

Collaborative and cross-stakeholder ontology engineering

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Motivation

The SC3 Ontology Platform

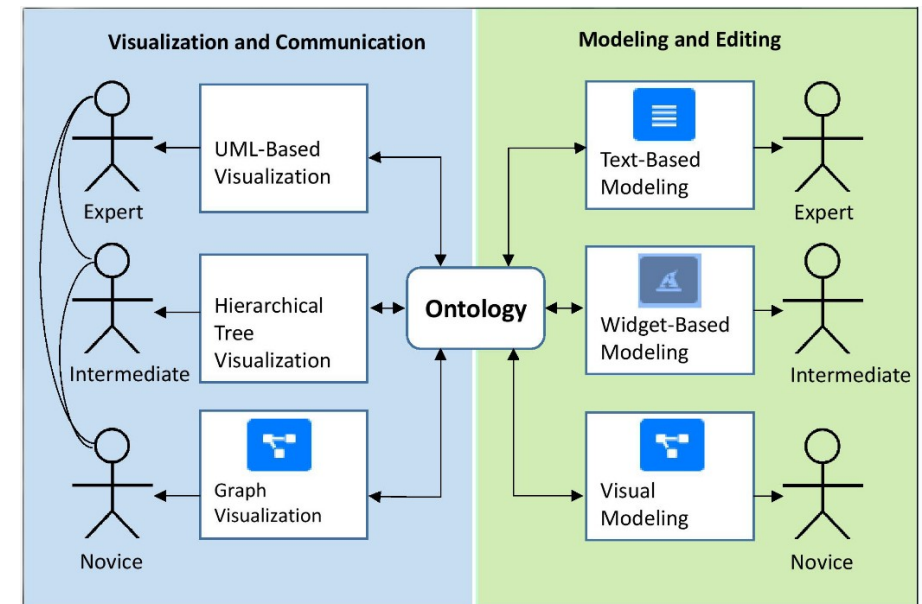
- **Semantically Connected Semiconductor Supply Chains (SC3)**
 - EC H2020, Coordination and Support Action (CSA)
 - Runtime: 01.10.2020 – 20.09.2023
- **Motivation: Semiconductor** production is a **complex industry**
 - E.g. supply chains are complicated by **short product cycles** and **strong dependencies** to further industries
 - Requires a stable generic **industrial reference communication platform**
- **Objectives:**
 - To support **collaboration of industrial and academic stakeholders** to encourage **interoperability** between semiconductor companies and further industrial domains, based on **Digital Reference (DR) Ontology**
 - To develop a framework to ensure an **agile development**, validation and refinement loop



Motivation

The SC3 Ontology Platform

- **Challenge**
 - An ontology is a joint work between **domain experts** and **knowledge engineers**
 - We need a tools to achieve a **common understanding** of the **domain** and its **formal representation**
 - Visualization of ontologies for different expert groups
- **Objective:** To understand the content of ontologies we need cross-stakeholder:
 - **Collaborative** ontology development platform
 - Ontology **visualization**.
- **Proficiency** levels considered: Novice, Intermediate, and Expert

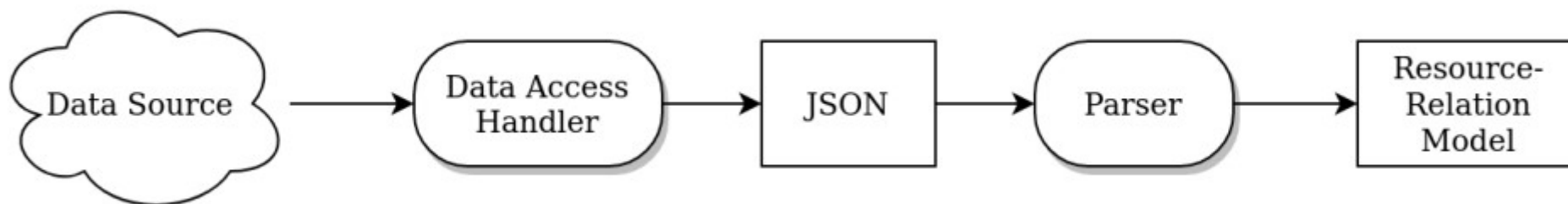


Pipeline Components (@Vitalis Wiens)

