Semantic-based representation, enrichment and computation of product breakdown structures

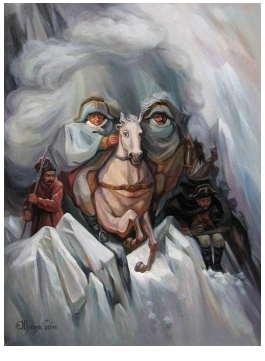
Jose María Alvarez-Rodríguez, Juan Llorens, Manuela Alejandres and Jose Fuentes

INCOSE IS 2015, Seattle, US

Universidad Carlos III de Madrid
www.uc3m.es

the REUSE company

Can we see/manage something in different forms?



What is first?

EBOM

PBS-What?

WBS-How?

OBS-Who?

CBS-How much?

...

x Breakdown Structures

Underlying structures for...

Systems of Systems

Systems of Interest

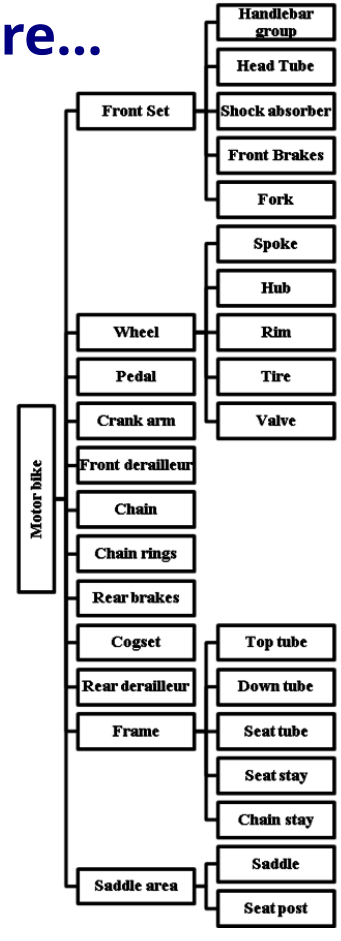
(SOI)

The Product Breakdown Structure

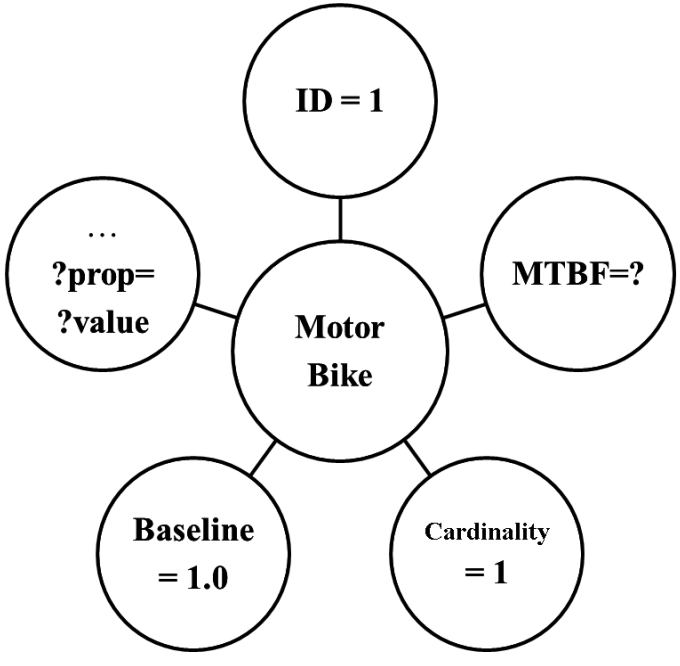
(PBS)

A motorbike PBS...

A structure...



...and...



...an underlying graph.

