

TWINQL

Automated compliance checking using LBD

TEAM 7

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SSoLDAC2022 - Challenge - Ontology-based compliance checking

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Compliance checking in design & construction

- Contractors & designers don't always adhere to national **norms and regulations**
- Difficulty **checking for compliance**
- Lack of standards for **checking design** model quality
- **Closed software** solutions for compliance checking



Design intend \neq construction reality

Value Proposition

We propose a new solution for digitized compliance checking using BIM and other data sources with the added benefits of:

1. Improve productivity in design & construction processes
2. Improve quality of design by reducing errors
3. Automated compliance checking in any design
4. Reduce design errors
5. Based on open standards



Our solution

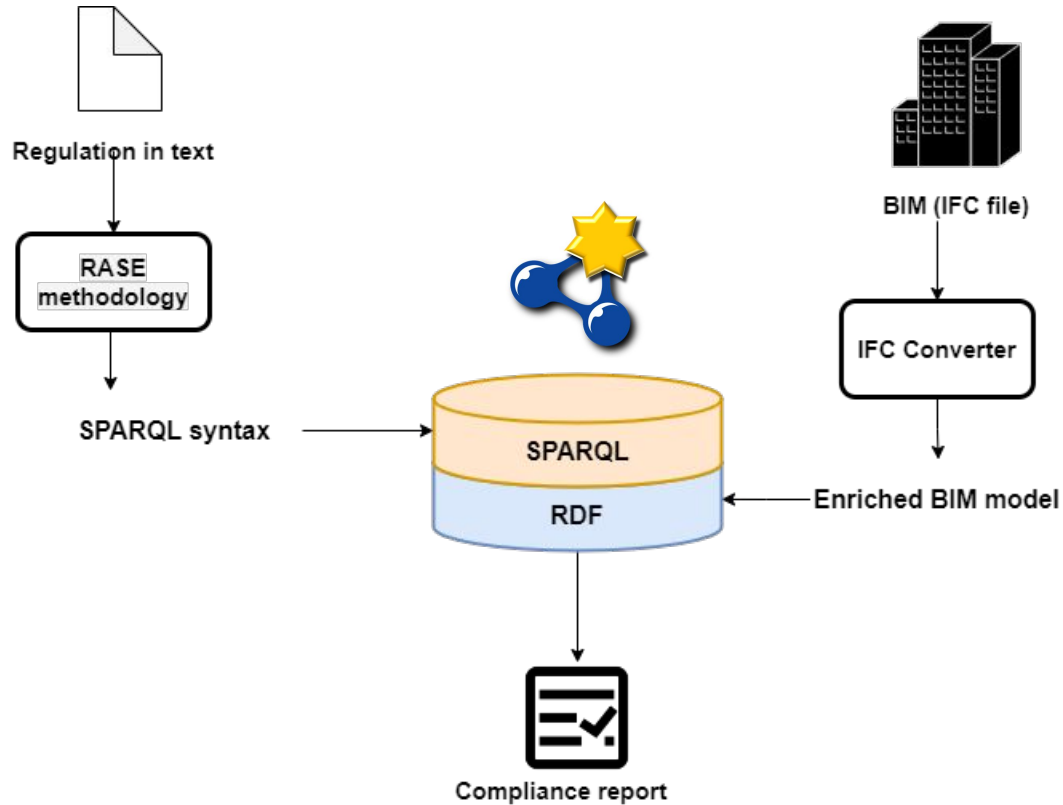
An automated tool for compliance checking based on open and neutral data exchange standards.

- Driver for the development of a semantic framework
- Driver for rule formalization
- Interoperable
- Adaptable
- Scalable and flexible