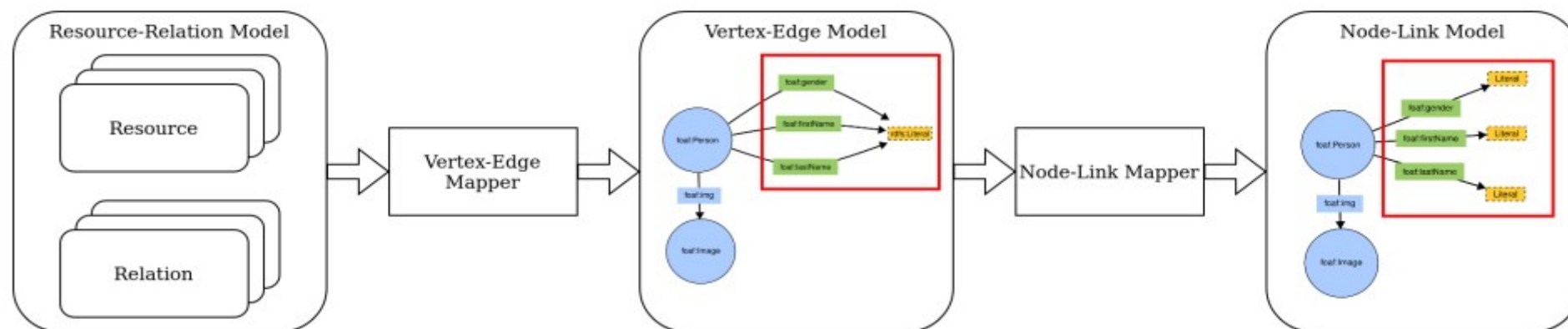
- **Data Processing Layer**
 - Pre-process data and convert to RRM
- **Resource Relation Model**
 - A data model which serves as a foundation for visualizations and synchronization between different modes of operation
 - It is a textual representation of the ontology
 - Created through pre-processing step
 - provides some re-organization of triple statements to enable different modes of operation
- **Vertex Edge Model**
 - Designed to reflect a basic graph structure using vertices and edges.
 - Vertices are derived from resources
 - Edges are derived from relations and provides source and target attributes for the connection between vertices
- **Node Link Model**
 - Modify the Graph Structure for Visualization . Merge, split and nesting mappings
 - Nodes have an id, a type, and a name.
 - Links have a source and a target node additionally to form the connections

Mapping Pipeline

Pipeline (@Vitalis Wiens)