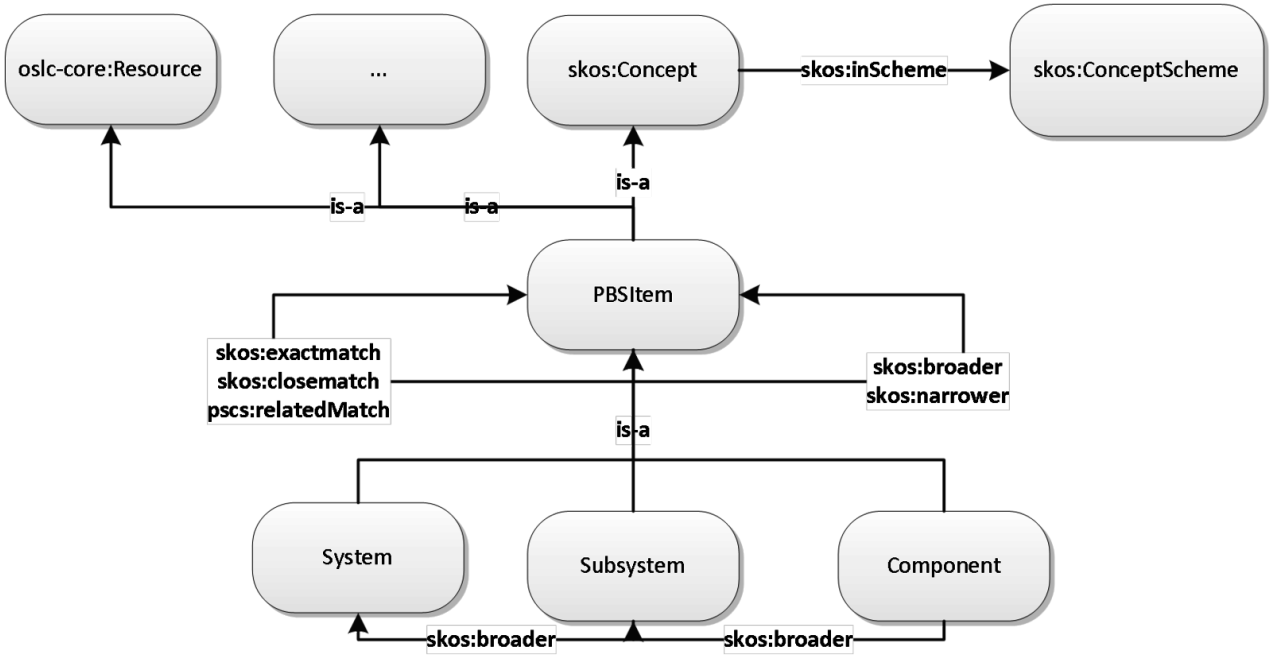
Needs and Challenges

- A common representation model
- Interoperability
- KPIs for each subsystem/component
- Validation (data & structure)
  - Bottom-up. E.g. Weight, MTBF?
- Computation
- …

View or profile over the same structure

Characterization of a PBS

1-Hierarchical structure



Vocabulary & Conceptual Model

2-Dynamic structure

- **New** subsystems and components can be added
- **Observations** are dynamically generated
- **Validation** is required
  - Checking consistency
  - Data integrity
- Different **views of the same structure** (relationship-based)
- ...

