

Score System for a Multi-criteria Decision Analysis based on the SSbD framework for MCNM/HARN Risk Management – The DIAGONAL Decision Support Tool Case

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1. Introduction

Within the European Green Dealⁱ, the Chemicals Strategy for Sustainability (CSS)ⁱⁱ, which aims to reduce the harmful effects of chemicals on human health and the environment, introduces the Safe and Sustainable by Design (SSbD) frameworkⁱⁱⁱ. The European Union has proposed a framework that aims to go beyond legal requirements by providing standards for the sustainability and safety of materials and chemicals. The SSbD framework integrates dimensions, aspects, methodologies, and indicators to support research and innovation activities that evaluate and create environmentally friendly solutions, therefore advancing the goals of the Green Deal, from early stages. With its comprehensions into the framework's dimensions and techniques, this paper acts as a fundamental resource that will help shape future EU policies and activities.

Specifically, regarding DIAGONAL^{iv} project, its main goal is bringing SbD knowledge and tools to a development stage which can be implemented in the MCNMs and HARNs related industries, relying on experimental (*in-vitro*) and modelling (*in-silico*) research, to study specific hazard and exposure properties that MCNMs & HARNs exhibit along their life cycle, with emphasis in the interactions between NM constituents, with other particles and the environment, as well as their release rate and fate. Within this project, the developing and integration of an interactive Decision Support Tool is contemplated with the aim of supporting regulators, industries and other stakeholders on the selection of the best available approaches to reduce risk at source and control the exposure at all stages of the life cycle; and to assess the benefit/risk balance of specific MCNMs and HARNs, and to propose suitable SbD alternatives and/or RMM dynamic charts and textual reports for decision making.

Consequently, the implementation of a comprehensive score-system based on a multi-criteria decision analysis for those steps addressed by the current SSbD framework seems to be the best solution for supporting the decision-making process of the final user.

The integration of every step of the SSbD framework in a user-friendly score-system is a challenging task which involves the development of experimental, modelling and

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literature research, to bring the cutting-edge knowledge of the MCNM/HARN in a same tool.

2. Adapting the framework to the project

DIAGONAL (**D**evelopment and scaled **I**mplementation of **sA**fe by design tools and **G**uidelines for multic**O**mponent **aNd** h**A**rn nanomaterial**Ls**) start in May 2021, more than one year before the publication of the JRC Technical Report with the current Safe and Sustainable by Design chemicals and materials framework. Therefore, SSbD framework had to be adapted since the initial Grant Agreement was not align with the framework and criteria definition. Thus, the five-step approach was chosen for SSbD assessment of the MCNM/HARN and evaluating the suitability of the subsequent strategies.

In the same way, criteria and evaluation definition for MCNM/HARN was previously defined, so the expected experimental and modelling research had to be adapted and included in the new framework, including specificities for this kind for advance materials.

As a result, a new workflow was described to establish the connections between the experimental and modelling SSbD assessment with the SSbD Framework.

3. Score System

The 5-steps stepwise approach proposed in the SSbD Framework was included in the DIAGONAL score system, evaluating individually each step considering the work developed under the project:

- For Step 1 (*Hazard assessment of the chemical/material*), current criteria definition has been considered for grouping the MCNM/HARN under criterion H1-H2-H3, but only for those experiments which have been performed in DIAGONAL. The score will cover Human health, Environmental and Physical hazards.
- For Step 2 (*Human health and safety aspects in the chemical/material production and processing phase*) a control banding strategy is applied for obtaining a score value considering the nanoscale nature of the materials and the processing specifications.
- For Step 3 (*Human health and environmental aspects in the final application phase*) information derived from a specific MCNM/HARN environmental fate model is combined with information from step 1 to get a score value.
- For Step 4 (Environmental sustainability assessment) results from the LCA are used to express a score value based on the 16 impact categories.

However, within Step 5, some recommendations will be proposed but no score value will be given, unable to perform a general socio-economic evaluation in the DIAGONAL platform.

