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PROCEEDR
OPTIMISING RESOURCE USE FOR ROADSIDE INFRASTRUCTURES

Prototype version of the LCA-/LCCA-online tool

Deliverable D3.1

Version 1.0

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AIT AUSTRIAN INSTITUTE OF TECHNOLOGY
CHALMERS UNIVERSITY OF TECHNOLOGY
ERF EUROPEAN UNION ROAD FEDERATION
TRL

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CEDR TRANSNATIONAL RESEARCH PROGRAMME

Call 2020: Resource Efficiency and the Circular Economy

D3.1 Prototype version of the LCA-/LCCA-online tool

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Executive summary

This deliverable describes the approach how to develop the PROCEEDR software tool to assess the environmental and economic performance as well as the Circular Economy potential of European Noise and Safety barriers. The deliverable starts by defining the key terms before outlining the software development process.

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1 Introduction

A main product of the research project PROCEEDR is the development and creation of two tools (an online tool and a software tool) to enable National Road Administrations (NRAs) to identify innovative and sustainable roadside infrastructure solutions (noise as well as safety barriers, see Figure 1) to facilitate the transition from linear to a circular economy.

Figure 1: Different types of integrated noise and safety barriers of different materials in Europe (steel & transparent left side and fully concrete type right side).

In general, the assessment of the application of such solutions should be based on an environmental life cycle approach (LCA) (ISO14040:2006/AMD 1:2020) taking into consideration cradle-to-cradle impacts, including resource impacts, long-term environmental performance (maintenance) and End-of-life (decommissioning) as defined in EN 15804 Environmental Declaration (see Figure 2).

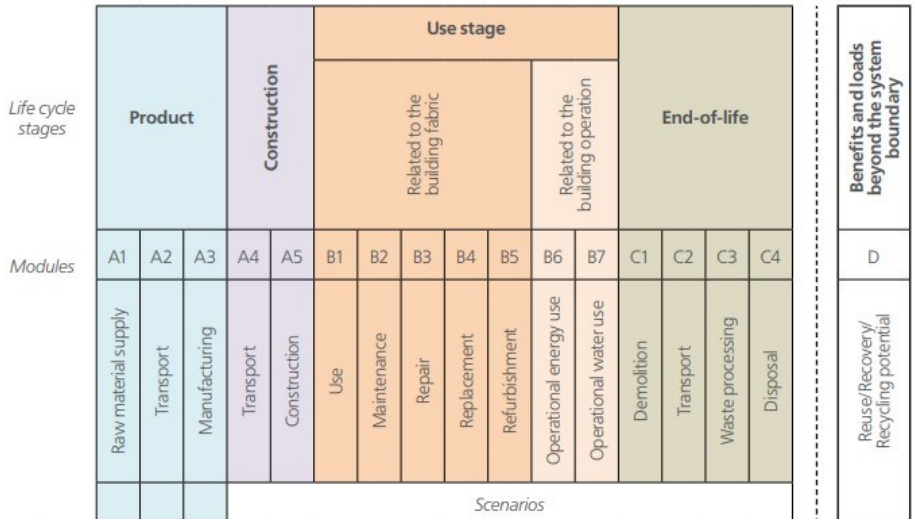

Figure 2: Life cycle stages, as defined in EN 15804 Environmental Declaration on a product level.

To ensure a holistic life cycle engineering approach a lean Life Cycle Cost Assessment (LCCA) will be applied as well. The relevant aspects that will be considered are:

I. the technical requirements (e.g. safety, acoustic and structural performance),
II. durability,
III. maintenance,
IV. costs and
V. different functionalities.

In addition to that, security of supply, adaptability, lifespan extension options, high-value recycling/reuse options, carbon capture capacity might also be considered with the goal of supporting a circular economy.

2 Specification of the online tool

2.1 Target audience(s) and user(s)

The main target audience is the NRAs. A secondary user group might be, for example, consultants that want to use the calculations to plan, design and optimise their project bids.

The main users have technical expertise, both regarding the construction work as well as impact assessment and the interpretation of the results achieved.

As one of the next steps, different user stories will be developed that will allow the software developers to understand the user's demand to perform the tasks that the software will be created for.

2.2 Geographical framework

The tool should represent a European perspective and, hence, be representative of the EU member states. In the first phase, the tool will especially cover the countries represented by the CEDR program on Resource Efficiency and Circular Economy, namely Belgium (Flanders), Denmark, Ireland, Israel, Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The geographical spread will allow for the consideration of different climate zones.

