Measuring reuse potential and waste creation of wooden façades

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Problem of pollution is getting bigger and bigger!
Waste generation is growing more and more!

Building industry produces 38% of total waste and 40% of total CO2 emissions and uses 50% of all natural resources (EIB 2015).
If there were **guidelines** for buildings to be **designed/redesigned** with capacity to be **restored/modified** and **used longer**, more stakeholders would be interested in their **reconstruction** and **sustainable reuse**. They would not be turned into waste on the landfills.

Bosnia and Herzegovina continues to have a problem regarding **building regulations and waste management**.

Unfortunately, many countries in Europe and the countries all over the world are in the same situation.
We should make a plan and measures for the process of designing future building structures for adaptability.

How?

By using the methodology developed within Buildings as Material Banks (BAMB) project.

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The enclosure systems are the ones that are the most exposed to physical damages and require frequent reparations. The main focus of this research is façade and how to construct it in more reversible and therefore more sustainable way.

Decreasing the waste from any part of the building will help reducing total waste during the building’s life span.

Different parts of the building have different life expectances.

Ruined building facade, Sarajevo, B&H
Source: www.drukciji.ba

Source: BAMB pilot project - exploded module GDC Mostar, E. Durmisevic & R. Androsevic
When the requirements change, all parts of the wall should:
- be easily disassembled and removed without affecting surrounding systems and elements,
- allow the additional layers to be added and attached to the wall system,
- make it easy to disassemble and assemble all parts together in the system again.

The goal: include all parts of the enclosure system in circular low waste building industry and circular economy!

Source: BAMB pilot project – exploded external wall of GDC Mostar, E. Durmisevic & R. Androsevic
This strategy aims to **extend functional lifespan** of external envelope.

This would:
- reduce the amount of consumed resources,
- reduce generated waste during the construction, maintenance, transformation and demolition.

Façade should follow **transformations** of the building
- **without waste creation**
- **without causing** large financial or environmental **impacts** during its total life cycle.
This study is using **method Durmisevic** for designing and assessing reversibility and reuse potential of a building.

The assessment measures:
1. functional,
2. technical and
3. material (physical) dependences

on three levels of a building’s composition:
- building
- system
- component.

Source: „Transformable building structures“ E. Durmisevic
Eight indicators for reversibility and reuse potential from model Durmisevic (2006)
The first case study, a **conventional façade system in wood**, consists of primarily fixed multilayer panels made for quick assembly on site.

1. Three layer reinforced façade 6mm
2. Styrofoam 200 mm
3. OSB board 12 mm
4. Solid wood frame 160 mm
5. Rock wool 160 mm
6. PE foil
7. OSB board 12 mm
8. Insulation-installation wooden grill 45 mm
9. Rock wool 45 mm
10. OSB board 12 mm
11. Gypsum cardboard board 12.5 mm

Source: www.krivajahomes.com
The second case study is the prototype façade system made of wood, developed for the Green Design Center in Mostar.

Source: BAMB pilot project – external wall of GDC Mostar, horizontal section, E. Durmisevic & R. Androsevic
The overview of the main criteria of reversibility and the final score of the reuse potential of 11 layers wall - prefabricated façade system in wood using method Durmisevic
Vertical section of the developed façade system wall of the GDC

Source: BAMB pilot project – external wall of GDC Mostar, vertical section, E. Durmisevic & R. Androsevic

The overview of the main criteria of reversibility and the final score of the reuse potential of the GDC wall - developed façade system using method Durmisevic
The results are divided into three categories:

1. If $Rp < 0.3$, than this system will be characterized as **irreversible** and the end of life option is **recycling/down cycling**;

2. If $0.3 > Rp < 0.6$, then its end of life options would be **repair, direct reuse** and **remanufacturing**;

3. If $Rp > 0.6$, than besides direct **reuse** and **repair** of its parts, the system can be **reconfigured** and **upgraded** and its dimensions **adjusted** to fit new requirement.

**Application of Reversible Building assessment with focus on Reuse Potential (method Durmisevic)**
Application of Reversible Building assessment for evaluation of the reversibility (method Durmisevic)
For transformation scenario, it has been considered that the window will not be necessary any more at the existing position - window position can be changed. Third scenario shows that the window has been replaced with a wall.
Material stream analyses indicate that the GDC wall system can perform transformations without creating waste in comparison with the existing passive façade system on the market.

Application of Reversible Building assessment for material use during transformations (method Durmisevic)
The scenario that has been considered for both case studies (GDC and existing wall) is that the transformation will take place every 10 years, in the period of 50 years.

Application of Reversible Building assessment for evaluation of the transformation costs (method Durmisevic)
As the results show, the first case study, existing wooden façade has low reuse potential, which means:

- it does not allow separation of components, elements and materials,
- it does not allow transformation of façade without waste creation.

Source: www.krivajahomes.com
Most of the existing prefabricated wooden façade systems developed so far:

- use many synthetic materials,
- have similar structural problems when it comes to transformation and reuse,
- are designed as energy positive buildings, but they are very fixed,
- do not accommodate easy adaptations.

As a result, transformation is linked to demolition, waste creation and purchase of new material.

Source: www.krivajahomes.com
The prototype of the **GDC reversible façade** is designed to have **high reuse potential** but can still be improved.

Indicator for the structure and material level can be high if the elements are clustered into prefabricated independent components.

The importance of the **type of the connections** in each façade system is noticeable.

The connections have a big role:
- **for assembly**
- **for disassembly** of the system and
- regarding the **waste creation**.
7. Type of connection
Wall
- average 0.2
REUSE POTENTIAL OF THE WALL OF THE BUILDING GDC IN MOSTAR

7. Type of connection
Wall
- average 0.87
Another new approach has been tested.

The intermediary is been introduced as a very important part for the transformation.

This is the way to extend the life cycle of the components in the system.
There are almost no reversible or easy connecting and disconnecting solutions.

Construction industry was, and is developing towards easy assembly, but not easy disassembly solutions.
This study illustrates:

- the importance of implementing **reuse potential design protocols** during design and evaluation phase in order to indicate what can be done in order to design reversible and sustainable building systems and how design solutions can be improved during the design process.

- there is a close link between the **reuse potential and construction waste**.

- If reuse and **transformation potential** is high, then the **construction waste** is low and vice-versa.
- The case studies of façade systems show the weak points in existing facades and the way to design a façade with high reuse and transformation potential with low environmental impact and create very low amount of waste during its lifecycle.

- The selection of waste management and reuse methods and technologies is crucial if a selected system is to be sustainable under the present economic and social conditions.
Example of the existing and future façade systems in BiH and their reuse potential can open the eyes to the
- new building design approach and
- new building design protocols!