4. Integration of Decision Support Tool workflow

A good integration of experimental and modelling work performed as databases or models for a comprehensive evaluation of MCNM/HARN are directly related to the good performance of the score system. In Figure 1, we can observe the workflow of the Decision Support Tool involved in the score-system which supports decision making between a batch of SSbD strategies in comparison to the original material as a baseline.

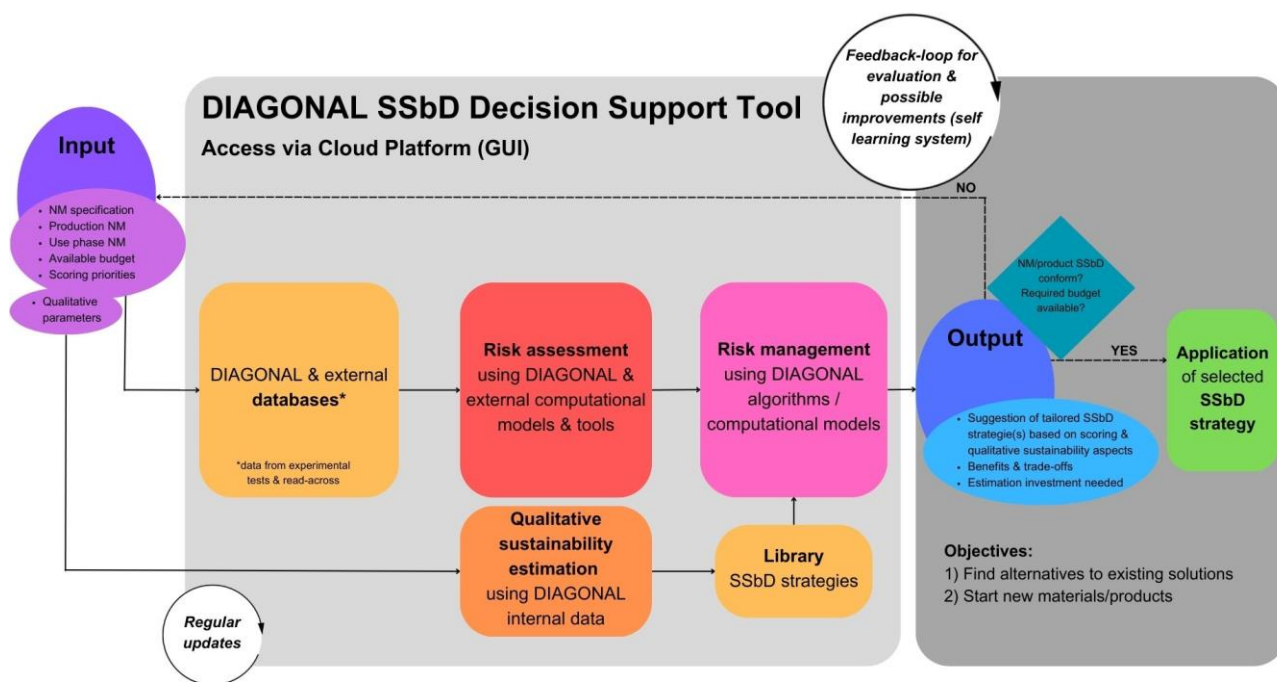


Figure 1: Decision Support Tool workflow

5. Conclusions

A multi-criteria optimization process based on proposed framework for SSbD has been implemented through a score system. The goal is to support decision making regarding SSbD strategies for MCNM/HARN using a software environment. This Decision Support Tool will evaluate the safety and sustainability of MCNM/HARN and classify different SSbD strategies according to their benefits.

For that, the proposed SSbD framework by EC has been adapted to DIAGONAL idiosyncrasy, using the proposed experiments and models to predict hazard and exposure related with safety and sustainability.

Finally, the score system will be presented in a user-friendly interface for an easy understanding of the SSbD framework and the criteria definition.

6. References

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^{iv} Development and scaled Implementation of sAfe by design tools and Guidelines for multicOmponent aNd hArn nanomaterials (DIAGONAL) Grant agreement ID: 953152 doi:10.3030/953152