# ***Report of the ontology: Waste sorting to improve recycling***

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**Github link: https://github.com/renaud-paul-quentin/ontology-project/tree/main**

**Context:**
Waste designates anything, a product or a substance which is no longer suited for its intended use. It can be a used package of the smartphone you just bought, the components of the previous one probably out of usage, the peel of the orange you have just eaten but also the obsolete pesticides that made the orange grew, or plenty of other wastes. We see that waste is not limited to household waste; in fact, it can have many origins which leads to different kinds of waste as displayed in *Figure 1* below. This high variability of waste conducts to different ways to treat or recycle wastes according to its material, level of awareness and plenty other features (descriptors of wastes).
Materials and substances that are directed for recycling or re-use are often (but not always) regarded as waste since the producer or holder discards them and they will only cease to be waste if certain procedures are completed and documented.


*Figure 1. Waste classification by origin. Different activities generate different types of waste.*
*Source: National Audit Office of Estonia*

**Problems:**
The problems of all those wastes generated by human activities is that it is often highly resilient and take a long time to decompose. Consequently, it contributes to a high level of environmental pollution recognised as a huge threat to human health and the surrounding natural resources[1]. Moreover, the lack of shared knowledge about how those wastes should be treated or recycled leads to situations where materials and substances that could be re-used or recycled are simply considered as mere waste by their producers (industries, people, corporations, …) who merely discard it.

**Solution:**
The solution we propose to implement is based on an ontology called "Waste sorting to improve recycling" which aims at classifying any waste according to the following features which are inherent descriptors of the considered waste:

- WasteMaterial: the material or substance the waste is composed of;
- WasteOrigin: the origin of the waste, from what sector it came from;
- Hazardness: waste that has been identified as potentially causing harm to the environment and human health and therefore needs special, separate treatment and handling (flammability, corrosiveness, toxicity, explosiveness, etc);
- Radioactivity: because it is dangerous;
- State: physical state of the waste belonging either to solid, liquid, gas or powder;
- WasteManagingScale: if the waste was gathered at the scale of a city (households and commercials) or national (chemical waste gathered in waste management entities).

This will allow the ontology to classify the waste among 6 main classes and 254 subclasses, which will allow the entity to know how to handle waste sorting. A simplified, non-exhaustive diagram on *Figure 2* helps to understand how waste is generally categorised.


*Figure 2. Simplified diagram displaying some general categories of waste*
*Source: National Audit Office of Estonia*

[1] https://waste4change.com/5-kinds-of-environmental-pollution-caused-by-waste/

## Metrics of the ontology:

| Metrics | |
|---|---|
| Axiom | 540 |
| Logical axiom count | 316 |
| Declaration axioms count | 112 |
| Class count | 104 |
| Object property count | 9 |
| Data property count | 0 |
| Individual count | 0 |
| Annotation Property count | 1 |
| **Class axioms** | |
| SubClassOf | 254 |
| EquivalentClasses | 21 |
| DisjointClasses | 16 |
| GCI count | 0 |
| Hidden GCI Count | 0 |
| **Object property axioms** | |
| SubObjectPropertyOf | 0 |
| EquivalentObjectProperties | 0 |
| InverseObjectProperties | 2 |
| DisjointObjectProperties | 0 |
| FunctionalObjectProperty | 9 |
| InverseFunctionalObjectProperty | 4 |
| TransitiveObjectProperty | 0 |
| SymmetricObjectProperty | 0 |
| AsymmetricObjectProperty | 0 |
| ReflexiveObjectProperty | 0 |
| IrrefexiveObjectProperty | 0 |
| ObjectPropertyDomain | 4 |
| ObjectPropertyRange | 6 |
| SubPropertyChainOf | 0 |

