OOPS ! and Competency Questions for Evaluating the Intelligent Business Process Management Ontology

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Her research interests include business process management, Industry 4.0, business process modelling and ontologies.

Aims and contributions of our paper

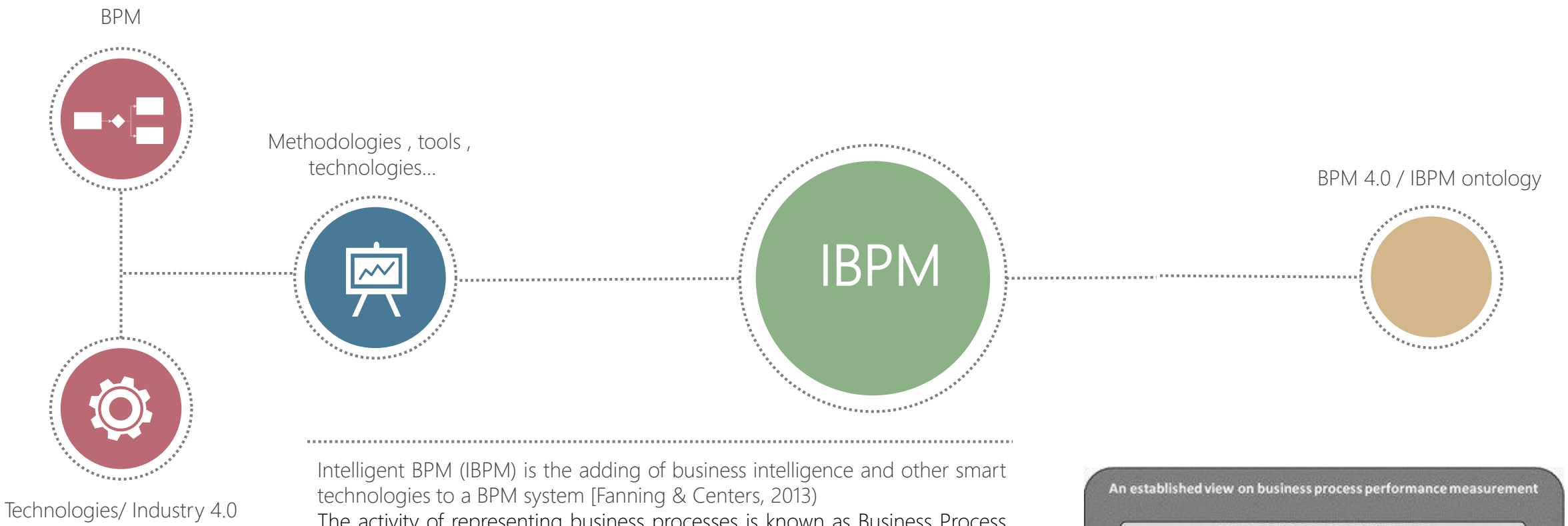
In our paper, we aimed at:

1. To adopt an evaluation process in order to improve the IBPMO.
2. To assess the quality and the content of the IBPM Ontology (IBPMO).

Contributions of our study are threefold:

1. We present our IBPMO Ontology
2. We adopt an evaluation process in order to improve the IBPMO.
3. We evaluate our IBPMO, using the CQs, the technology-based evaluation and the application-based evaluation.

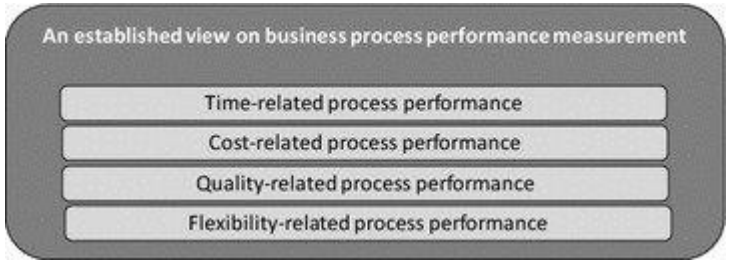
Ontology-based Approach overview



Intelligent BPM (IBPM) is the adding of business intelligence and other smart technologies to a BPM system [Fanning & Centers, 2013)

The activity of representing business processes is known as Business Process Modelling (BPM); it is an active research area that attracts more and more attention with the emergence of Industry 4.0 [3].