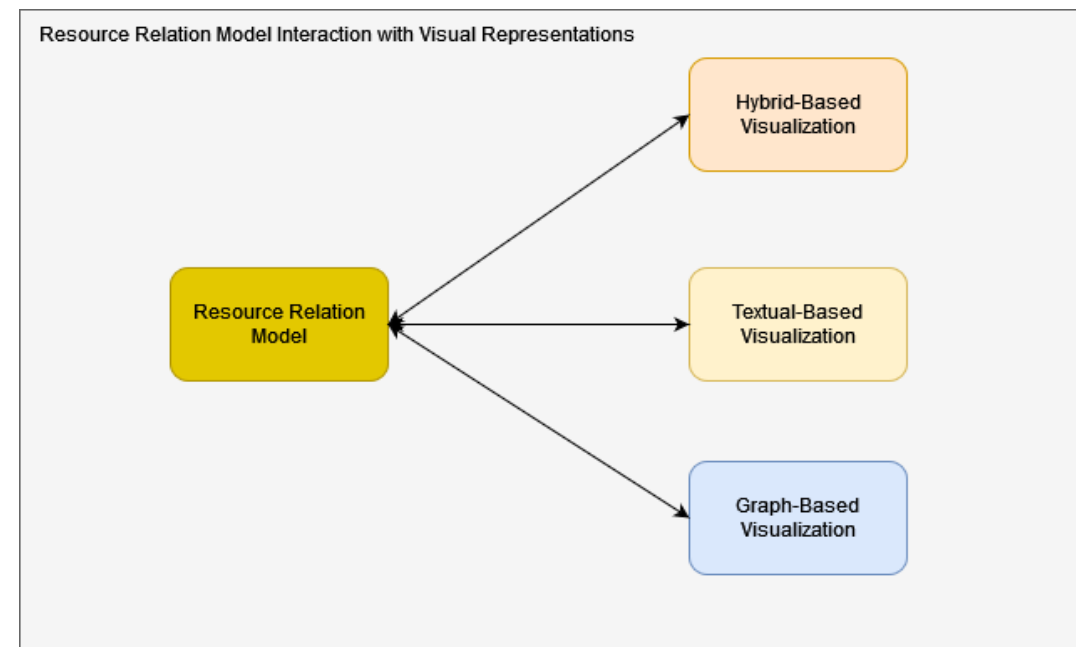
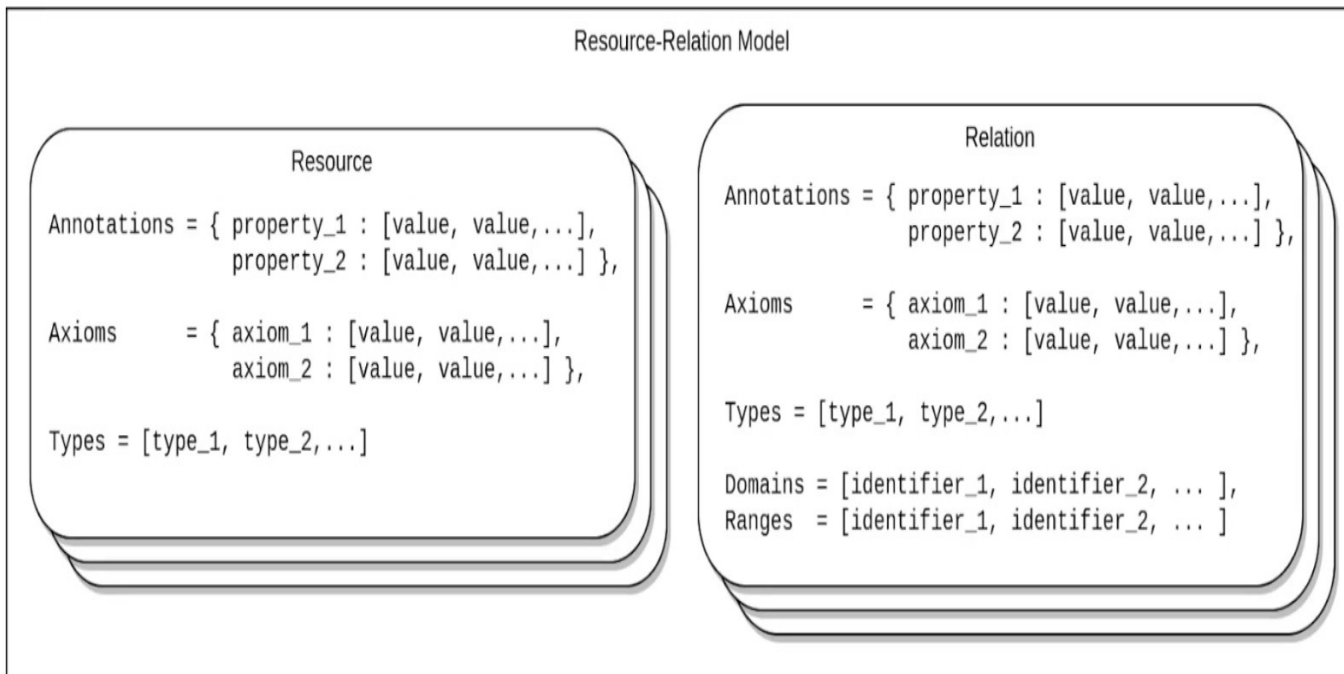