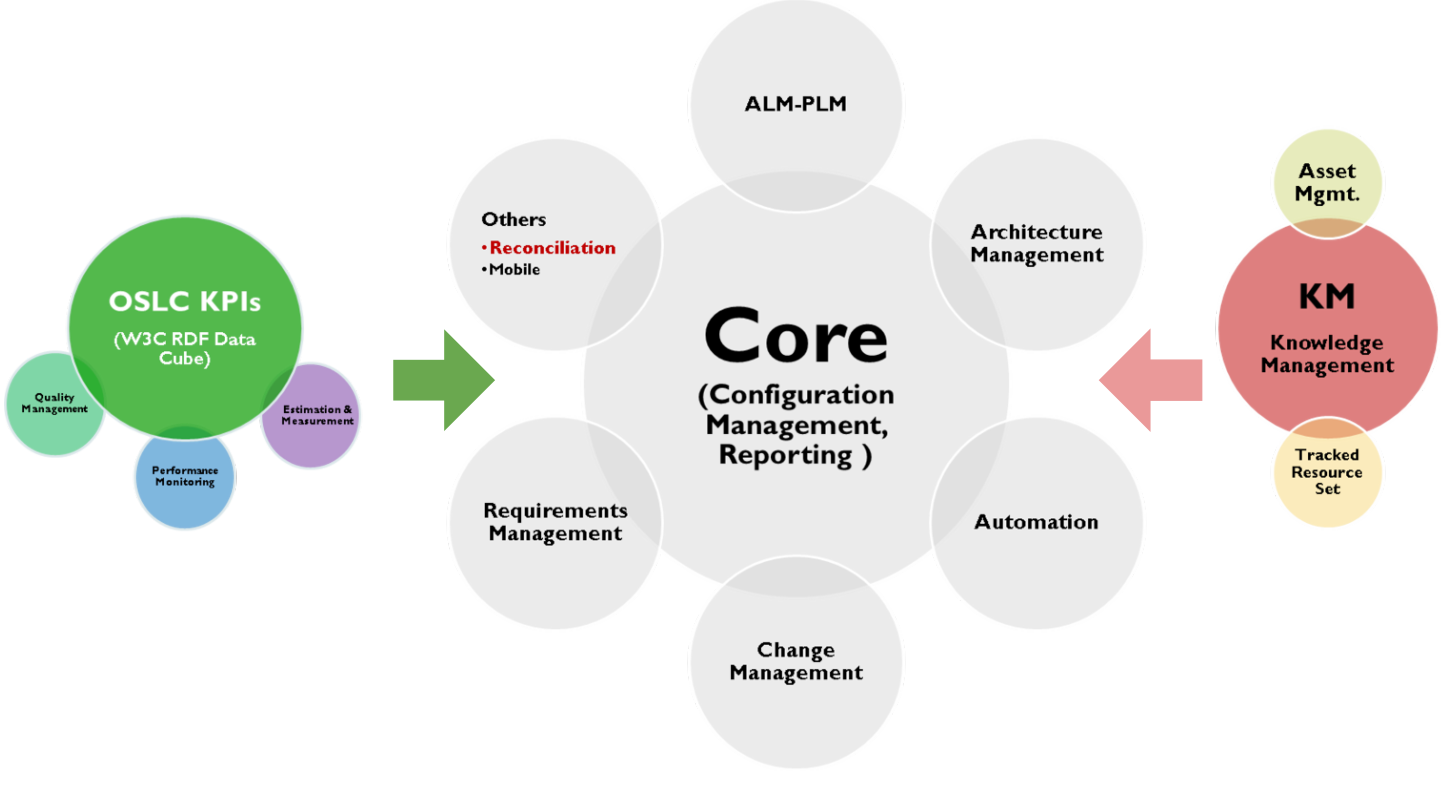
3-OSLC Resource

OSLC Knowledge Management

OSLC KPIs

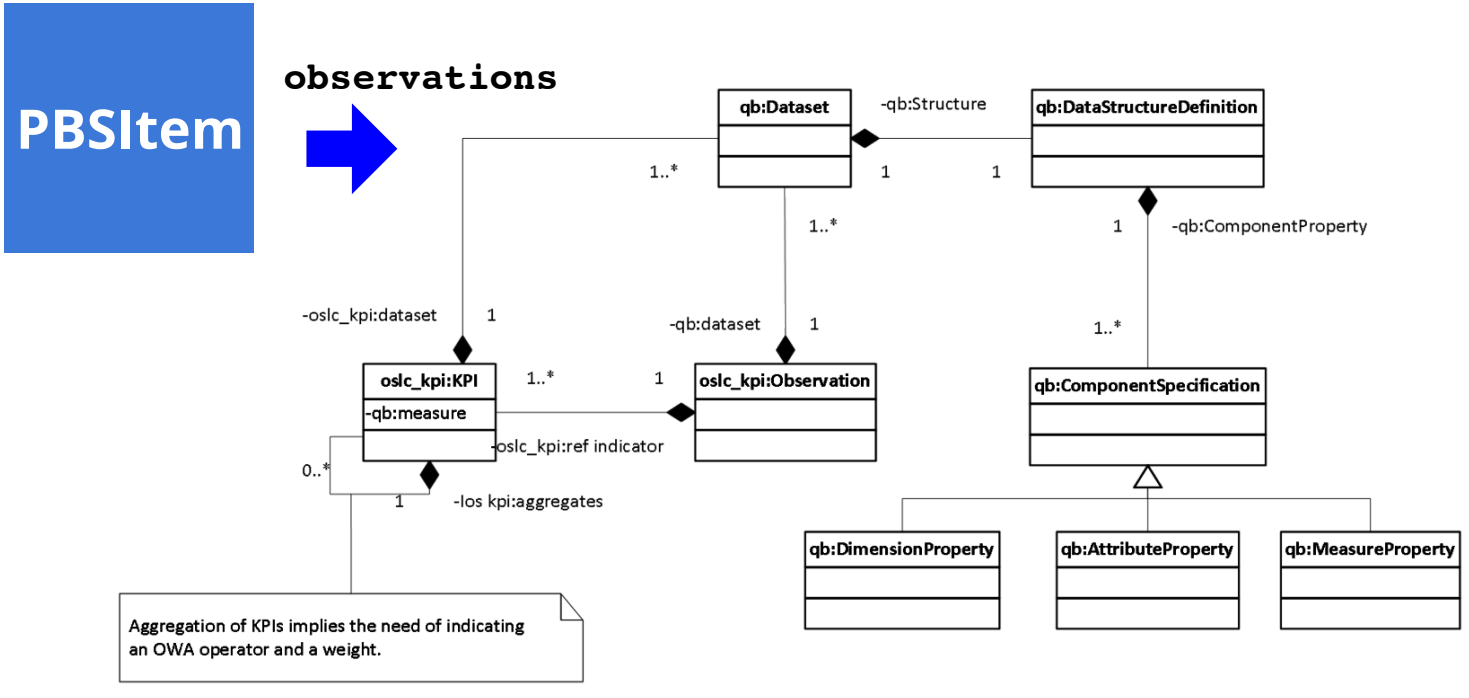
OSLC Overview

Situating contributions

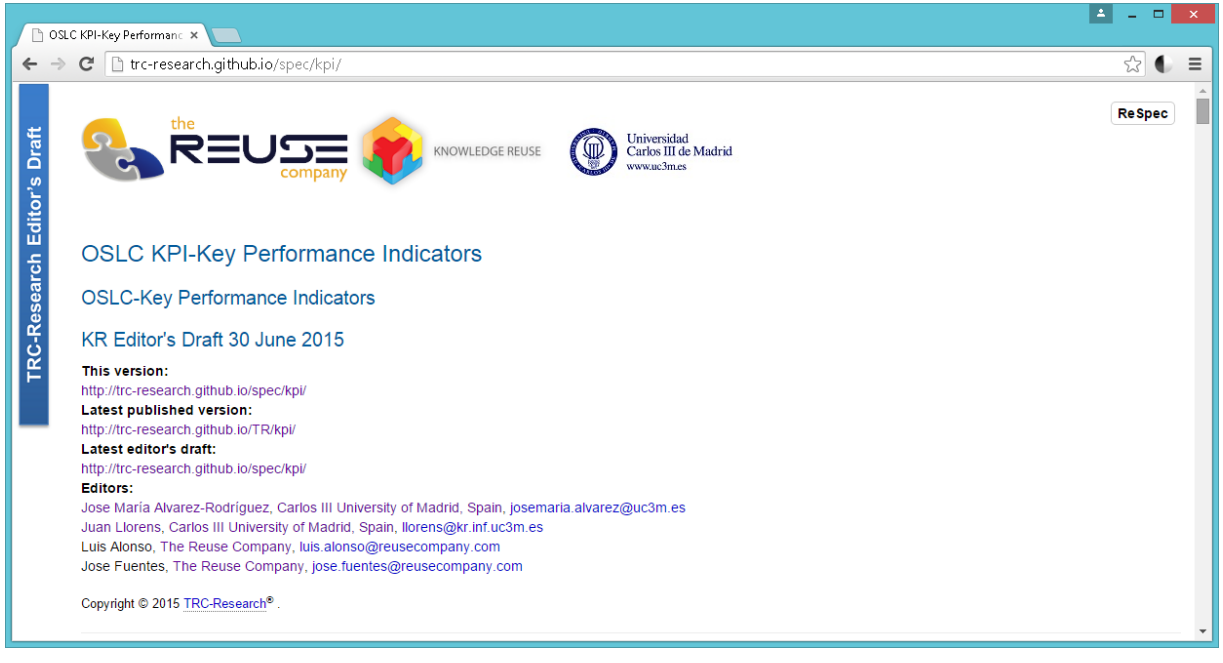


OSLC KPIs

- Observations are linked to any PBS item.
- **Based on the W3C RDF Data Cube Vocabulary**



OSLC KPIs (spec.)



http://trc-research.github.io/spec/kpi/

Implementation

Vocabulary

& Conceptual Model

Knowledge Manager by

The REUSE Company

Validation
and
Computation

RDF-data validation

(existing **approaches**)