2.3 Goal&Scope

The online tool should allow an advanced assessment as well as the comparison of the environmental impacts based on an environmental life cycle assessment (LCA) and the circular economy (CE) potential as well as a “lean” Life Cycle Cost Assessment (LCCA) of roadside equipment (with a focus on noise and safety barriers).

It is envisaged that the tool will take account of sourcing, transportation and manufacturing of raw materials, transportation to, and installation at the site, and associated machinery and equipment, and reuse and recycling at end of life.

The tool should allow the calculation over the full life cycle A1-C4 and D (see Figure 2 and D2.2 A table/list of reasonable and representative assumptions of production, construction, maintenance, end-of-life as well as transportation processes of roadside infrastructure solutions) but should also work if the information is only available for a few of the life cycle stages.

The goal is NOT to have standalone software that needs to be installed on individual machines. Instead, the software tools will be provided as a cloud-based solution that will ensure easy use, maintenance as well as extension opportunities.

2.4 Life Cycle Inventory

The online tool is planned to offer a variety of inventory data (default data) necessary to conduct an impact assessment but allows project-specific data usage as well. The default data might represent European average data or – if available – specific data from the CEDR program funding member states. The tool shall cover the most common roadside equipment (sound and safety barriers) products/solutions in Europe (see D1.2 State-of-the-art report on roadside infrastructure equipment and D2.1 A table/list of the specifications of the roadside infrastructures developed in D1.2).

2.5 Life Cycle Impact Assessment methods

The online tool offers users to choose from a range of life cycle impact assessment (LCIA) methods, e.g. ReCiPe, CML2000 and respective environmental impact categories, e.g. Global Warming Potential, Abiotic Depletion Potential, Cumulative Energy Demand, Eutrophication etc. The LCIA methods as well as the environmental impact assessment categories will be discussed and decided with the Program Evaluation Board (PEB) in a later stage.

3 Online tool software architecture

3.1 Functional Requirements

The online tool shall enable users to assess the environmental impacts, life cycle costs and Circular economy potential. Parameter changes should become effective immediately in changed outputs/results. Users shall be able to actively decide on the

- life cycle stages,
- applied database/values (default/project-specific),
- impact assessment method/category,
- result visualisation

to be calculated.
It should be possible for the user to log-in, create and save a project. Results shall be able to be saved at least online to allow a comparison of two/several alternatives.

3.2 Non-Functional Requirements

The online tool should allow it to be updated over time. This embraces new and updated product data, impact assessment methods and categories, cost data etc. After the completion of the project, the final product might be operated and maintained by a third party. Hence, a modular software architecture would be preferable.

3.3 Backend

The back-end should provide:

- Storage of project data for each assessment
- A connection to a calculation engine
- A database of generic product data (possibly country-specific ones)
- The possibility for the user to create a project-specific database of components

For the backend, a "nice to have" would be access to the backend through a public API.

3.4 Frontend

The front-end should display a single-page interface for data entry, assessment control, and result visualisation.

3.5 Input

User input, database input and default inputs.

3.6 Output

The results should be displayed on two levels, a summary level as well as on a detailed level. The results should be exportable, e.g. to Excel, as a pdf-file.

4 Development process

The online tool development process to achieve a Minimum Viable Product (MVP) will be iterative, where time constraints allow, and because the development team is very small, will follow a combination of software development methodologies including Prototype Methodology and Rapid Application Development (RAD) (see Figure 3):

The development process will contain:

1. Gather and define requirements:

- Discuss current processes with the stakeholders to define requirements.
- Gather small subsets of test data and understand how data sets relate.
- Create user stories to describe users' roles, what tasks they do or need to do to reach their goals and the acceptance criteria from a user perspective.
- Create use cases to describe system functionality and features, and how users will interact with the application as a series of step-by-step processes to achieve their goals.
- Investigate existing solutions, what they can and cannot provide.

2. Design and prototyping:

- Quickly design and rapidly prototype frontend with minimal database to support frontend selection list functionality. Initially, wireframe more complex parts of the application with no working functionality. Functionality can be gradually introduced through subsequent iterations as requirements become more concrete.
- Hold feedback workshops with users to evaluate the flow and functionality of the interface and evaluate usability and learnability using the cognitive walkthrough method.
- Iterate and refine as appropriate.