# Object properties:

| Object Property | Func | Sym | Inv Func | Trans | ASym | Refl | Irrefl | Domain | Range | Inverse |
|---|---|---|---|---|---|---|---|---|---|---|
| owl:topObjectProperty | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | |
| hasRadioactivity | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | Radioactiveness | |
| hasOrigin | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | Waste | WasteOrigin | isOriginOf |
| hasHazardness | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | Hazardness | |
| hasScale | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Waste | WasteManaging... | |
| isOriginOf | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | | | hasOrigin |
| hasState | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | State | |
| hasMaterial | ☐ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | Waste | WasteMaterial | isMaterialOf |
| isMaterialOf | ☑ | ☐ | ☑ | ☐ | ☐ | ☐ | ☐ | | | hasMaterial |
| isPackageOf | ☑ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | Packaging_Waste | | |

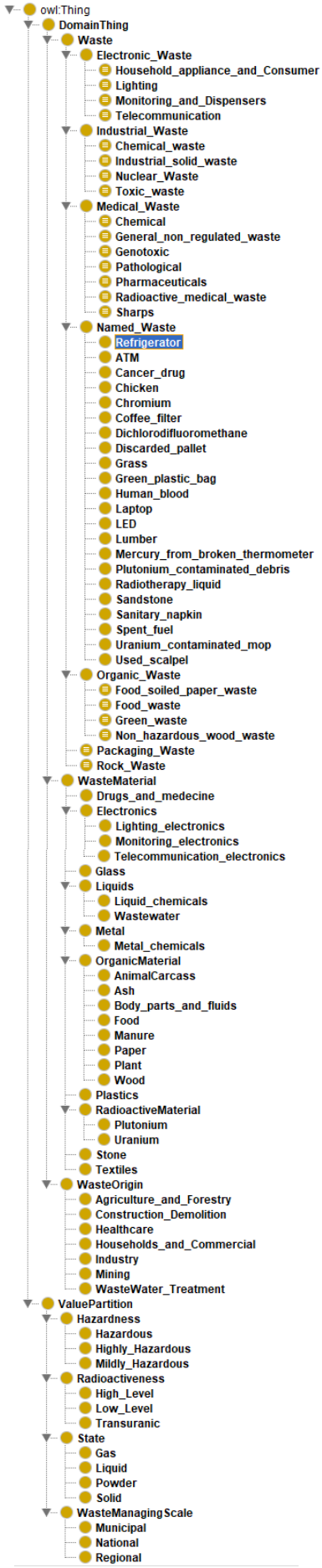


*Figure 3 : Asserted ontology*

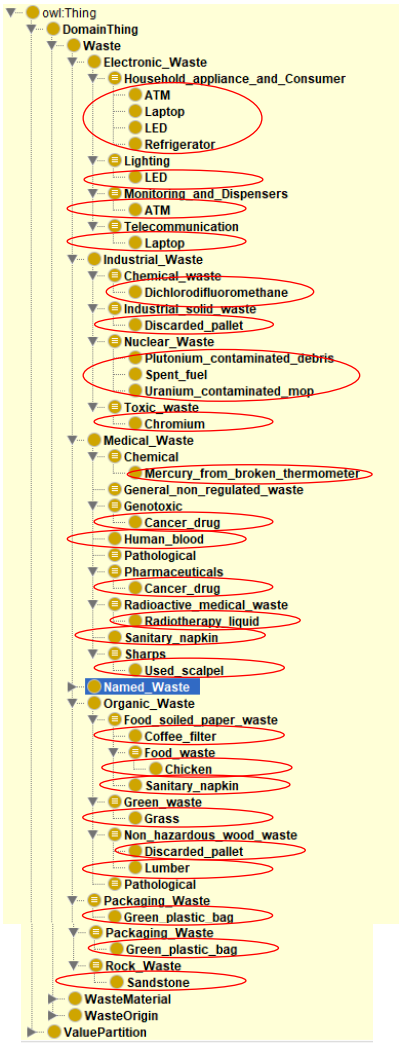


*Figure 4 : Inferred ontology*