessments ranging from "Very High" to "No Impact."
- Quality of Responses: There was a significant variation in the quantity and quality of responses received across different regions and stakeholder groups. This indicates a diverse level of engagement and awareness regarding the topics discussed.
- Companies were the best respondents in most countries (apart from single exceptions: In the majority of participating countries, companies demonstrated the highest level of responsiveness and engagement with the survey questions. This trend underscores the active role that businesses are playing in addressing issues related to the circular economy and digital transformation. However, there were notable exceptions, such as Romania, where other stakeholder groups may have been more prominent.
- Citizen stakeholders were difficult to identify: Identifying and engaging citizen stakeholders proved challenging. This difficulty highlights the need for improved strategies to reach and involve the general public in discussions and initiatives related to the circular economy and digitalization.
- Identification of incorrect or controversial data that could affect large deviations in the performance of analytical calculations. These data required careful verification more than once in different countries and for different question groups. All this was done in order not to draw false conclusions from the numbers.
- A key issue was the question of whether sufficient know-how and tools are available to solve the problems.

- **Digitalization and Sustainability**

- The awareness of digitalization varied significantly among the countries, with some showing a higher degree of familiarity than others.
- In terms of digitalization in the construction sector, respondents reported varying levels of knowledge, with many expressing that digitalization is important for their institutions, despite another stated that they have never heard of it.
- Most countries, except Austria, the Czech Republic, and Croatia, indicated minimal engagement in digitalizing products and processes within the construction sector, although some institutions reported having pilot projects underway.
- A reluctance to fully embrace the principles of the circular economy can be stated, with varying levels of adoption and understanding across different countries.
- Problem-solving in digitalization and sustainability is crucial in the academic sector. There is a clear deficit in understanding the need for circular economy principles. Many respondents believe this responsibility lies with the Department of Economics
- Knowledge about circular economy concepts varied across countries, with some respondents possessing profound knowledge while others reported superficial understanding or deemed the concepts unimportant for their institutions.
- Respondents from all countries, except the Czech Republic, indicated limited engagement in circular economy concepts, with interest in learning more about its potential applications.

- **EU Legal Framework**
  - The EU legal framework of data law and ESG regulation with or without specific regulation for the construction sector showed a wide range in awareness and implementation.
  - Most ideas about the impact of the EU Legal Framework came from Germany and Croatia.
  - There are alarming differences in awareness and understanding of the EU legal framework.
  - Countries like Germany, Austria, Croatia, and the Czech Republic demonstrate a strong understanding of the CPR regulation, which is seen as crucial for compliance and product safety, while Slovakia expresses concerns about its potential to hinder the circular economy.

- Many countries, especially Bosnia and Herzegovina, Bulgaria, Serbia, Montenegro, Slovenia, and Romania, show a lack of concrete ideas regarding the Ecodesign Regulation, leading to vague responses ranging from "Very High" to "No Impact."
- In terms of the Data Governance Act, countries like Germany and Croatia are more knowledgeable and actively engaged, while others are still trying to grasp its implications, reflecting disparities in data governance infrastructure.
- The Data Act reveals varied levels of awareness, with countries like Croatia and Germany recognizing its benefits, while Slovakia and the Czech Republic show respondents who are either unaware of the Act or struggle to evaluate its impact.
- The General Data Protection Regulation (GDPR) sees the familiarity and implementation in Austria, Germany, and Slovenia, while many countries, particularly in Eastern Europe, express limited awareness, indicating varying levels of adaptation and integration across the continent.
- Czech Republic and Germany prioritize speeding up demolition, conducting pre-demolition audits, and managing materials with detailed "birth certificates" to reduce waste and improve efficiency. Improved communication and access to information enhance tracking of materials and building life cycles, leading to better resource management.

- **Digital applications in the construction sector**
  - Respondents from nearly all countries, except Montenegro, reported familiarity with digital applications like the Building Resource Passport, while only Bulgaria stated they are not familiar with the Digital Logbook.
  - Both Serbia and Montenegro showed unfamiliarity with digital applications such as the Digital Building Pass, and several countries in the Danube region, including Austria and Slovakia, lack familiarity with optimization-based design and artificial intelligence for decision support.
  - Despite these gaps, respondents across all countries indicated familiarity with Building Information Modeling (BIM), although there were also respondents from Slovakia, Romania, Bosnia and Herzegovina, Serbia, Montenegro, Croatia, Bulgaria, and Moldova reported a general unfamiliarity with various digital applications in the building and construction sector.