Process	Type	Creation	Scope	Refs.
Structure and data validation (Consistency check)	Vocabulary-based	Semantic Web reasoner	RDF Datasets	(Baclawski et al. 2002)
Structure validation	Query-based	Hand-made RDF templates	RDF datasets	(Bizer and Cyganiak 2009)
Data validation	Vocabulary-based	Hand-made	RDF datasets	(Hogan et al. 2012)
Structure validation	Query-based	Hand-made	RDF Data Cube Vocabulary	(Cyganiak and Reynolds 2014)
Structure	Vocabulary-based	Hand-made or automatically generated by an OSLC API	OSLC Resource Shape	(Ryman, Hors, and Speicher 2013)
Structure	Vocabulary-based	Hand-made	Dublin Core Description Set Profiles	(Coyle and Baker 2013)
Structure and data validation	Query-based (generated from ShEX expressions)	Automatic generation of SPARQL queries	RDF datasets	(Boneva et al. 2014)
Structure and data validation	Vocabulary and Query-based	Hand-made	Computex vocabulary	(J. Alvarez-Rodríguez, Labra-Gayo, and Ordoñez de Pablos 2013)
Structure and data validation	Vocabulary and Query-based	Automatic generation of SPARQL queries	OWL and RDF under Closed World Assumption	
Structure and data validation	Query-based	SPIN language + SPARQL queries	RDF datasets	(Holger Knublauch, James A. Hendler, and Kingsley Idehen 2011)

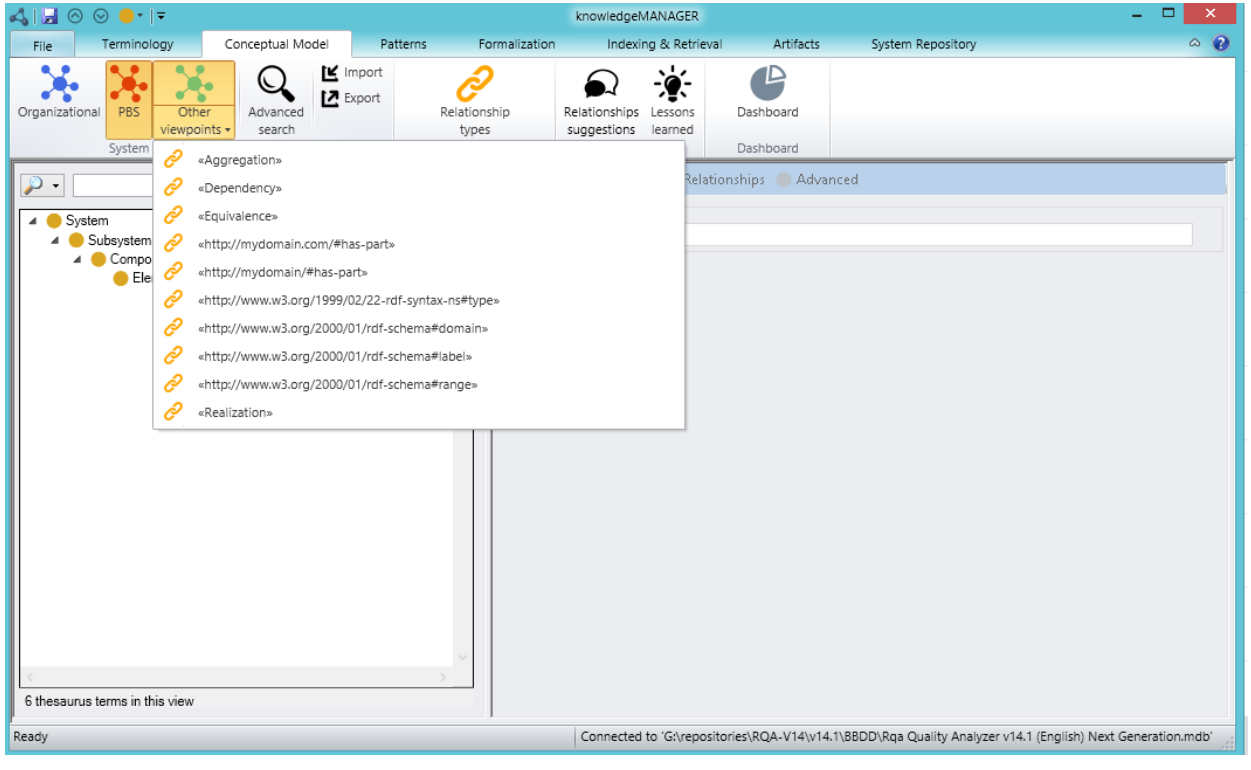
On-ongoing effort W3C SHACL (Sept. 2014)