Data Processing Layer



Two-fold mappings from RRM to Node-Link Model

Resource Relation Model



RRM model and its interaction with other views in SC3 Ontology Platform

Collaboration

Roles: Public User, Key User, Member, Project Admin, System Admin

Projects: Public Projects, Private Projects

The screenshot displays the SC3 web application interface. At the top, a blue navigation bar contains links for Home, Management & Visualization, WebProtege, DR Specification, Documentation, and FAQ. Below this, a sidebar on the left lists project options: 'Default', 'Default Project', 'Semantically Connected Semiconductor Supply Chains (SC3) Project', and 'Cognitive Economy Intelligence Plattform für die Resilienz wirtschaftlicher Ökosysteme (CoyPu)'. The main content area is titled 'You are currently viewing index of ontologies for **Default** project'. It features three buttons: 'Upload', 'Filter', and 'Search'. Below these buttons, a list of ontologies is shown, each with a lock icon, a name, a checkmark, and a trash icon:

- Advanced Example ✓
- Digital Reference ✓
- EXAMPLE ✓

Visualisations

Hybrid Mode Visualization

```

@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix ex: <http://example.com/> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix vs: <http://www.w3.org/2003/06/sw-vocab-status/ns#> .
@prefix wot: <http://xmlns.com/wot/0.1/> .
@prefix xml: <http://www.w3.org/XML/1998/namespace> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

#####
# Ontology
#####
<http://example.com/> rdf:type owl:Ontology ;
    dcdescription "Advanced example Ontology. Holding multiple sub ontologies" .

#####
# Classes
#####

### http://xmlns.com/foaf/0.1/Agent
foaf:Agent rdf:type owl:Class .

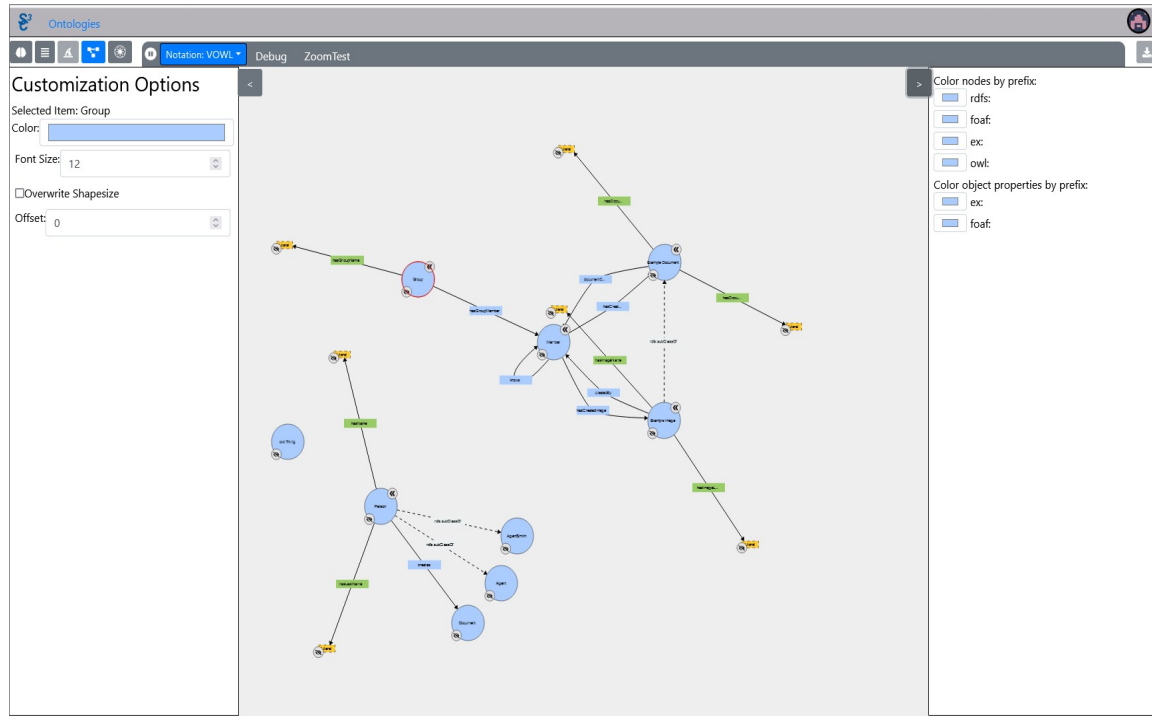
### http://example.com/Image
ex:image rdf:type owl:Class ;
    rdfs:label "Example Image" ;
    rdfs:subClassOf ex:Document .

### http://example.com/Document
ex:Document rdf:type owl:Class ;
    rdfs:label "Example Document" .

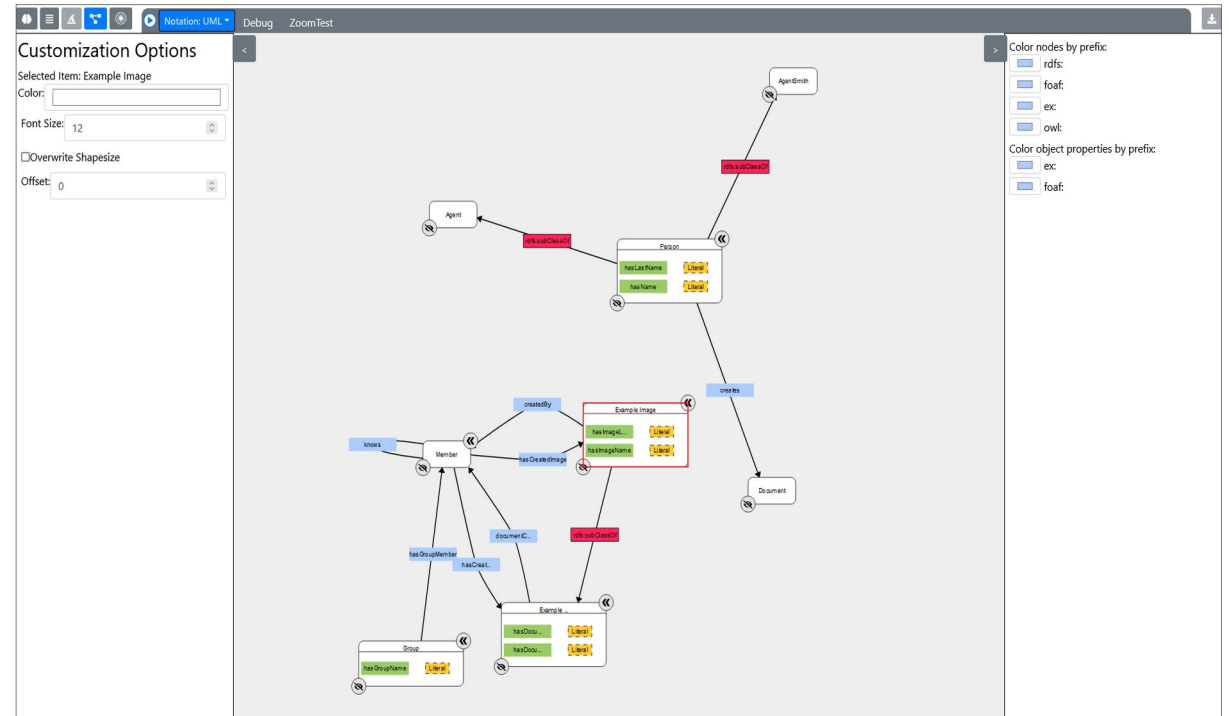
### http://xmlns.com/foaf/0.1/Document
foaf:Document rdf:type owl:Class .
    
```

Textual-Based Visualization

Visualisations



Graph-based Visualization with VOWL Notation



Graph-Based Visualization with UML Notation

SC3 Platform evaluation (approach)