- In the Czech Republic, some view digitization as just one tool for modernization, arguing the industry's physical nature requires addressing structural problems beyond digital solutions.
- Germany's legal and tender systems are not yet aligned with Building Information Modeling (BIM), hindering the full implementation of modern digital practices.

- The main advantages of a circular economy in the construction sector, according to respondents from various countries, include environmental benefits such as reducing waste and CO2 emissions, highlighted by Austria, Germany, and Slovakia. Economic benefits, including cost savings and job creation, were emphasized by Bosnia and Herzegovina, Bulgaria, and Romania. Croatia and Hungary stressed sustainability and resource efficiency, while Slovenia and the Czech Republic noted innovations and the development of new technologies as key advantages.
- Digital innovations in the construction sector could lead to economic benefits through increased efficiency and cost reductions, as noted by Austria, Germany, Bosnia and Herzegovina, the Czech Republic, Hungary, and Croatia. Bulgaria, Slovakia, and Montenegro focused on improving process efficiency. Germany, Austria, and Hungary emphasized better sustainability and reduced environmental impact, while Serbia, Romania, and Slovenia highlighted improved communication and collaboration among stakeholders.
- Cooperation can be enhanced through active collaboration and the creation of networks among stakeholders, as suggested by Austria, Bosnia and Herzegovina, Bulgaria, Croatia, and Hungary. Education and awareness-raising were stressed by Bosnia and Herzegovina, Croatia, and Montenegro. Financial support and incentives, proposed by Romania, Hungary, and Serbia, could motivate stakeholders to adopt circular practices. Germany and Bulgaria pointed out the need for technological innovation and data management, while Austria and Germany emphasized the importance of a clear regulatory framework.
- Austria, Germany, and Hungary proposed the creation of technological standards and data exchange to facilitate seamless communication between stakeholders. Bosnia and Herzegovina, Montenegro, and Romania highlighted the importance of joint projects and knowledge exchange. Croatia and Slovakia emphasized the need for education and training on digital technologies, while the Czech Republic and Slovakia stressed the necessity of uniform regulations and legal support. Croatia and Austria suggested developing collaboration models through organized forums and partnerships with academic institutions.

- **Conclusions by countries based on the distribution of respondents' responses across the Quadruple-Helix Groups (Industry, Academia, Government, Civil Society), considering awareness of the circular economy and digitalization**

Austria

- **Industry**: Exhibits a mix of superficial and profound knowledge on circular economy concepts, viewed as institutionally important. Digitalization engagement ranges from limited understanding to pilot project capability, with some respondents achieving mastery.
- **Academia**: Demonstrates strong engagement in both circular economy and digitalization concepts, with mastery indicated and a consistent institutional emphasis on importance.
- **Government**: Profound understanding of circular economy concepts with institutional importance recognized, and some pilot projects in digitalization already in progress.

Croatia

- **Industry**: Displays superficial to advanced engagement with circular economy, with many respondents desiring more knowledge. Digitalization engagement ranges from minimal to advanced, with a subset initiating pilot projects.
- **Academia**: Shows profound knowledge of both circular economy and digitalization, with an active engagement in institutional pilot projects.
- **Government**: Engages with circular economy concepts at varying levels, mainly superficial to profound, valuing it institutionally. In digitalization, superficial knowledge is prevalent, although some pilot project engagement exists.
- **Civil Society**: Demonstrates minimal to superficial engagement in both domains, though there is a clear institutional interest in expanding knowledge on circular economy.

Germany

- **Industry**: Reflects a range from superficial to profound knowledge in circular economy, with some viewing it as less institutionally relevant.

Digitalization shows mixed engagement, from no involvement to limited pilot projects, though some desire to explore it further.

