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for establishing an information system to assess environmental properties of building materials

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by

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Abstract

In order to better consider and evaluate the environmental properties of building materials in future infrastructure projects, a needs and stakeholder analysis was carried out to establish an information system for assessing the environmental properties of building products and materials. The study is divided into three work packages.

In the needs analysis (first work package), existing publicly accessible databases on environmental aspects and/or chemical properties of building products and materials were identified, systematically analyzed and evaluated. The evaluation shows that although there are various already-existing databases that take the environmental properties of building materials into account, the databases relate primarily to the field of building construction, and local environmental impacts are given less or no consideration. No information system was identified that fully meets the requirements of the project.

The second part of the analysis identified the demand of selected stakeholders for an information system that enables assessment of environmental properties of building materials along with the stakeholders' requirements and expectations, as well as success factors and expected barriers in the development and establishment of such system. In 31 interviews with experts, it became clear that the stakeholders are generally aware of the importance of the environmental properties of building products and materials. However so far, the environmental properties have largely not been taken into account (voluntarily) or were only partially considered. In many cases, the stakeholders surveyed rely on legal regulations or on the standardization and approval of building materials. 23 out of 31 stakeholders reported that they consider a new information system for assessing environmental properties of building materials to be useful, and advocate the development of such an information system.

A model structure for an information system for authorities was therefore developed in the third work package. This potential information system considers general, product group-specific information as well as, if available, manufacturer-specific data and offers three possibilities for the level of detail:

1. Product group level (product group-specific data)
2. Manufacturer level (manufacturer-specific data), including only publicly available information such as from safety data sheets
3. Detailed manufacturer/product level (manufacturer-specific data), including details on the composition or experiences regarding the use of the products

For each of the three levels and a supplementary glossary, design drafts were developed which show the possible structure of the information system, i.e. user interfaces (output) and input framework (input).

The authors recommend reviewing the implementation of the developed model structure in a next step to realize such a system. In this way, information on environmental influences of building materials and building products could be made centrally available and taken into greater account in future building projects. However, some stakeholders noted that simply providing information would not be sufficient to make the transport infrastructure more environmentally compatible. In addition to the development of an information system, further measures should therefore be taken to establish environmental compatibility as a relevant assessment criterion in the selection of materials.

1 Introduction

Environmentally friendly infrastructure construction is one of the most pressing transport planning issues. Building materials can contain a large number of chemical substances and possible transformation products. Through outgassing, abrasion, solvation or corrosion, these substances can be emitted into the air, soil, groundwater, surface water and seawater, where they can impair the environment and human health. An assessment of the environmental compatibility of building materials as well as structures is also explicitly required by the amended EU Construction Products Regulation (No. 305/2011). With regard to construction projects, environmental compatibility must therefore be guaranteed at every stage of the life cycle (construction - maintenance - removal).

A needs and stakeholder analysis was carried out to establish an information system (ISy) for evaluating the environmental properties of building materials. It aims to better considering and evaluating future construction and structure-related emissions in civil engineering as well as local environmental impacts of building materials in construction projects in the infrastructure sector.

The study is divided into three work packages:

1. A requirements and needs analysis for a web-based information system to evaluate the environmental properties of building materials
2. A stakeholder analysis, by means of which the demands and expectations towards an information system are determined in the course of expert interviews
3. The derivation of a model structure for the information system based on the insights gained.

This report is an abridged version of the detailed results report.

2 Needs Analysis

As part of the first work package, existing national and international databases on chemicals, building materials and building products were identified and pre-selected. The result of this step was a list of six existing databases with information on environmental properties of building materials and products as well as on ecotoxicology: baubook, ETOX, INIES, ÖKOBAUDAT, STARS and WECOBIS.

These six databases were systematically evaluated in terms of their usability for infrastructure projects on the basis of a defined evaluation framework comprising content, technical and legal criteria. Content criteria include, for example, the question of the extent to which concrete data on environmental properties are contained. The quality of the data was also assessed based on standards and norms taken into account during collection, as well as the timeliness of the data records. The technical criteria include topics such as access rights and fees as well as usage-related criteria such as user friendliness, comprehensibility and legibility. Legal criteria relate to provider and user security.