3. Development and testing:

- Convert the prototype into a working model.
- The application will be developed using an open-source web application framework supported by a database in the backend. Developer competence exists for both Django and Laravel:
  - Django (https://www.djangoproject.com/) is a high-level Python framework.
  - Laravel (https://laravel.com/) is a PHP Framework.
- The framework intended to be used for this project is Django for several reasons, including but not limited to:
  - built-in user authentication system;
  - built-in automated testing environment;
  - written in Python will enable easier integration with backend algorithms.

- The database will:
  - serve frontend interface elements, for example lists and selection items;
  - support the backend by storing user input, results of calculations and storing comparisons to present to the user.
- Hold further feedback workshops throughout this stage to catch potential issues early on.
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4. Implementation and maintenance:

- Deploy application and database.
- Monitor for issues and bugs.
- Deploy security updates.
- Provide support.

These stages are not necessarily followed linearly or in isolation and can be iterated over regularly if requirements change or new core functionality is identified.

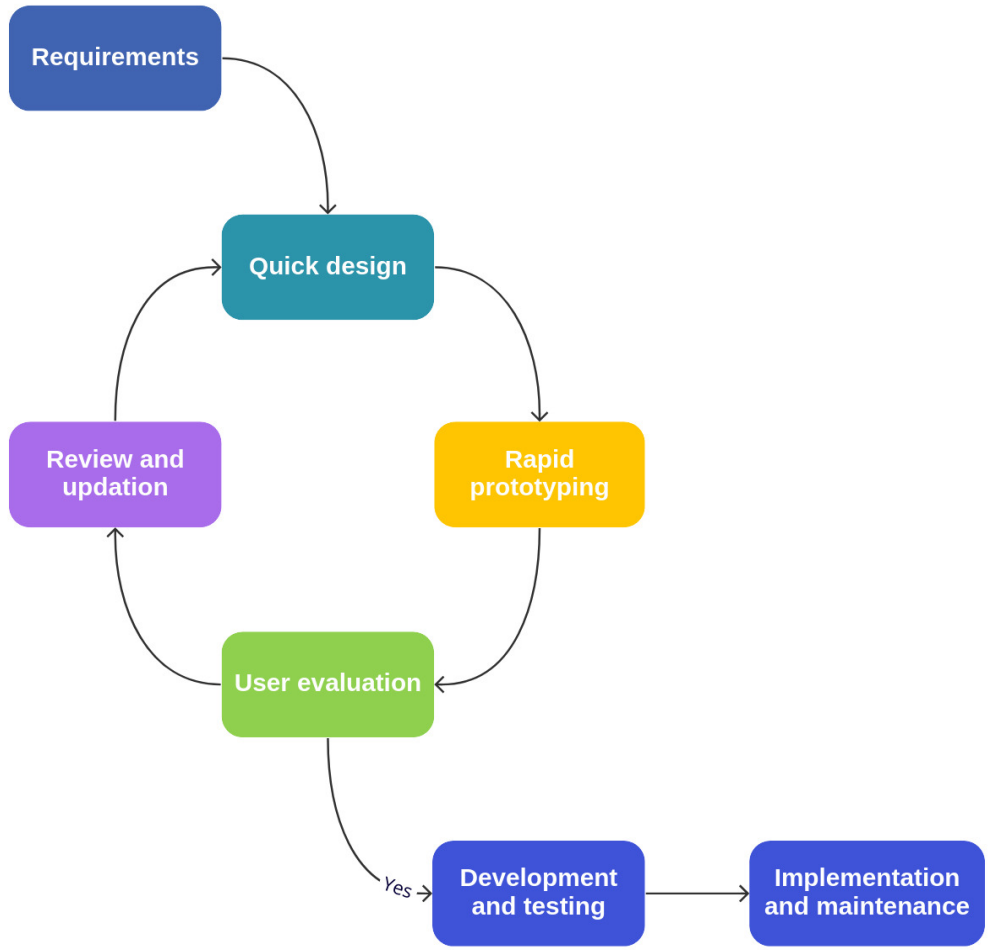

Figure 3 Tool development process

References

CEN ISO 14040:2006/A1:2020(AMENDMENT) Environmental management - Life cycle assessment - Principles and framework - Amendment 1 (ISO 14040:2006/Amd 1:2020)

International Standard ISO 14044 (2006) Environmental management — Life cycle assessment — Requirements and guidelines.

EN 15804:2012+A2:2019 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products.