- **Academia**: Exhibits profound knowledge in both areas, with digitalization projects across institutions; some view superficial knowledge of digitalization as less important.
- **Government**: Primarily superficial understanding of circular economy, with digitalization engagement low or superficial. Pilot projects are infrequent, though some readiness exists.
- **Civil Society**: Superficial engagement in circular economy with institutional importance, while digitalization engagement is limited to some pilot projects and general curiosity to deepen involvement.

Hungary

- **Industry**: Shows varied knowledge on circular economy, from superficial to profound, although some find it unimportant institutionally. Digitalization engagement is minimal, often superficial, with pilot project capabilities in isolated cases.
- **Academia**: Reports profound understanding in circular economy, actively engaged in digitalization with mastery levels within institutions.
- **Government**: Exhibits profound knowledge in circular economy but considers it of low institutional importance. Digitalization engagement is mostly absent or minimal.
- **Civil Society**: Minimal to superficial engagement in both circular economy and digitalization, with limited to no institutional emphasis on their importance.

Moldova

- **Industry**: Reports little knowledge of circular economy and minimal digitalization engagement, with only superficial interest in either area; the importance to institutions is generally low.
- **Academia**: Lacks significant knowledge or engagement in both areas, with only isolated instances of profound understanding. Little institutional emphasis on either domain.
- **Government**: Superficial to profound knowledge in circular economy without active institutional involvement; minimal digitalization awareness, with few pilot project capabilities.

- **Civil Society**: Holds mostly superficial knowledge in both areas, with digitalization seen as relatively unimportant for most institutions. Circular economy knowledge is also limited.

Montenegro

- **Industry**: Indicates minimal or superficial knowledge of circular economy, with some interest in further exploration. Digitalization engagement is largely absent, though a few have expressed curiosity.
- **Academia**: Displays superficial to minimal understanding of circular economy, with digitalization engagement limited to basic familiarity or mastery in isolated cases.
- **Government**: Varies between no engagement and superficial knowledge in circular economy, with minimal institutional application. Digitalization engagement is mostly absent, though some familiarity exists.
- **Civil Society**: Holds a range of engagement levels in circular economy, from superficial to profound, with limited digitalization knowledge and low institutional priority.

Slovakia

- **Industry**: Mixed levels of engagement with circular economy, from no knowledge to some mastery. Digitalization knowledge also varies widely, with capability for pilot projects but inconsistent institutional support.
- **Academia**: Strong engagement with both circular economy and digitalization, showing mastery and the ability to conduct pilot projects.
- **Government**: Engagement in circular economy is minimal, with a mix of superficial to profound understanding and some pilot projects. Digitalization knowledge ranges from minimal to moderate, though some respondents remain unsure of their engagement level.
- **Civil Society**: Mostly superficial understanding of both areas, with limited institutional emphasis. However, some institutions reported mastery of circular economy across sectors, though digitalization engagement remains low.

- **Quadruple-Helix Groups Assessment of Awareness and Familiarity with Key EU Legal Framework**

Industry

- Ecodesign Regulation for Sustainable Products, Data Governance Act, GDPR: High familiarity across all countries surveyed.
- European Data Act: Known by most respondents, though unfamiliar to those in Montenegro.
- AI Act: Generally known, with exceptions in Hungary and Montenegro.
- Construction Products Regulation: Widely known, but unfamiliar to Montenegro.
- No Knowledge: Slovakia had industry respondents with no familiarity with digital applications.

Academia

- Ecodesign Regulation, GDPR: Familiar to most, except for Croatia with Ecodesign Regulation.
- Data Governance Act, European Data Act, AI Act: Generally recognized, except in Austria and Montenegro.
- Construction Products Regulation: Known only in Germany, Moldova, and Montenegro, unfamiliar to others.
- No Knowledge: Some respondents in Slovakia reported no knowledge of digital applications.

Government

- Ecodesign Regulation: Known in most surveyed countries, though not in Austria and Hungary.
- Data Governance Act, GDPR: Well-recognized, with limited unfamiliarity in Croatia and Montenegro.
- European Data Act: Mixed familiarity, with knowledge concentrated in Germany, Hungary, and Slovakia.
- AI Act: Known by few, primarily in Germany, Moldova, and Slovakia.
- Construction Products Regulation: Recognized in Austria, Croatia, Moldova; unfamiliar in Germany and several other countries.
- No Knowledge: Some government respondents in Germany had no familiarity with digital applications.

