

Conceptual Design of the HARMLESS Decision Support System



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HARMLESS Project and DSS Introduction

- Potential users of Safe and Sustainable-by-Design (SSbD) approaches suffer from **the sheer vastness and variety** of existing knowledge, testing methods and tools.
- We **aim to guide them** in making important decisions throughout their entire design process on safety and sustainability of **advanced nanomaterials and HARNs**.
- To this end, the **HARMLESS project** is developing a **user-friendly intelligent SSbD Decision Support System (DSS)** as an online IT tool.

Here, we present our **functional design of the HARMLESS DSS**:

- based on previous **experience and stakeholder analysis**
- bringing a novel multi-faceted **Safe Innovation Approach (SIA)**
- creating a tool-box of **New Approach Methodologies (NAMs)** ...
- ... converted into **FAIR data, knowledge and models**
- brought together into a **unified HARMLESS framework**
- made available as a **online user-friendly Safe and Sustainable-by-Design Decision Support System**

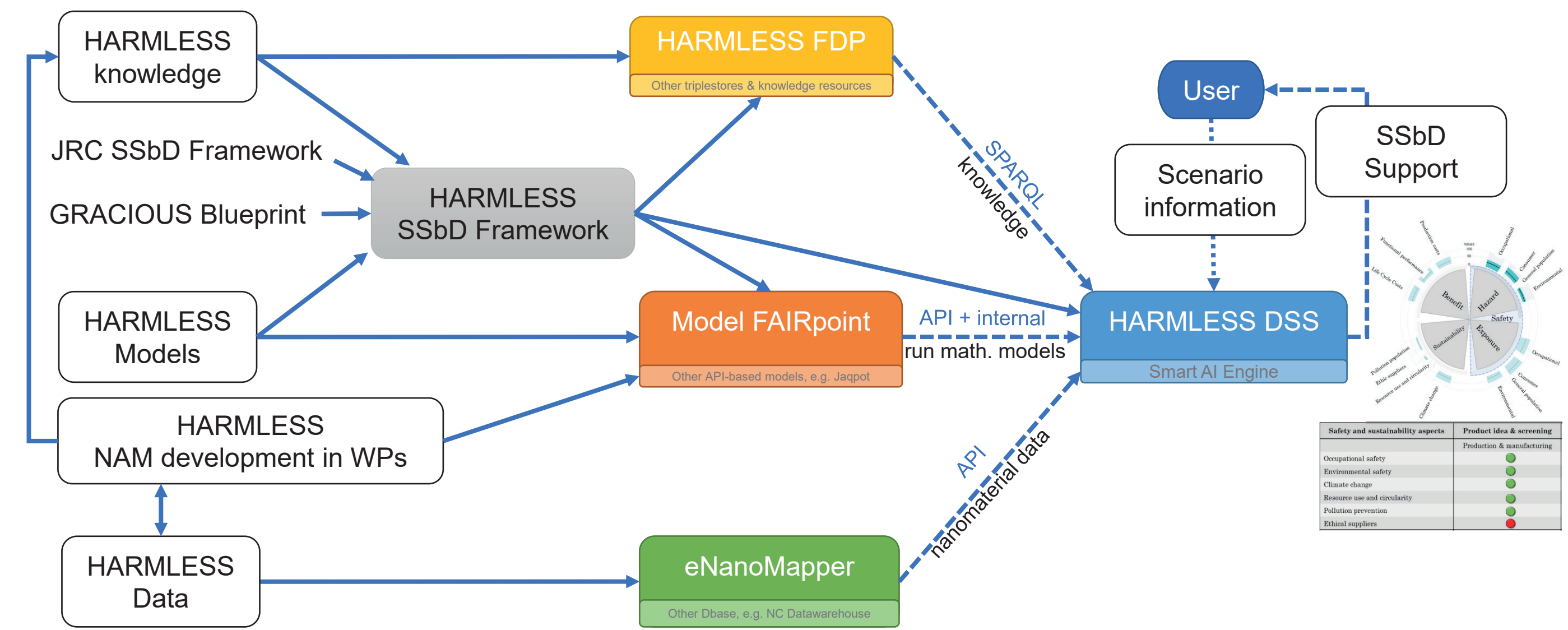
The conceptual design of the HARMLESS DSS contains

- 1) an **IT-architecture**,
- 2) a **data and model integration approach** and
- 3) a **decision support framework**

This conceptual design functions as a **technical blue-print** for the actual implementation of the HARMLESS DSS.

Modular IT-Architecture and Workflow

- The IT-architecture describes a **modular and FAIR approach**
- All data, knowledge and models are captured (in standardized fashion) in **stand-alone, but interconnected & exchangeable components**, i.e.
 1. **eNanoMapper** as a **database** to store all nanomaterial & experimental **data**
 2. a new official **FAIR Data Point** and **GraphDb Triplestore** to capture all **knowledge and decision rules** in Resource Description Framework (RDF)
 3. a novel **Model FAIRpoint** with runnable **algorithms**
 4. a new smart interactive **Decision Support System interface**