- *“Usability Evaluation focuses on how well users can learn and use a product to achieve their goals.”*
- **Pre-test survey** as preparation for extensive evaluation (usability + mental workload)
- **Applied methodologies**
 - Usability evaluation
 - **The System Usability Scale (SUS)**. Easy to scale, useful with small response sizes
 - 10 item questionnaire
 - **Scale:** strongly agree to strongly disagree
 - Subjective mental workload assessment
 - **NASA Task Load Index (NASA-TLX)**
 - *“a subjective workload assessment tool which allows users to perform subjective workload assessments”* [2]
 - **determine the MWL of a participant while they are performing a task**
 - **rates performance across six dimensions to determine an overall workload rating**

[1] <https://www.usability.gov/what-and-why/usability-evaluation.html#:~:text=Usability%20Evaluation%20focuses%20on%20how,related%20to%20a%20new%20site.>

[2] <https://humansystems.arc.nasa.gov/groups/tlx/>

SC3 Platform evaluation (approach)

The System Usability Scale (SUS)

- Consists of 6 sections
 1. About you
 2. Experience with SC3 platform
 3. Task Load
 4. About the SC3 platform approach
 5. Additional Feedback
 6. General

- radio button selections
- rating scales from 1 - 5
- Freetext fields

I found that various functions of the SC3 platform were well integrated *

	1	2	3	4	5	
Strongly disagree	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Strongly agree

7 Persons took part in the pre survey

SC3 Platform evaluation results

The System Usability Scale (SUS) results

Participant	SUS raw score	SUS final score
1	27	67.5
2	28	70
3	26	65
4	31	77.5
5	31	77.5
6	21	52.5
7	27	67.5
Average:	27.29	68.21
Users experience with SC3 platform		

Average of all **SUS final scores** is equivalent to **68.21** that is marked as C grade (65.0 – 71.0)

1. **Users experience** with SC3 Ontology Platform
2. between **OK (51.7 – 62.6) GOOD (71.1 – 72.5)**.

Only three participants have experience with using SC3 Ontology Platform which is between C+ (good) and A (excellent)

SC3 Platform evaluation results

The System Usability Scale (SUS) results

SC3 Ontology Platform functionalities / performances	Percentage of participants that agree and strongly agree
User interface is easily understandable	85.7
Hybrid mode for ontology modelling	71.5
The dropdown buttons in Hybrid mode	71.5
Easy to find the search/filter functionality valuable	85.7
Easy to interact with the graph based visualization	71.5
The interaction with the graph is clear	71.4
Easy to navigate between different views	71.5
Performance of the platform is fast in terms of ontology editing	71.4
The role of collapsible sidebars is clear	100%
Participants' opinion about SC3 Ontology Platform functionalities	

- Second column summarizes percentages of agreed and strongly agreed scores about **listed functionalities** in the first column.
- In total more than **71 percent** of participants agreed or strongly agreed on selected functionalities.
- **Critical points** in SC3 Ontology Platform functionalities which participants observed are **interaction** with graph and how the platform is **fast** in terms of ontology editing, that is in total 71.4 percent of votes.



SC3 Platform evaluation results

NASA Task Load Index (NASA-TLX) results

- amount of effort participants took to upload, visualize and modify ontology.
- **High (34.29) mental activities** is required for all users to **upload, modify and visualize** ontology when using the SC3.

Temporal results: **time pressure** that participants felt during the work with the SC3 is also **high (54.29)**

All participants **require high (41.43) amount of effort** to achieve requested level of performance when using the SC3

On individual basis, all participants, except one, needs high mental, temporal activities when using the SC3

Participant/ NASA-TLX subclasses	Mental	Physical	Temporal	Performance	Effort	Frustration	Individual score results
							Raw/Unweighted (Mean*)
1	40	-	80	90	30	10	50
2	20	-	10	100	10	10	30
3	30	-	50	80	80	100	68
4	50	-	50	50	50	50	50
5	20	-	80	100	30	20	50
6	20	-	50	50	50	80	50
7	60	-	60	70	40	40	54
Group score results	34.29	-	54.29	77.14	41.43	44.29	Overall: 50.29
Raw/Unweighted (Mean*)							

Thank you for your attention!

Questions!

<https://service.tib.eu/sc3/>