Powered by W3C



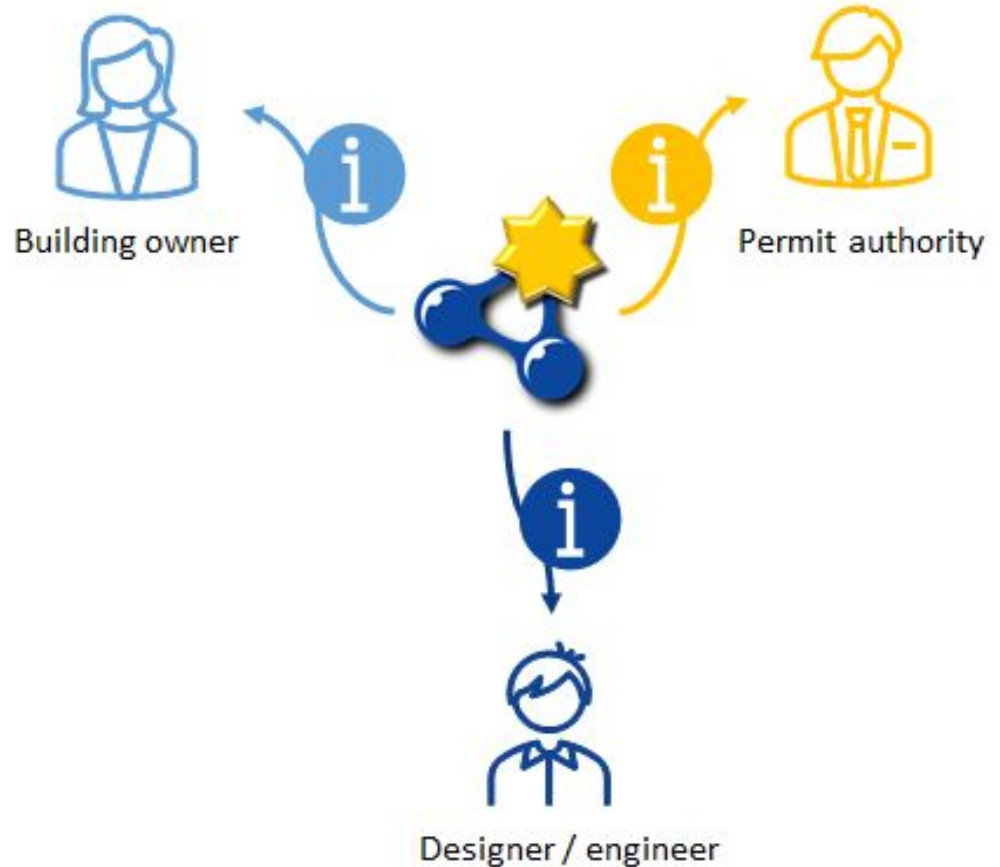
Our solution



Intended Users

The **degree of compliance** depends on the user profile.

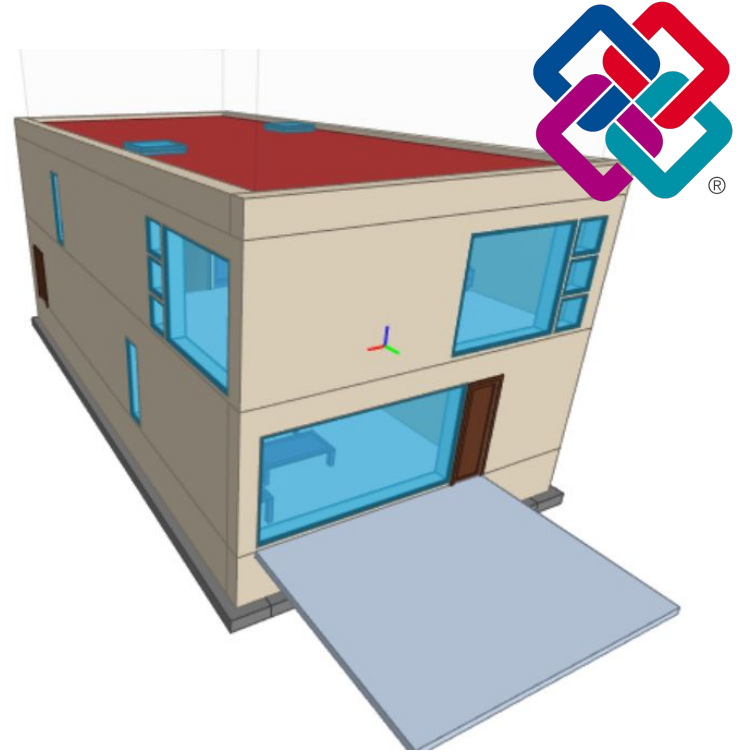
- o Building owner
- o Designer/ Engineer
- o Building permit authority (e.g. Municipality)



How it Works

The possible checks:

- Consistency of BIM models with information requirements (e.g. employer's requirements)
- **Compliance checking** and assurance of BIM models
- Compliance of BIM models with norms and regulations






How it Works

Example of an accessibility norm

2.13 Doors to accessible entrances will satisfy requirements M1 and M2 if:

- a. where required to be self-closing, a power operated door opening system is used when through calculation and experience it appears that it will not be possible otherwise for a person to open the door using a force no greater than 20N at the leading edge;

RASE methodology.