Civil Society

- Ecodesign Regulation, GDPR: Generally familiar, except for limited awareness in Croatia and Hungary.

- Data Governance Act: Mixed familiarity, unknown to respondents in Croatia and Slovakia.
- European Data Act: Known by most, except in Croatia.
- AI Act: Familiar to most, but unfamiliar in Slovakia and Montenegro.
- Construction Products Regulation: Generally known but unfamiliar in Hungary, Montenegro, and Slovakia.
- No Knowledge: Some civil society respondents in Hungary indicated no familiarity with digital applications.

- **Quadruple-Helix Groups Assessment of Digital Application Awareness and Usage**

Industry

- Respondents across Austria, Germany, Croatia, Moldova, and Slovakia are most familiar with a broad range of digital applications, especially the Digital Logbook and Building Information Modeling (BIM).
- Notable knowledge gaps exist in Building Resource Passport in Montenegro and Hungary, Digital Building Pass in Croatia and Montenegro, and in Optimization-based Design/AI for Decision Support in Austria and Slovakia.
- Some respondents from Croatia, Montenegro, and Slovakia reported no familiarity with any digital applications.

Academia

- BIM is the most recognized digital tool, familiar to respondents in Austria, Germany, Croatia, Hungary, Moldova, and Slovakia, but not familiar in Montenegro.
- The Digital Logbook and Optimization-based Design/AI for Decision Support are also known across multiple countries but remain unfamiliar to respondents, especially in Austria.
- Notably, respondents from Moldova, Montenegro, and Slovakia reported no awareness of any digital applications.

Government

- Knowledge of Building Information Modeling (BIM) is widespread, except in Montenegro.

- Other applications like Building Resource Passport, Digital Building Pass and Optimization-based Design/AI for Decision Support are familiar primarily to Croatia, Germany and Moldova but are less known in Austria, Montenegro and Slovakia.
- A government respondent in Montenegro, Moldova, and Slovakia reported no familiarity with any applications.

Civil Society

- Respondents in Germany, Croatia, Moldova, and Slovakia show familiarity with Digital Logbook and BIM applications.
- Building Resource Passport and Digital Building Pass are recognized to a lesser extent, with notable unfamiliarity in Hungary and Montenegro.
- Some respondents in Montenegro and Slovakia reported no knowledge of digital applications in the building sector.

- **Summary of Respondents' Insights on EU Legal Framework Regulations Impact**

  The responses show varied levels of awareness and perceived impact across QHG (Industry, Academia, Government, Civil Society) in the countries studied, namely Austria, Croatia, Germany, Hungary, Moldova, Montenegro, and Slovakia for six EU regulatory frameworks—the Construction Products Regulation (CPR), Ecodesign Regulations, Data Governance Act, Data Act, General Data Protection Regulation (GDPR), and Artificial Intelligence (AI) Act. This variation underscores differing regional priorities, sectoral familiarity, and operational challenges in aligning with EU regulations.

  Construction Products Regulation (CPR)

  - Industry in countries like Austria, Croatia, and Germany report significant impacts, noting the regulation's importance in safety and product compliance. Austria and Croatia are proactive in integrating CPR for SMEs and concrete production. In contrast, Hungary and Moldova lack familiarity, suggesting a potential gap in regulatory awareness.
  - Academia in Germany and Slovakia recognizes CPR's relevance in curriculum development to match industry standards, while Hungary acknowledges the need for regulation-focused education.

- Government response shows that Germany actively incorporates CPR into documentation practices like BIM, whereas Moldova and Slovakia show inconsistency in awareness and practical application.
- Civil Society in Germany and Croatia recognizes CPR's role in product safety and compliance, while limited familiarity and engagement are reported in Hungary, Montenegro, and Moldova.