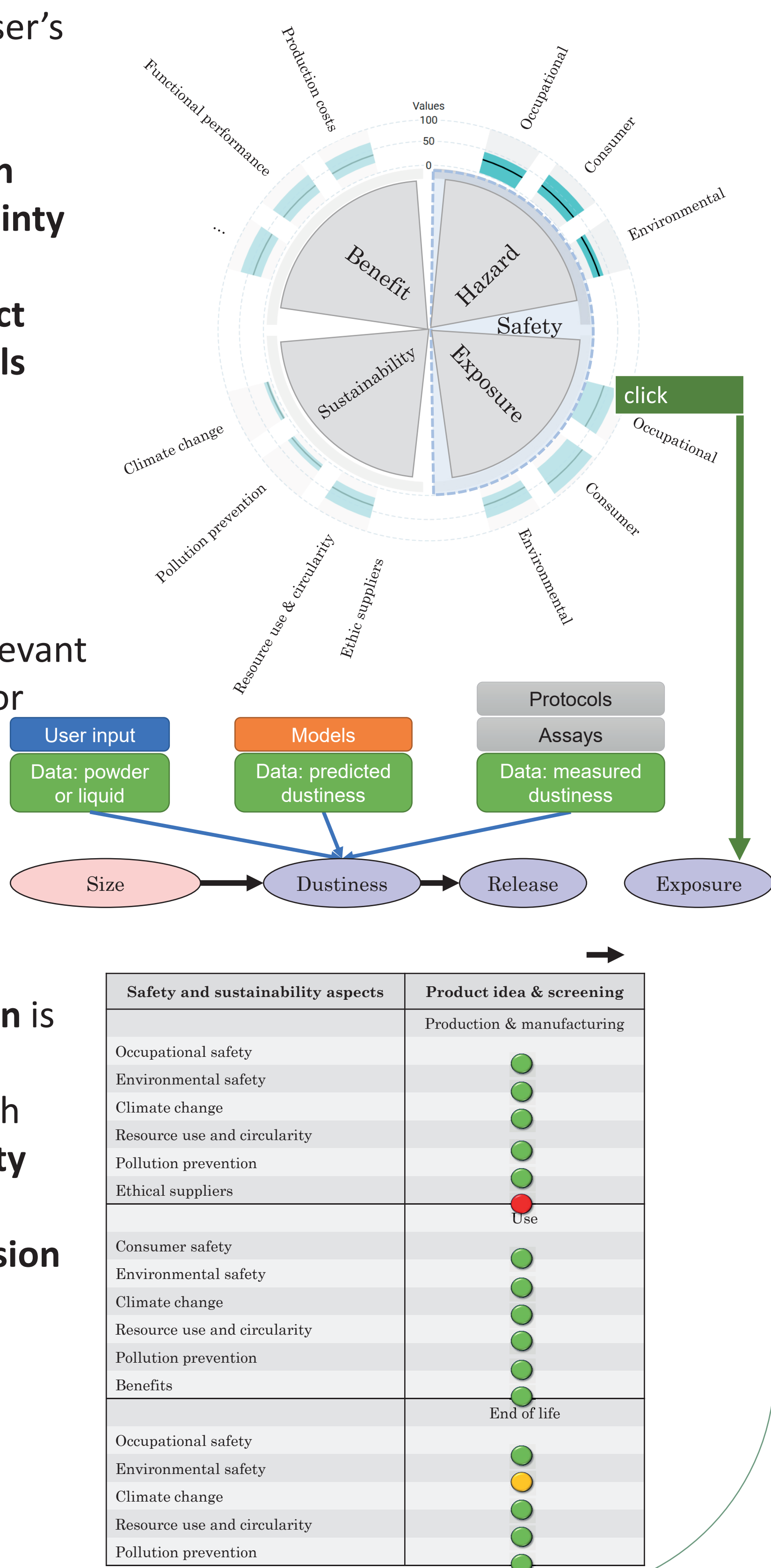
Being **modular and FAIR**, the **DSS interface** connects to the **HARMLESS components**, but can also connect to **external components** (e.g. NanoCommons Data Warehouse, SBD4Nano Semantic landscape, Jaqpot, ...)

And likewise, other **nanosafety IT-systems** can in turn connect to and exploit each of the **individual stand-alone HARMLESS components**.

Decision Support by Interactive Visualization

Relevant information about the user's safety situation is presented in an

- user-adaptable ontology-based interactive **circular visualization**
- showing **the value and uncertainty** for each high-level criterium
- the user is **guided** how to **collect** more **data** and run more **models** thereby **selectively reducing uncertainty**
- Decision rules** will construct **SSbD advices** adapted to the user's current situation
- Knowledge pages** collect all relevant information for each SSbD factor
 - up- & down-stream factors
 - relevant models & assays
 - data availability
 - text mining
- Status & Stage-gate progression** is presented by **stage-dependent decision criteria** indicating both **data sufficiency** as well as **safety itself**
 - Criteria are captured in **decision rule logic**



Data and Model Integration Approach

Schematic diagram of a small part of the **network of influencing factors** indicating **Safe-by-Design** choices:

- Knowledge pages** for each node create an **interactive SSbD encyclopedia**
- Runnable Models** allow to calculate factor values
- a **Bayesian Network model** will be used as an underlying integrative modelling framework
 - Allowing the **fusion of knowledge (RDF), data and models**
 - Semantic knowledge (RDF)** can create the underlying network
 - Heterogenous data can be used to determine **probability function**
 - Existing models** can be fused with the Bayesian model
 - Allowing to calculate values including their **uncertainty distribution**
 - Allowing a **tiered-approach** as not all inputs need to be known
- a **Business Rule Engine** will allow decision rules to
 - formulate **adaptive SSbD advice** texts (on each page/moment in the DSS)
 - How to improve insight in current status (which data/models)
 - How to improve design and process (which changes)
 - Stage-dependent decision criteria** (traffic lights)

Decision Support Process

The decision support process is based on a well-established concept of **Risk Informed Decision Making** adopted by NASA & US NRC, based on the fusion of deterministic and probabilistic risk assessment. This allows decision making based on the probability density functions coming out of the Bayesian Network