-  Applicability (knowledge resource)
-  Requirement
-  Exception

How it Works

SPARQL QUERY

```
2 PREFIX beo: <https://pi.pauwel.be/voc/buildingelement#>
3 PREFIX props: <http://lbd.arch.rwth-aachen.de/props#>
4 select * where {
5     ?door a beo:Door;
6         #first sentence
7         props:partOfAccessibleEntrance_simple ?valuePartOfAccessibleEntrance.
8     filter(?valuePartOfAccessibleEntrance=<https://w3id.org/express#TRUE>)
9         #2.13_A
10    ?door props:isSelfClosing_simple ?valueClosingSimple.
11    filter( ?valueClosingSimple =<https://w3id.org/express#TRUE>).
12    ?door props:poweredDoorOpeningClosingSystemUsed_simple ?valuePoweredDoorOpening.
13    filter(?valuePoweredDoorOpening = <https://w3id.org/express#TRUE> )
14    ?door props:forceRequiredToOpenDoorAtLeadingEdge_simple ?forceRequiredToOpenDoor.
15    Bind( IF(?forceRequiredToOpenDoor <= 20, "PASS","FAIL") As ?results)
16 }
```

How it Works

SPARQL QUERY

```
2 PREFIX beo: <https://pi.pauwel.be/voc/buildinge
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9         #2.13_A
10    ?door props:isSelfClosing_simple ?valueCl
11    filter( ?valueClosingSimple =<https://w3id.
12    ?door props:poweredDoorOpeningClosingSystem
13    filter(?valuePoweredDoorOpening = <https://
14    ?door props:forceRequiredToOpenDoorAtLeadin
15    Bind( IF(?forceRequiredToOpenDoor <= 20, "P
16 }
```

1. Select door
2. Select property set
3. Filter property 1
(self closing door)
4. Filter property 2
(powered door system)
5. Filter property 3
(force required to open door)
6. Set condition value
(Pass of Fail)

Demonstration

The screenshot displays a web browser window with the address bar showing 'SSoLDAC22' and '127.0.0.1:8000'. The page title is 'TWINQL | Ontology-based Compliance Checking'. The interface includes a 'User Profile' dropdown menu set to 'Engineer'. Below this, there are two main sections: 'Provide Model' and 'Regulations'. The 'Provide Model' section has three radio buttons: 'Connect to A Database' (selected), 'Upload Model in RDF', and 'Upload Model in STEP'. It features a 'Database URL' input field and a green 'Connect' button. The 'Regulations' section has a dropdown menu with the text 'Please select a regulation' and a green 'Check' button.

SSoLDAC22 x +

127.0.0.1:8000

TWINQL | Ontology-based Compliance Checking

User Profile: Engineer

Provide Model

Connect to A Database Upload Model in RDF Upload Model in STEP

Database URL

Regulations

Please select a regulation

Demonstration

The screenshot shows a web browser window with the URL 127.0.0.1:8000. The page title is "TWINQL | Ontology-based Compliance Checking". The user profile is set to "Please select a user profile". The main content area displays two sections of compliance checking results.

Compliance Checking Result

Back

Door opening force

| Door ID | Check Result | Expected Value | Actual Value | Recommendation |
|---|--------------|---------------------------|--------------|---|
| door_26c33000-0000-0000-0000-48d00e51c290 | Pass | Less than or equal to 20N | 10 | - |
| door_26c33000-0000-0000-0000-48d00e7df290 | Fail | Less than or equal to 20N | 25 | Change power operated door opening system |

Minimum effective clear widths of doors

| Door ID | Check Result | Expected Value | Actual Value | Recommendation |
|---|--------------|--------------------------------|--------------|---------------------------------|
| door_26c33000-0000-0000-0000-48d00e51c290 | Pass | Greater than or equal to 800mm | 1.25 | - |
| door_26c33000-0000-0000-0000-48d00e7df290 | Fail | Greater than or equal to 800mm | 0.45 | Increase width of door to 900mm |

Market & Development

- Results can be further used for
- BIM model delivery according to requirements defined in Information Delivery Manual (IDM)
 - Roles
 - Processes
 - Date of delivery
 - Information requirements
- Enlarge to Building permitting processes
- Creating information guidelines for structured data models
 - > download of IDMs / Information requirements beforehand ?
- Integrate other technical solutions (e.g. automated conversion of IFC models to turtle,..) Integrate existing compliance checking tools

Future Prospects

- Complete norm portfolio
- Compliance checking of geometrical and spatial norms
- Multiple report templates for different users
- API's for design & modelling software