Semantic Web technologies, especially ontologies, are promising means to advance BPM and to realize the Industry 4.0 vision. In this scope, we developed the BBO (BPMN 2.0 Based Ontology) ontology for business process representation, by reusing existing ontologies [3].



Dumas et al. (2013)

PRESENTATION OF OUR IBPMO ONTOLOGY (1)

- The IBPMO is an important part of our approach, which ensures the selection of the most suitable technologies 4.0 for BPs. Regarding the first step, the scope of our ontology is to develop an ontology for iBPM
- Tool : Protégé 5.5.0
- Number of classes: 75 classes
- Number of relations: 53 relations

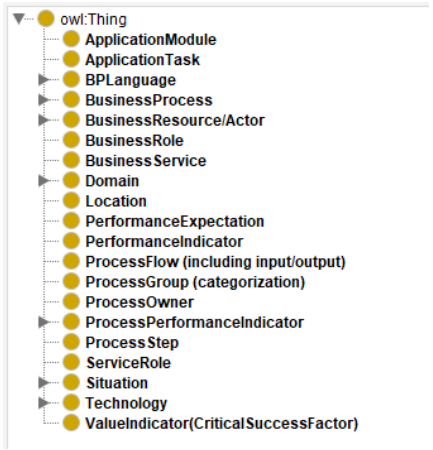
PRESENTATION OF OUR IBPMO ONTOLOGY (2)

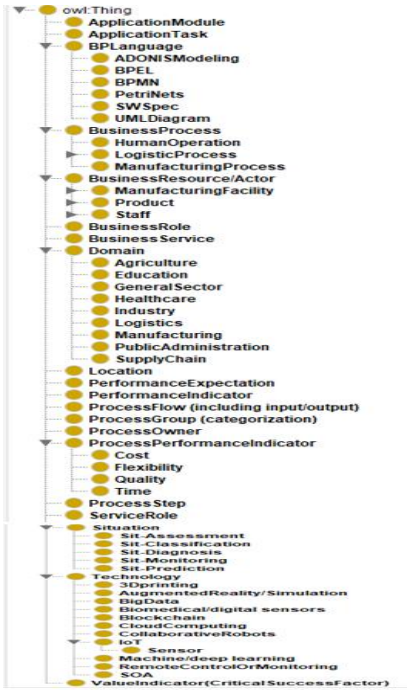
- **Selection of the existing BPM ontology** presented in (von Rosing M, Laurier W, Polovina S. The BPM ontology 2015)
- New classes: (Sensor, Location, Machine, Workstation, Line, Technology4.0)
- New relations:
  - A sensor is located in a location. The business process can be linked to the technology 4.0 through the adopts property.
  - 3D printing, Augmented reality/simulation, Big data, Biomedical/digital sensor, Cloud computing, Collaborative robots, IoT, Machine/deep learning and Remote control or monitoring are introduced as sub-classes of Technology 4.0.

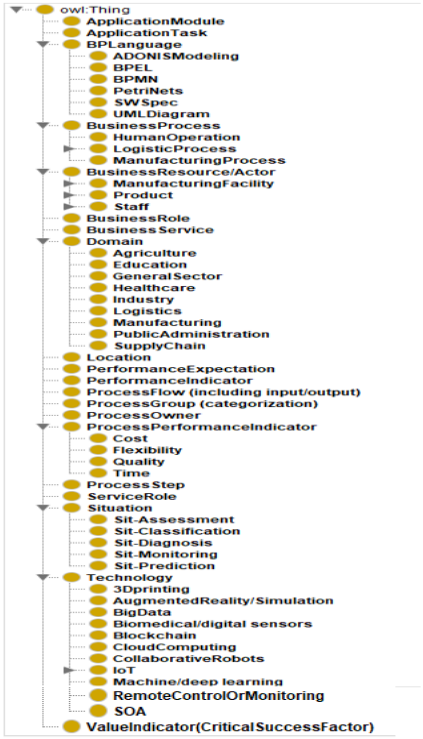
➢ The IBPMO models the most important concepts in the context of both BPM and Industry 4.0.