14 of a total of 26 criteria were recorded descriptively, while the remaining 12 were quantitatively evaluated on a scale from "++" (very suitable) to "- -". (not suitable). In order to reflect the high relevance of selected criteria for the project in the evaluation, additional weighting was applied. This results in a calculated average value for the content and technical criteria, which is rounded up or down to an overall result, also on a scale between "++" and "- -".

2.1 Analysis of the Existent Databases

In the course of the analysis, each of the six databases and the substances and products they contain was randomly checked relative to the content, technical and legal criteria in order to gain an impression of the suitability of the platforms for the objective of the project. Detailed analysis of the platforms showed that several established databases dealing with the environmental impacts of construction products exist already, particularly in the field of building construction. Despite the large number of databases, none were identified that explicitly pertain to civil engineering or infrastructure construction and structure-related emissions into water and soil. In addition, the existing databases often focus on global climate and environmental impacts. Local impacts on water and soil, as required by this project, were only explicitly addressed in STARS, which was last updated in 2007.

Analysis of the existing databases resulted in the following evaluation:

TABLE 1: COMPARISON OF THE EVALUATION OF THE DATABASES

	baubook	**ETOX**	**INIES**	**ÖKO-BAUDAT**	**STARS**	**WECOBIS**
Client/ publisher	baubook GmbH[1]	UBA[2]	Alliance HQE-GBC[3], Centre Scientifique et Technique du Bâtiment	BMI[4]/responsible in terms of press law BBSR[5]	BMU[6], UBA[2], Oberfinanzdirektion Hannover, BMVI[7]	BMI[4]/responsible in terms of press law BBSR[5], Bayerischen Architektenkammer
Country of client	AT	DE	FR	DE	DE	DE
Content evaluation	+	o	+	+	o	+
Technical evaluation	+	o	+	+	o	+
Total	**+**	**o**	**+**	**+**	**o**	**+**

Overall, the French platform **INIES** and the German platform **WECOBIS** scored particularly well in the evaluation. Both databases are characterized by their clear focus on environmental properties of building products and the clear orientation towards existing regulations and standards such as the European standard EN 15804 or the BNB standard (assessment system for sustainable building). Furthermore, the systems are designed in a modularly way, so that additional products and criteria could be added. In addition to the language, the two databases differ in particular with regard to the type of data: Unlike WECOBIS, INIES offers manufacturer-specific information in addition to cross-product data. While WECOBIS is initiated and maintained by the BMI[4] or rather the BBSR[5]INIES is backed by a variety of stakeholders. Apart from public authorities and ministries, these also include associations from the residential or environmental sectors as well as unions.

2.2 Development of an Evaluation Framework for Building Materials

In consideration of the previous work steps, criteria for a database were developed to evaluate the environmental properties of building materials.

[1] Owners are the Energieinstitut Vorarlberg and the Austrian IBO

[2] German Environment Agency (UBA)

[3] Centre Scientifique et Technique du Bâtiment

[4] Federal Ministry of the Interior, Building and Community (BMI)

[5] Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR)

[6] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)

[7] Federal Ministry of Transport and Digital Infrastructure (BMVI)

Initially, criteria for the evaluation of building materials were collected by means of a review of existing literature. The results of this research were supplemented by screening all 53 identified databases and are as follows:

- Eleven **usage-related criteria for the evaluation of building materials** such as product classes and properties, approval data, declared ingredients according to the safety data sheet, and information on occupational health and safety or potential environmental declarations
- Ten **criteria for assessing the environmental properties of building materials**, including information on legally regulated ingredients, emission behavior and information on exposure and release scenarios, as well as information on removal, recyclability and disposal.