Ecodesign Regulations

- Industry responses from Austria and Germany indicate awareness, with an emphasis on eco-friendly design and energy efficiency. Croatia also recognizes the regulation's significance, though Hungary and Moldova reveal limited engagement.
- Academia in Slovakia and Hungary sees Ecodesign as impactful for education in energy efficiency, whereas Moldova and Croatia show low understanding.
- Government bodies in Croatia and Germany highlight the regulation's importance for energy labeling and waste reduction, while Hungary and Moldova demonstrate minimal familiarity.
- Civil Society reports indicate indirect involvement, with limited proactive adaptation seen across most countries.

Data Governance Act

- Industry in Germany and Hungary acknowledges administrative compliance demands, with a focus on data security, while Slovakia and Moldova display limited understanding.
- Academia shows some awareness, notably in Hungary and Slovakia, where educational adjustments are anticipated, though Croatia and Germany report minimal familiarity.
- Government sectors in Germany and Slovakia emphasize digital trust and transparency as outcomes, but Moldova and Montenegro responses vary significantly in understanding.
- Civil Society in Germany and Croatia appears to engage moderately, yet Slovakia and Montenegro show little familiarity, suggesting a need for broader sectoral education.

Data Act

- Industry views in Germany and Croatia indicate the Data Act's role in promoting fair data access, with Hungary and Moldova showing moderate understanding but limited implementation. Slovakia reports mixed awareness levels.
- Academia in Germany and Hungary sees potential research benefits, while Croatia and Moldova show minimal engagement, reflecting gaps in academic familiarity.
- Government perspectives from Germany and Hungary view the Data Act as crucial to digital transformation, though Moldova and Montenegro responses reflect limited awareness.
- Civil Society responses range from moderate familiarity in Germany to limited knowledge in Slovakia and Montenegro, underscoring inconsistent understanding across regions.

General Data Protection Regulation (GDPR)

- Industry across Austria, Croatia, and Germany demonstrates high GDPR awareness, mainly for data privacy, with Hungary viewing it as an administrative task. Slovakia and Moldova display varied impacts.
- Academia in Germany and Slovakia sees GDPR as essential for transparency in data management, while Croatia shows minimal engagement, indicating a need for broader institutional adaptation.
- Government in Germany highlights GDPR's role in digital transformation, with Croatia, Moldova, Montenegro and Slovakia noting its application in public administration.
- Civil Society in Germany and Hungary acknowledges GDPR's administrative demands for data handling, but operational impact remains limited in Croatia and Moldova.

Artificial Intelligence (AI) Act

- Industry in Austria, Germany, and Croatia shows some awareness, noting the AI Act's relevance for fair, reliable AI use, while Hungary and Moldova report mixed levels of understanding. Slovakia and Montenegro demonstrate low familiarity.
- Academia exhibits minimal engagement, except in Hungary, where ethical standards in AI education are noted. Moldova and Montenegro show varied familiarity.

- Government in Germany underscores the importance of standardized AI frameworks, while Hungary and Moldova report inconsistent understanding.
- Civil Society shows varying levels of awareness, with Germany and Croatia reflecting some understanding, but overall limited familiarity is evident across Slovakia and Montenegro.

The responses indicate that Germany, Austria, and Croatia, especially industry sector, generally display the highest regulatory awareness and engagement across sectors, particularly in industry and government roles. Hungary, Moldova, Montenegro, and Slovakia reflect lower familiarity and impact, especially in civil society and academia. This variation points to a need for targeted educational programs and cross-sectoral support to enhance awareness and practical engagement with EU regulations, particularly in civil society and academia. The uneven response across countries and sectors suggests that while some regions proactively align with these EU regulations, others require support to close knowledge gaps and foster a consistent approach to regulatory compliance and implementation.

- **Advantages of Circular Economy Approaches in the Construction Industry**
  - Respondents highlight key advantages of a circular economy in the construction sector, emphasizing environmental benefits, resource efficiency, and cost savings. In the **Industry** sector, countries like Austria and Germany see the circular economy as a way to reduce CO_2 emissions, enhance resource use, and create local jobs, reflecting a focus on sustainability and long-term impact. Slovakia and Hungary also recognize benefits like local material use and waste reduction, though engagement here is at an earlier stage.
  - In **Academia**, there is a strong emphasis on reducing primary material use, fostering innovation, and developing new materials. Austria and Croatia highlight the potential for CO_2 reduction and sustainable growth, while Germany and Slovakia focus on reusing materials and reducing environmental impacts in construction. Hungary and Montenegro support

green solutions and sustainable development, particularly through recycling and lower environmental impact.