PRESENTATION OF OUR IBPMO ONTOLOGY (3)

- Class Hierarchy of our IBPMO







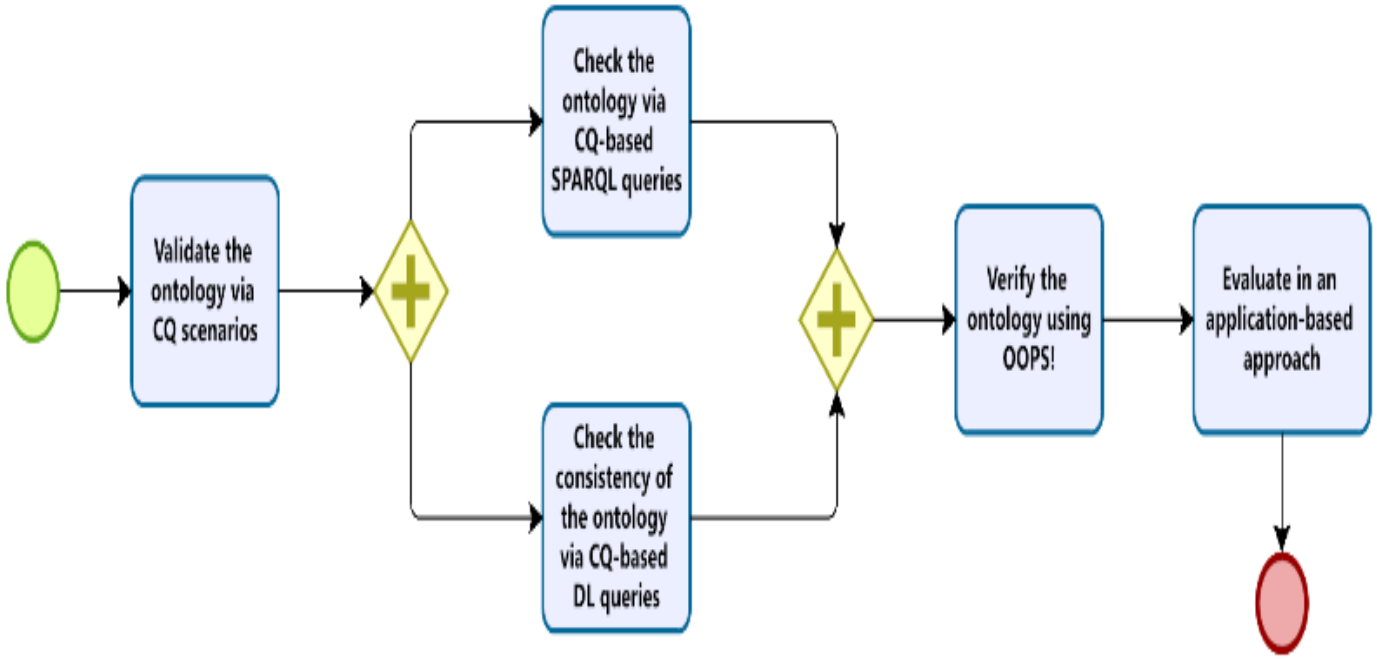
RESEARCH METHODOLOGY

We adopt an evaluation process:

(1) Checking the ontology via SPARQL queries and via Description Logic (DL) queries