(Shapes Constraint Language)

RDF-data validation

Process	Type	Tool	Scope
Structure Data validation	Vocabulary-based	Pellet	SKOS, RDF Data Cube Vocabulary and OSLC Resource Shape
Structure validation	Query-based	Hand-made SPARQL queries (74) and a SheX processor	SKOS
Structure validation	Query-based	SPARQL queries (22) from the specification and a custom Java-based processor	RDF Data Cube Vocabulary
Structure validation	Query-based	Auto generated SPARQL queries and a SheX processor	OSLC Resource Shape
Computation validation	Query-based	Auto generated SPARQL queries and a custom Java-based processor	RDF Data Cube Vocabulary

Advanced checkings



Evaluation

- **Compare traditional** vs **Semantic** PBS
- **Apply a multi-criteria** technique
- **Establish** a ranking

Traditional

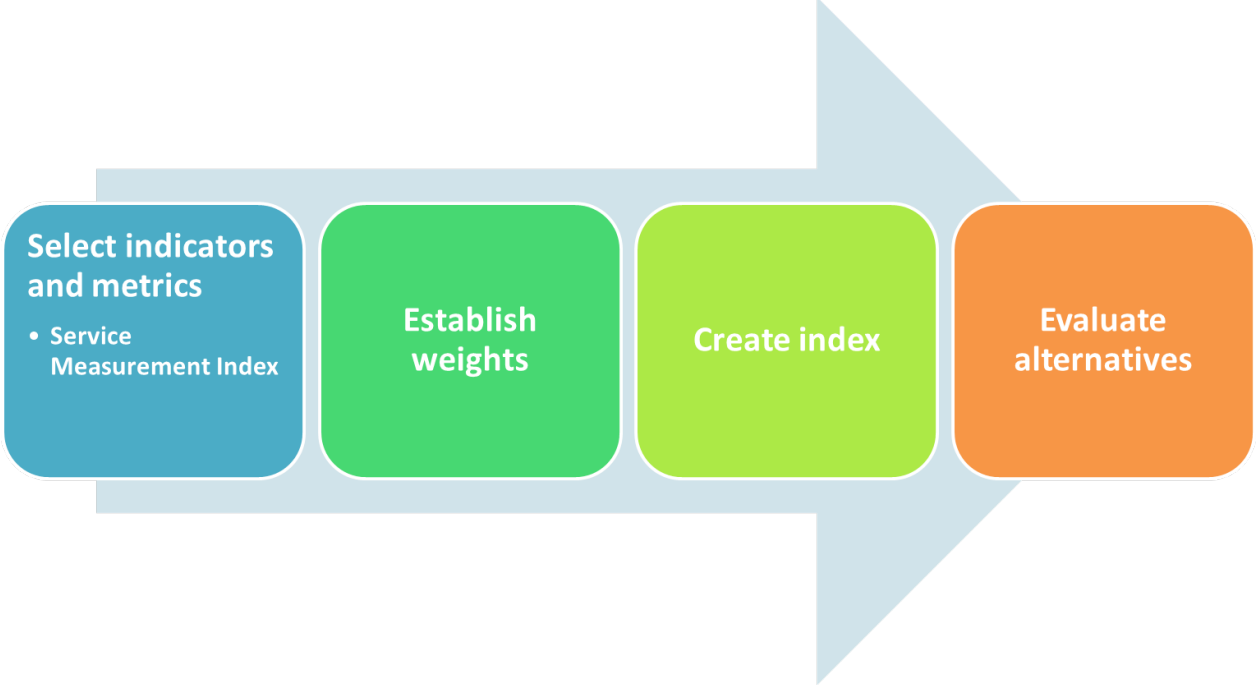
vs

Semantic

PBS

AHP

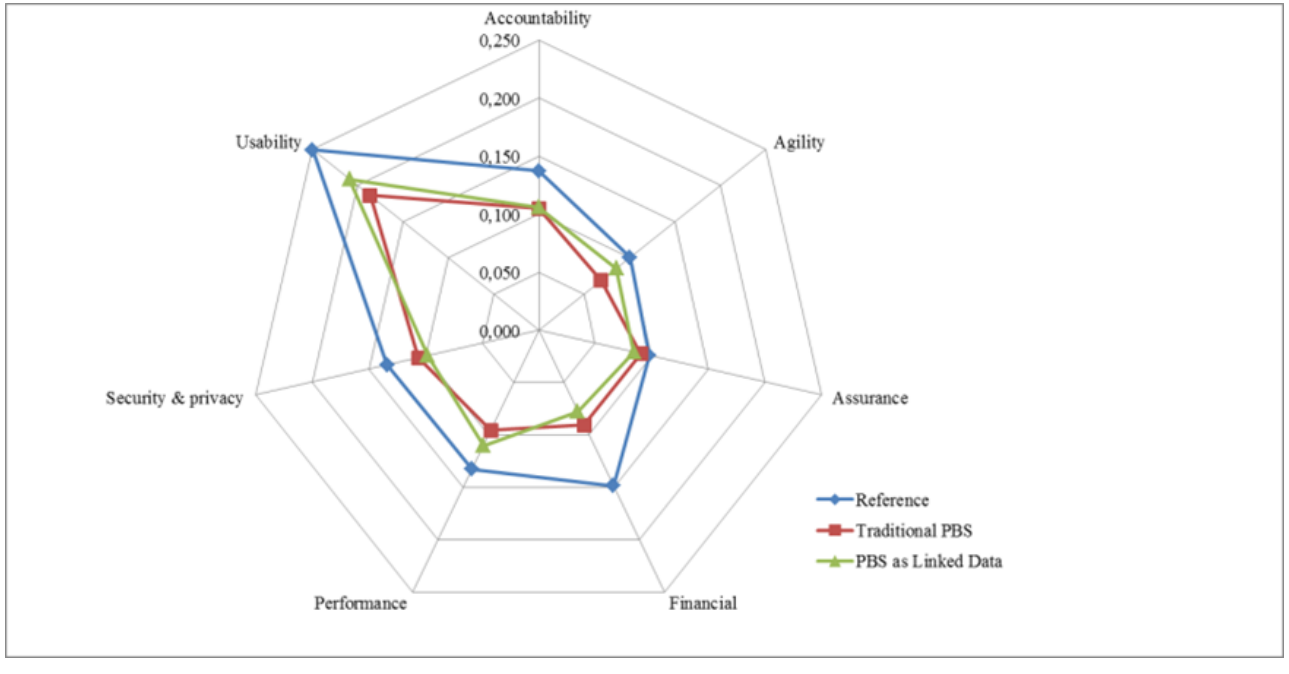
(Analytical Hierarchy Process)



Criteria

- PBS as a Service
- Use of the **Service Measurement Index** (v2.0)

Results


Accountability
0,250
0,200
0,150
0,100
0,050
0,000
Agility
Assurance
Financial
Performance
Security & privacy
Usability
Reference
Traditional PBS
PBS as Linked Data

Conclusions