The assessment can be carried out at the product group level or at manufacturer-specific construction products level. In the context of the analysis of legal requirements for an information system (see results report chapter 1.4), it became apparent that the provision of information on the environmental properties of specific manufacturer products in an information system operated by a public institution is only possible to a limited extent. This is due to the fact that the provision of information by public authorities can influence the basis of consumer decisions in a purposeful manner, which would constitute a market intervention. In particular, a practical assessment of the environmental compatibility of construction products, for example in the form of a traffic light system, is difficult from these points of view.

3 Stakeholder Survey

The primary objective of the second work package was to identify the relevant actors for the development and establishment of a web-based information system, as well as their requirements for such an information system, and potential barriers to its implementation. For this purpose, an overview of the actors involved in the construction process was prepared in the course of performing a stakeholder and environment analysis. In 31 expert interviews, current consideration of environmental properties in the profession were discussed, along with the demands and requirements for an information system, including possible success factors and barriers.

The stakeholders are employed in public authorities, companies, associations and scientific organizations and were divided into the following categories:

- *Public actors: Contracting authorities (8), expert network of the* BMVI (*Federal Ministry of Transport and Digital Infrastructure) (6), (other) public authorities (4) (with the exception of contracting authorities and public authorities of the expert network of the BMVI)*
- *Private sector actors: Construction companies/associations (5), manufacturers/associations (3), engineering/planning offices (2)*
- *Scientists (3)*

Statements from 31 interviews were included anonymously in an Excel file containing a total of 778 statements. These were then coded and systematically evaluated according to the Grounded Theory methodology.

3.1 Results of the Stakeholder Survey

The stakeholder survey showed that the experts surveyed are generally aware of the importance of the environmental properties of building materials. In many cases, however, the stakeholders appeared to rely on legal regulations or requirements, standardization and approval, assuming that in doing so environmental properties are already sufficiently taken into account. Further, the environmental properties of building materials have not for the most part been taken into account (voluntarily) or were considered only partially. When stakeholders explicitly consider environmental issues, they often do so on the basis of specific legal requirements or the requirements of the client or contracting authority.

The lack of consideration of the environmental properties of construction products can also be linked to the assessment of the current availability of information. About two thirds of the stakeholders surveyed believe that information on the environmental properties of building materials is currently insufficient or only partially available. The interest in an information system was therefore high, with 23 of 31 stakeholders reporting that they see a need for such an information system. Nevertheless, there was a divergence of views with respect to the creation of such a system.

Five stakeholders prefer an internal information system. This wish was justified, among other things, by the fact that the technical information contained could be misinterpreted without the necessary expertise and would contribute to uncertainty. However, other stakeholders said that existing information should be made public, at least to those involved in the construction process, in order to enhance its effectiveness. Accordingly, eight stakeholders explicitly prefer a public information system. Different views were also identified on the required level of detail of the data. An essential argument for the provision of manufacturer-specific data was that the environmental properties vary due to the sometimes-significant differences in the formulation of a product. Almost as many stakeholders indicated that they consider data

at product group level to be sufficient, since, for example, public authorities are obliged to tender plans and come to decisions in a product-neutral manner.

Irrespective of the level of integrated data chosen, stakeholders identified a number of substantive criteria/categories in terms of data scope that should be included in an ideal information system. The three most frequently mentioned categories were:

- **Emission behavior** (8 stakeholders named different criteria in 16 statements, such as leaching, outgassing, etc.)
- **Disposal & recyclability** (8 stakeholders named different criteria in 13 statements, such as information on final disposal)
- **Condition of use** (8 stakeholders named different criteria in 10 statements, such as use in sensitive areas, e.g. nature reserves or near rivers)

The stakeholders surveyed agree that the transparent preparation and reliability of the data are decisive factors for the success of the information system. The inadequate availability of data, on the other hand, is one of the main challenges seen by stakeholders. The timeliness and validity of the information as well as the comparability of the data are also essential requirements that stakeholders would want from such an information system.

3.2 Derivation and Evaluation of Two Variations of an Information System

The stakeholder survey did not provide any clear guidelines for the development of a model structure. Therefore, two different variations of an information system were developed in the next step using seven variables (Table 2) and evaluated with regard to their suitability.