(2) Verifying the ontology using the OOPS! Tool

(3) Evaluating the IBPMO in an application-based approach



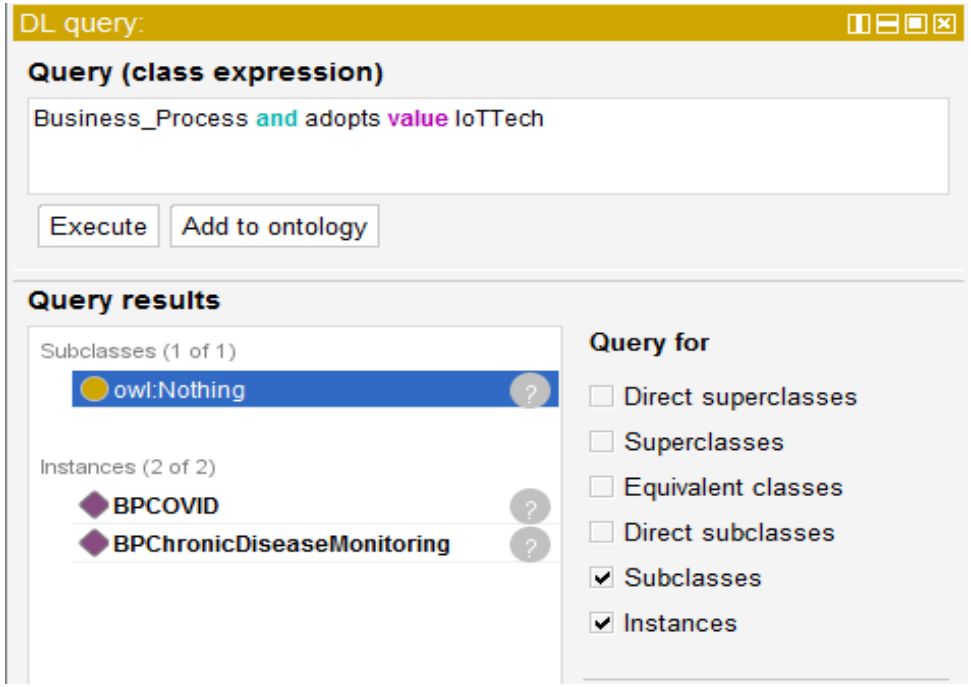
EVALUATION OF THE IBPMO

We evaluated the IBPMO Ontology by using three approaches:

- CQs: Reformulating CQs as queries to retrieve data from the ontology
  - Verifying whether the CQs are positively answered or not?.
- Technology-based evaluation (OOPS!): A web-based evaluation tool used for the detection of common pitfalls.
  - Ensuring the correctness and usability of the IBPMO
- An application-based evaluation: Using the ontology in a dedicated application.
  - Ensuring the ability of the IBPMO

COMPETENCY QUESTIONS EVALUATION (1)

- Consistency check via CQ-based DL
  - CQ: What are the BPs that have adopted the IoT Technology ?
  - ➢ Results of DL query (correspond to this CQ): To easily access to most important information related to the monitoring of chronic disease BP, the food selection and guidance for diabetic and hypertensive patients BP and the monitoring of COVID 19 patients BP in a short time.



COMPETENCY QUESTIONS EVALUATION (2)

- CQ-based SPARQL

- CQ1: What are the Business Processes contained in the ontology?
- ➢ The result of this query contains the BPs modeled in the IBPM Ontology.

The fact that the obtained results are conform to the expected results contributes to proving the validity of our ontology.