- The **PBS** is one of the **basic structures** for any product development
- **Valuable data** and **information**
  - **Static and Dynamic**
- Different **views** on the same data
- Need of **validation** and **computation**
  - Data consistency and integrity
  - Advanced checking
- ...

Future Work

- PBS as a **resource** that can be **fully exchanged**
- **Reactive** and **continuous** validation of PBS data
- **Quality** assurance
- **Alignment** to new **specifications** E.g. SHACL
- Merging with existing **PBS management tools**
- ...

Speakers

- **Dr. Jose María Alvarez-Rodríguez**
  - Carlos III University of Madrid, Spain
  - Member of INCOSE and the OSLC RM working group
  - E-mail: josemaria.alvarez@uc3m.es
  - WWW:
    - http://purl.org/krgroup/web
    - Personal site

- **Prof. Dr. Juan Llorens**
  - Carlos III University of Madrid, Spain
  - Member of INCOSE
  - CTO of The Reuse Company Inc.
  - E-mail: llorens@kr.inf.uc3m.es
  - WWW:
    - http://purl.org/krgroup/web
    - **Personal site**


THANK
YOU
GRACIAS
ARIGATO
SHUKURIA
DANKSCHEEN
TASHAKKUR ATU
YAQHANYELAY
TINGKI
BİYAN
SHUKRIA
SUKSAMA
EKHMET
MEHRBANI
GRAZIE
MAAKE
KOMAPSUMNIDA
GOZAIMASHITA
EFCHARISTO
JUSPAXAR
PALDIES
BOLZÏN
MERCI