TABLE 2: VARIATIONS OF THE INFORMATION SYSTEM

	Government information system	**Public information system**
Publisher	Federal Ministry of Transport and Digital Infrastructure in exchange with other infrastructure authorities	Multi-stakeholder initiative
Primary target group	Tendering infrastructure authorities	Construction companies, infrastructure authorities, engineering/ planning offices
Access	Internal access by public authorities (considering the option of public access)	Public with separate non-public access
Type of data input	• Basic information on product categories • Where feasible, manufacturer-specific	• Manufacturer-specific basic information • Where appropriate, information on product categories
Primary data provider	Infrastructure authorities, where appropriate manufacturers	Manufacturers, where appropriate infrastructure authorities
Classification/ evaluation of	• Specify average values for product groups	• Specify average values for product groups

products	• Compare/present alternatives	• Compare/present alternatives • Classification according to evaluation system
Development approach	New ISy as an independent system	a) Interfaces to e.g. WECOBIS or baubook b) Merging of ISy and e.g. WECOBIS in one solution c) ISy as portal

These two variations were subsequently evaluated on the basis of the four criteria of data availability, necessary external support/cooperation, cost/effort and effectiveness. In addition to the stakeholder interviews, the evaluation was based on further discussions with those responsible for the GESTIS and WECOBIS databases.

Weighting all criteria equally, the defined government information system containing product group-specific information is preferable to the defined public information system with manufacturer-specific data. This is due to better data availability, less need for cooperation with project partners and lower costs. However, the biggest disadvantage of the authority information system is the limited access, whereby not all stakeholders involved in the construction process would have access to the data.

Based on the results of this work package (stakeholder survey and evaluation of the two variations) it was decided to develop a model structure for a government information system in the further course of the project.

4 Derivation of a Model Structure

Within the course of the third work package, a model structure for a web-based authority-internal information system was developed, based on the results of the first two work packages.

The information system provides data on three different levels of detail:

1. Product group level (product group-specific data)
2. Manufacturer level (manufacturer-specific data), but only publicly accessible information, e.g. from safety data sheets
3. Detailed manufacturer/product level (manufacturer-specific data), e.g. including details on the composition or experiences regarding the use of the products

Information at manufacturer level (2. and 3.) should not be mandatory, but – depending on the data situation – can be added in the system. It should be possible to include scientific results, studies etc. as well as literature references at each of the three levels mentioned above. The authority information system would be modularly structured in such a way that subsequent (partial) access to the data on the first and second level is made possible for experts (planners and architects' offices).

4.1 Model Structure

The contents within an information level are divided into different clusters, which are represented in the model structure of the information system in different tabs. The first level contains general product group-specific information in the following tabs: Basic information (typical components, operating conditions, etc.); technical and legal rules (DIN standards, laws, etc.); life cycle; comparison with alternatives; products.

In order to avoid duplication with information in existing databases, a link to these databases can be included in appropriate places. This is the case with the health and safety and hazard information, where reference can be made to WingisOnline of the BG Bau (German Social Accident Insurance Institution for the Building Trade). A comparison with alternative product groups is made possible by showing, for various criteria such as substance properties or environmental declarations, how many products of the corresponding product group have comparable environmental labels, or in which range the products are with regard to substance properties. For this comparison, the products stored in the information system are automatically read out meaning that the product group is not evaluated, but can be compared using objective criteria.