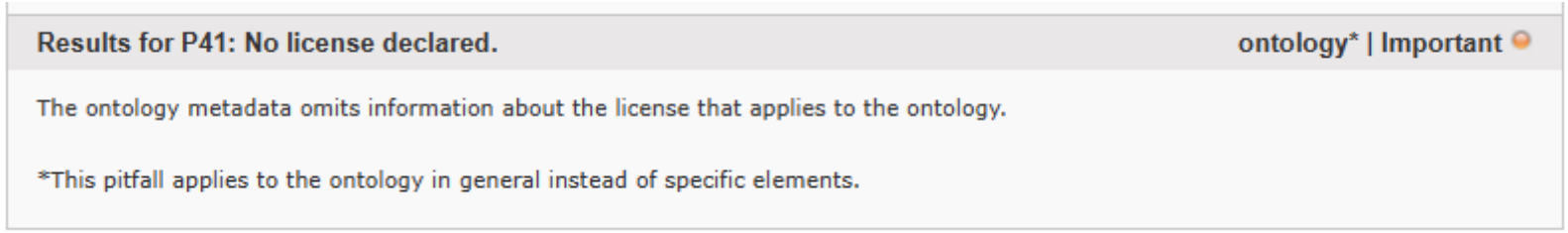
SPARQL query:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX bp: <http://www.semanticweb.org/user/ontologies/2020/7/untitled-ontology-8#>
SELECT ?businessProcess
        WHERE { ?businessProcess rdf:type bp:BusinessProcess}
```

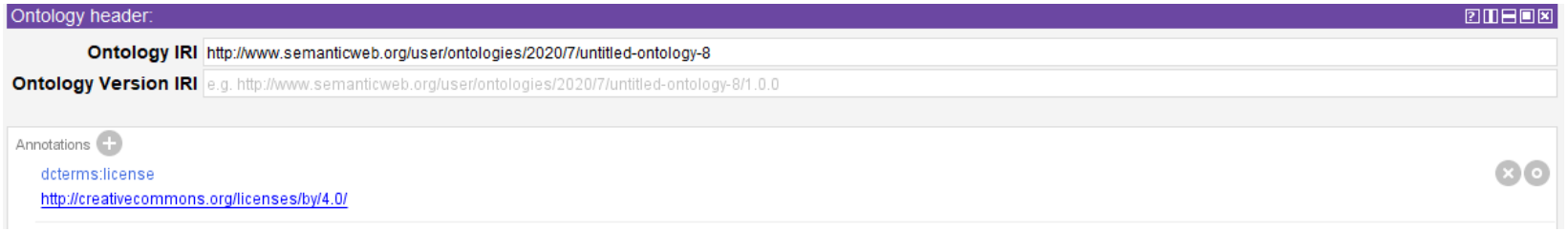
businessProcess
BPChronicDiseaseMonitoring
BPForFoodSelectionAndGuidanceBPForDiabeticAndHypertensivePatients
BPCOVID

TECHNOLOGY-BASED EVALUATION (OOPS!)

Pitfall in IBPMO (P41: No license declared). It reports about uses of no license agreement in the IBPMO.



- Correctness of the observed errors: The license of the IBPMO is declared

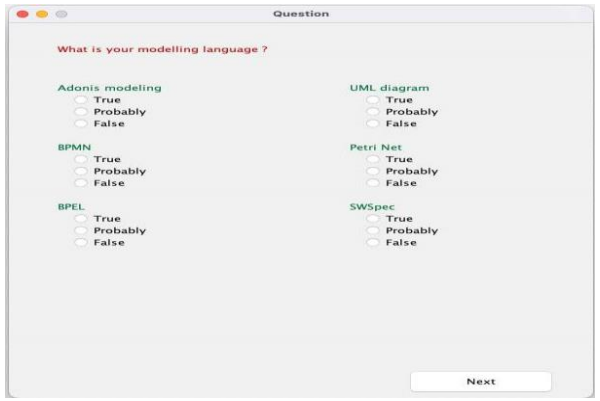


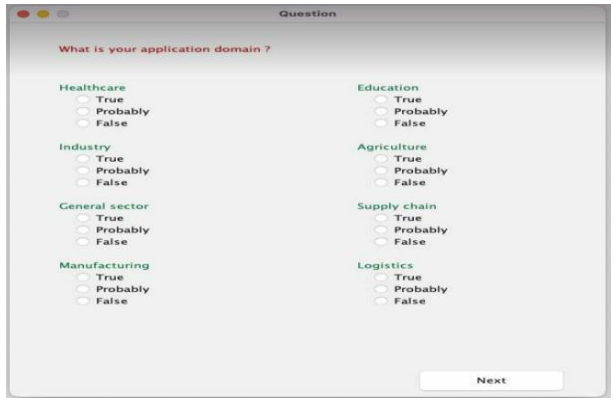
APPLICATION-BASED EVALUATION (1)

- The IBPMO is validated by providing the following applications.
  - BPIGuide tool: The IBPMO is used in conjunction with the BPIGuide tool. The BPIGuide tool enables the decision rules represented in the IBPMO to be automatically infered.

APPLICATION-BASED EVALUATION (2)

- Dedicated interfaces: The interfaces provided by the application are designed to configure user needs on selection criteria.
- Interface for performance criteria
- Interface for BP languages
- Interface for application fields





CONCLUSION AND FUTURE WORK

Conclusion:

- We developed the IBPMO, which ensures the selection of the most suitable technologies 4.0 for BPs.
- We evaluated of the IBPMO through the using of the CQs, the technology-based evaluation and the application-based evaluation

Future work:

- We will be upgraded the IBPMO with linked open data to enable domain knowledge sharing and reuse.

References

[1] S. Mejri and S. Ghannouchi. "Towards a New Approach for Intelligent BPM Based on Technologies 4.0". New Trends in Intelligent Software Methodologies, Tools and Techniques: Proceedings of the 20th International Conference on New Trends in Intelligent Software Methodologies, Tools and Techniques (SoMeT_21). vol. 337, pp. 313-326, September 2021. https://doi.org/10.3233/FAIA210030.

[2] V. R. Sampath Kumar, et al. “Ontologies for Industry 4.0”. The Knowledge Engineering Review. vol. 34, pp. e1-e17, November 2019. https://doi.org/10.1017/S0269888919000109.

[3] S. Jaskó, A. Skrop, T. Holczinger, T. Chován, and J. Abonyi. “Development of manufacturing execution systems in accordance with Industry 4.0 requirements: A review of standard-and ontology-based methodologies and tools”. Computers in Industry. Vol. 123, pp. 1-18, December 2020.