- In the **Government** sector, particularly in Austria and Croatia, there is support for circular practices as part of long-term societal goals, including waste reduction, resource efficiency, and environmental sustainability. Germany views circular practices as a necessary future requirement for cost reduction and CO_2 mitigation, while Slovakia sees it as a way to minimize primary material use and foster regional growth. Hungary and Montenegro recognize the benefits of resource efficiency and environmental protection but note the need for stronger systemic support.
- In **Civil Society**, especially in Germany and Croatia, the focus is on resource conservation, waste reduction, and local material reuse, with groups highlighting the social and environmental benefits of circular practices. Slovakia supports cross-sector collaboration for sustainable growth, while Hungary expresses an understanding of cost reduction and lower CO_2 emissions but lacks deeper operational insights. Moldova, Montenegro, and Hungary show an awareness of the environmental benefits but indicate that more systemic support is needed to operationalize these principles effectively.

8 Recommendations

Despite the varying situations in each country, promoting the circular economy, leveraging existing knowledge, and identifying innovative digital technologies for the construction sector in the Danube region involve similar activities. **The key difference lies in identifying weak points and uninformed stakeholders, according to each country's unique conditions.**

Enhancing Quadruple Helix Approaches (Industry, Academia, Citizen, Government) for driving innovation, digitalization, circular economy, greenhouse gas reduction, and sustainable development requires a concerted effort from all stakeholders. This involves both passive and active roles, taking into account the current experience, existing knowledge, and capabilities of individual countries.

- **Knowledge Transfer**
  - Develop comprehensive educational materials outlining the benefits and implementation strategies of digitalization and sustainability practices in the construction sector.

- Disseminate these materials through industry associations, workshops, and online platforms to ensure widespread access.

- **Funding**
  - Collaborate with government agencies and research institutes to identify funding opportunities and secure resources for digital innovation projects.
  - Encourage industry investment in research and development initiatives focused on digital technologies and sustainable construction practices.
- **Network**
  - Establish partnerships between different stakeholders to drive innovation and technological adoption in the construction sector in the Danube area, e.g. as a permanent network, by platforms or other means

9 Citations from the open answers of the questionnaire

Question 11: What do you think are the main advantages of a circular economy approach within the construction sector?

- **Resource Conservation:** Focuses on reusing materials, preventing waste, and conserving resources, which is crucial for sustainable development.
- **Reduction of Environmental Impact:** Includes lowering CO2 emissions, minimizing grey energy, and decreasing the overall environmental footprint of construction activities.
- **Cost Efficiency:** Potential cost reductions through waste avoidance, efficient resource use, and streamlined construction and transport processes.
- **Sustainability:** Promotes sustainable building practices, identifies sustainable products, and encourages forward-looking planning for construction and demolition phases.
- **Efficiency and Productivity:** Enhances efficiency and productivity by reducing resource consumption and optimizing material use throughout the building lifecycle.

- **Long-term Economic Benefits:** Underlines the potential for long-term cost savings and operational efficiencies, particularly when sustainability and CO2 reduction goals are achieved.
- **Promotion of Regional and Individual Procurement Concepts:** Encourages the adoption of local and personalized procurement strategies, further supporting sustainability efforts.

Question 12. What do you think could be gained by digital innovations in the construction sector?

- **Cost Reduction and Efficiency:** Digital innovations lead to cost savings, more efficient construction processes, and the potential for prefabrication and faster access to building materials.
- **Productivity and Automation:** Automation and digital processes increase productivity, help address skilled labor shortages and allow workers to focus on more meaningful tasks.
- **Competitive Advantage**: Enhanced margins, competitive edge, and improved attractiveness for personnel through more streamlined and efficient construction processes.
- **Simplification and Speed:** Simpler construction processes, faster decision-making, and optimized workflows through better data management and integration of digital tools.
- **Quality Improvement:** Improved planning and construction quality, reduced errors, and increased compliance with time and budgetary frameworks.
- **Sustainability**: Increased sustainability through efficient resource use, digital twins, and better lifecycle management of buildings.
- **Transparency and Collaboration:** Enhanced transparency, better collaboration, and seamless data sharing across all project participants, leading to better problem-solving and optimized outcomes.
- **Resource Optimization:** Better knowledge and management of building products, facilitating reuse, recycling, and addressing resource scarcity.