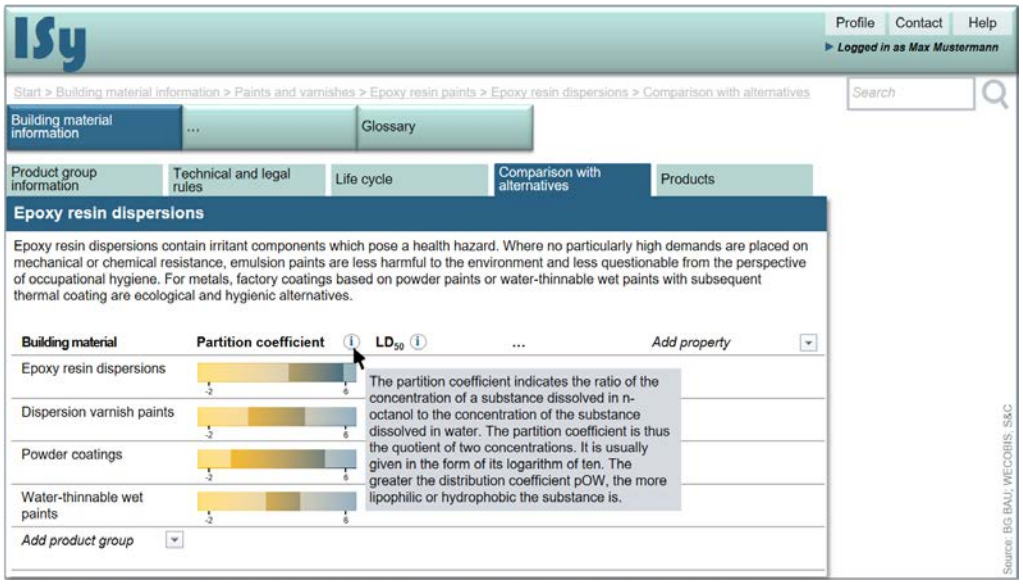

Figure 1: Model Structure for Product Groups

The fifth tab lists all products in the product group (including manufacturers) that are stored in the information system. For each of these products, a link provides access to the manufacturer-specific or substance-specific information on the second level. This information is divided into the following tabs: Safety Data Sheet, application information, exposure scenarios, toxicological information, and environmental information.

The information system provides material properties, which can be specified for the building material as a whole and for the individual components, depending on availability. Explanations are also included that enable users who are not experts in the field to interpret and assess the environmental effects of the product. Manufacturer-specific information that is not intended for the public, such as details on the composition or experiences regarding the use of the products, is linked to these tabs at the appropriate places, but is only displayed to users who have the corresponding user rights.

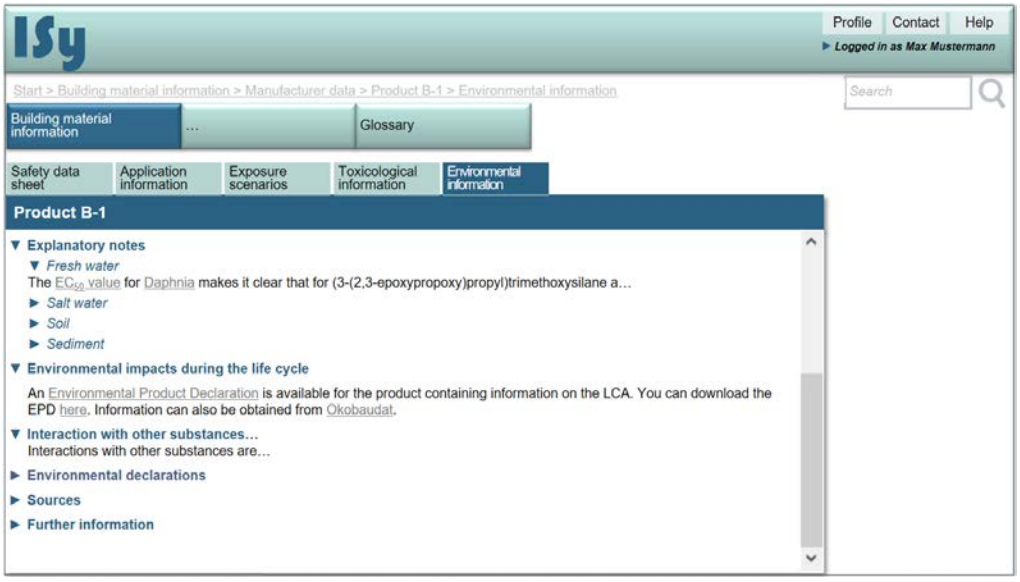

Figure 2: Model Structure for Manufacturer-Specific Information

The glossary contains descriptions and explanations of technical terms, legal requirements and technical rules, environmental declarations and other databases. In addition, a short description is created for all contents in the glossary, which can be viewed at all levels in the system.