[4] C. Kaar, J. Frysak, C. Stary, U. Kannengiesser, and H. Müller. “Resilient Ontology Support Facilitating Multi-Perspective Process Integration in Industry 4.0”. Proceedings of the 10th International Conference on Subject-Oriented Business Process Management. pp. 1–10, April 2018.

[5] A. Annane, N. Aussenac-Gilles, and M. Kamel. “BBO: BPMN 2.0 Based Ontology for Business Process Representation.” 20th European Conference on Knowledge Management (ECKM 2019). pp. 49–59, September 2019.

[6] M. Poveda-Villalón, MC. Suárez-Figueroa, and A. Gómez-Pérez. “Validating ontologies with oops!” Knowledge Engineering and Knowledge Management: 18th International Conference, EKAW 2012. Galway City, Ireland, pp. 267–81, October 2012.

[7] A. A. Alsanad, A. Chikh, and A. Mirza. “A Domain Ontology for Software Requirements Change Management in Global Software Development Environment”. IEEE Access. vol. 7, pp. 49352-49361, January 2019. https://ieeexplore.ieee.org/abstract/document/8684236/ (accessed January 30, 2023).

[8] A. Abdelghany, N. Darwish, and H. Hefni. “An Agile Methodology for Ontology Development”. IJIES 2019. Vol. 12, pp. 170–181, April 2019.

[9] N. Noy and DL. McGuinness. “Ontology development 101”. Knowledge Systems Laboratory, Stanford University 2001. vol. 2001, pp. 1-18, January 2001.

[10] W. Chansanam, K. Suttipapa, and A.R. Ahmad. "COVID-19 ontology evaluation". International Journal of Management. vol. 11, pp. 47-57, October 2020.

REFERENCES

[11] N. M. Yusof and S. A. M. Noah. "Malaysian food composition ontology evaluation". International Journal of Machine Learning and Computing. vol. 9, pp. 700–705, October 2019.

[12] C. Bezerra, F. Freitas, F. Santana da Silva. “Evaluating Ontologies with Competency Questions”. pp. 284-285, November 2013. https://doi.org/10.1109/WI-IAT.2013.199.

[13] M. Poveda-Villalón, A. Gómez-Pérez, and MC. Suárez-Figueroa. “Oops!(ontology pitfall scanner!): An on-line tool for ontology evaluation”. International Journal on Semantic Web and Information Systems (IJSWIS). vol. 10, pp. 7–34, April 2014.

[14] S. Jain, V. Meyer. “Evaluation and refinement of emergency situation ontology”. Int J Inform Educ Technol. vol. 8, pp. 713–719, July 2018.

[15] M. Richard, X. Aimé, M.C. Jaulent, M.O. Krebs, and J. Charlet. “From Patient Discharge Summaries to an Ontology for Psychiatry”. MEDINFO 2017: Precision Healthcare through Informatics, IOS Press. pp. 930–934, June 2017.