- **Simulation and Documentation:** Options for simulating energy efficiency and maintaining long-term documentation of the built environment, contributing to more informed decision-making.
- **Advanced Monitoring:** Ability to detect wear and damage early, improving maintenance and extending the life of structures.

Question 13. How can cooperation within the construction sector, specifically regarding the Danube region, be enhanced in the context of a circular economy?

- **Partnerships**: Establish partnerships with universities and technology partners to foster innovation and technological advancements.
- **Knowledge and Training**: Increase the knowledge of all stakeholders in the construction process, ensuring robust technology and simplified legal frameworks for using recycled and reused materials.
- **Exchange**: Promote the exchange of know-how and resources within the traditional economic area to drive innovation and efficiency.
- **Legal Framework**: Develop a clear and supportive legal framework to facilitate the use of recycled materials and address liability issues.
- **Uniform Standards**: Implement uniform evaluation criteria and classifications to standardize processes and improve collaboration.
- **Industry Dialogue**: Foster and maintain a trusting dialogue within the industry to enhance cooperation and knowledge sharing.
- **Resource Protection**: Promote resource protection by consciously reusing materials within the region, potentially through a "building materials directory“.
- **Regional Ties**: Leverage strong regional connections to share innovative solutions and best practices.
- **Digital Information Flows**: Ensure consistent digital information flows to streamline processes and improve efficiency.
- **Best Practices Platforms**: Create common platforms for sharing best practices, materials, and resources, supported by digital technologies.

- **Pilot Projects**: Define specific use cases, implement pilot projects, and publicly evaluate the results to showcase successful initiatives and encourage broader adoption.

Question 14. How can collaboration within the Danube region construction industry, particularly in relation to digitalization, be strengthened?

- **Organize Expert Meetings**: Facilitate regular meetings for industry experts to exchange knowledge and discuss best practices in digitalization.
- **Enhance Transparency**: Promote transparency in operations and data sharing to build trust among stakeholders.
- **Form Partnerships**: Establish partnerships with universities and technology companies to drive innovation and technological adoption in the construction sector.
- **Develop Uniform Regulations**: Create and implement uniform regulations across countries to ensure consistency and compliance in construction practices.
- **Standardize Labeling**: Introduce uniform labeling for building materials to facilitate easy identification and use across the region.
- **Create Common Standards**: Develop common standards for data exchange and construction processes to improve efficiency and collaboration.
- **Assess and Optimize Needs**: Identify the specific needs of stakeholders, develop relevant concepts for information processes, and optimize them through practical applications.
- **Overcome Barriers**: Address language barriers and cultural reservations to create trustworthy and cooperative regional structures.
- **Implement Common Data Environments (CDEs)**: Use CDEs and standards such as IFC and BCF to manage and exchange data effectively.
- **Develop Cross-Border Solutions**: Create uniform cross-border solutions for data storage and exchange, standardizing processes and interfaces.
- **Facilitate Experience Exchange**: Encourage the sharing of experiences, particularly in Building Information Modeling (BIM) for construction and infrastructure projects.

- **Leverage Regional Ties**: Use strong regional ties to exchange innovative solutions and best practices.
- **Achieve Seamless Digitization**: Aim for comprehensive digitization across all aspects of the construction industry to enhance integration and efficiency.
- **Strengthen Industry-Science Cooperation**: Foster closer cooperation between the construction industry and scientific institutions to promote research and innovation.
- **Organize Educational Events**: Hold events such as Crafts 4.0 and capacity-building programs for small and medium-sized enterprises to enhance skills and knowledge.
- **Create Cross-Border Networks**: Establish cross-border networks and digital platforms to share data, technologies, and best practices, promoting joint innovation projects.
- **Establish Clear Rules and Fair Compensation**: Set clear rules for digitalization efforts and ensure fair compensation for the additional work involved

10 Annex Documents: National Study Reports