For each tab, drafts were created for the design of the user interfaces (output) and the input masks (input) in PowerPoint. A total of 48 design drafts were developed, which are filled with actual data on a product group or a product. The detailed model structure can be viewed in the results report in Chapter 3.

4.2 User Profiles

In addition to the suggested content, potential user roles were developed, which would differ with regard to rights and duties in interacting with the information system:

- **Administrators** have comprehensive rights. They can view all content, enter, validate and update information. Administrators can also make adjustments to the system, such as adding tabs, and creating new users.
- **Contributors** are authorized to enter or update information within the framework of ready-made forms. It is not possible for contributors to make changes in the system on their own.
- **Validators** can optionally be named to ensure the quality of the information in the system. They would check and release entries; Without release by the validators, information would not be visible in the system.
- **Simple users** have read-only rights. In perspective, reading rights for simple users could be further restricted so that only selected information could be accessed. This could apply to potential users outside of public authorities, such as architectural and civil engineering offices.

User profiles are assigned by administrators. Properties such as the name of the user and respective authority are defined for each user profile by the administrator and can only be changed by an administrator. This ensures that any information entered into the information system and any changes can clearly be traced. Additional user roles can be added, or user rights further adjusted. This could, for example, create the possibility for manufacturers to independently enter certain information about their products into the system.

4.3 Development of an Implementation Plan

Based on project experience, a plan for developing and implementing an information system was developed. The implementation of a model structure into a realized information system is divided into two phases: preparation and the development and implementation of the information system.

The first step would be creation and formulation of a specification sheet. The specification sheet is a list of all requirements of the client for the software to be developed or used. The first requirements can be derived from the model structure. In order to develop these further, the information system contents should be concretized in a further project step.

The completed specification sheet forms the basis for the tender. In addition to the specification sheet, the complete tender documents contain further information, for example on general conditions or purchasing regulations. Evaluation criteria are defined to facilitate comparison of multiple offers. This includes application scenarios presented on-site by selected software developers. These presentations should be considered in the final decision for a software developer.

Further steps are strongly dependent on the software developer's procedure and must therefore be co-ordinated with the developer. Typical work steps are the development of system design, the examination by the developer, as well as by later administrators and selected users, training of administrators by the software developer, as well as the training of further users and initial filling of the information system. Commissioning of the information system is followed by further ongoing tasks, which include maintenance, continuous expansion and adaptation of the information system, first-level support and training of additional users. A rough project plan with these steps is shown in Figure 3.

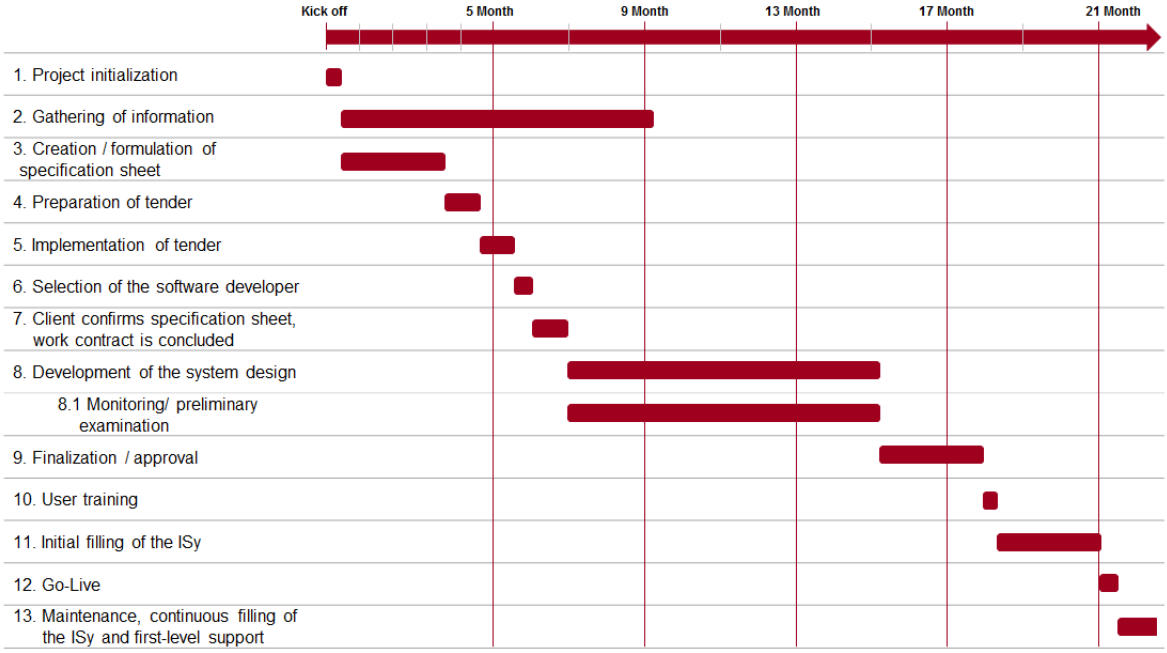

Figure 3: Development and Implementation Plan

5 Conclusion

Within the scope of the demand analysis, no existing information system could be identified that contained well-founded data on construction and structure-related emissions in civil engineering. Existing databases in the field of building construction differ from the project objectives in particular by the global level on which environmental properties are taken into account. The two existing databases INIES and WECOBIS were rated best in the analysis, even though they do not contain information on local environmental impact of engineering construction products. Nevertheless, the modular structure of the two databases seems to allow the addition of civil engineering specific materials and information on local environmental impacts.

The stakeholder survey confirmed the results of the demand analysis, indicating that no comparable database exists to date. 23 of the 31 stakeholders surveyed showed great interest in such an information system, with only four respondents stating that they already actively consider environmental properties in their work. Stakeholder suggested that environmental properties should be taken into account during the tendering process, i.e. the contractors should be asked to consider this information. In order to make this possible, the tendering authorities in particular need access to the relevant information. Since the tenders are to be product-neutral, information at product group level, which is partly available to the infrastructure authorities, is sufficient.

A possible basic variation for a suitable information system is therefore an authority-internal information system with product group-specific basic information and, where feasible, manufacturer-specific supplementary data, which is aimed at tendering infrastructure authorities. A possible model structure was developed for this variation. It is recommended that the information system is developed initially by the Federal Ministry of Transport and Digital Infrastructure, possibly in exchange with other infrastructure authorities, as a new, independent system. In this way, existing knowledge from other public authorities can flow into the development of the ISy. In order to use synergy effects, however, a possible cooperation with other databases, e.g. WECOBIS, was considered during development of the model structure. In addition, an extension of the information system to include public access remains an option for the future.

The model structure developed for a potential information system takes into account information at four levels: (1) product group level (product group-specific data), (2) publicly accessible information at manufacturer/product level (manufacturer-specific data), (3) detailed, non-public information at manufacturer/product level (manufacturer-specific data) and (4) comprehensive information in the form of a glossary. Links between the levels enable information from one level to be evaluated and displayed on another level. The structure also ensures that certain information can only be viewed by selected users.

The implementation plan provides an initial outline for the development and implementation of the information system. It is expected to take at least 21 months from project initiation to go-live.

In the course of the study, the need for an information system on the environmental properties of building products and materials was demonstrated. The implementation of the developed model structure is therefore recommended.

In the stakeholder survey, however, some experts also pointed out that the provision of relevant information in an information system alone would not be sufficient to be able to take greater account of the environmental properties of building materials in future infrastructure construction projects and thus increase the environmental compatibility of construction projects. In addition to the development of an information system, further measures should therefore be taken to establish environmental compatibility as a relevant evaluation criterion in the selection of materials.

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