[16] D. Kalita, and D. Deka. “Ontology for preserving the knowledge base of traditional dances (OTD)”. The Electronic Library. vol. 38, pp. 785–803, October 2020.

[17] T. Pizzuti, G. Mirabelli, Grasso G, and G. Paldino. “MESCO (MEat Supply Chain Ontology): An ontology for supporting traceability in the meat supply chain”. Food Control. vol. 72, pp. 123–133, Février 2017.

[18] M. Uschold and M. King. “Towards a methodology for building ontologies”. Citeseer. pp. 1-13, July 1995.

[19] M. Gruninger. “Methodology for the design and evaluation of ontologies”. Proc. IJCAI’95, Workshop on Basic Ontological Issues in Knowledge Sharing. April 1995.

[20] M. Fernández-López, A. Gómez-Pérez, and N. Juristo. “Methontology: from ontological art towards ontological engineering”. pp. 33-40, March 1997.

REFERENCES

[21] N. F. Noy, and D. L. McGuinness. “Ontology development 101: A guide to creating your first ontology”. Stanford knowledge systems laboratory technical report KSL-01-05. pp. 1-25, March 2001.

[22] H. S. Pinto, S. Staab, and C. Tempich. "DILIGENT: Towards a fine-grained methodology for DIstributed, Loosely-controlled and evolvInG Engineering of oNTologies”. ECAI. vol. 16, pp. 1-393, January 2004.

[23] M. C. Suárez-Figueroa, A. Gómez-Pérez, and M. Fernández-López. “The NeOn methodology for ontology engineering. Ontology engineering in a networked world”. pp. 9–34, Springer; December 2011.

[24] F. Giustozzi, J. Saunier, C. Zanni-Merk. “Context modeling for industry 4.0: An ontology-based proposal”. Procedia Computer Science. vol. 126, pp. 675–684, January 2018.

[25] H. Hlomani and D. Stacey. “Approaches, methods, metrics, measures, and subjectivity in ontology evaluation: A survey”. pp. 1-11, August 2014.

[26] Z. C. Khan.” Evaluation metrics in ontology modules”. pp. 1-13, April 2016.

[27] Kurukshetra, S. Jain S, and V. Meyer. “Evaluation and Refinement of Emergency Situation Ontology”. IJIET. vol. 8, pp. 713–719, January 2018.
[28] J. D. Warrender and P. Lord . "How, What and Why to test an ontology". pp. 1-4, Mai 2015.

[29] A. Rector, et al. “OWL pizzas: Practical experience of teaching OWL-DL: Common errors & common patterns”. Engineering Knowledge in the Age of the Semantic Web: 14th International Conference, EKAW. Whittlebury Hall, UK, pp. 63–81, October 2004. Proceedings 14, Springer.

[30] D. Allemang and J. Hendler. “Semantic web for the working ontologist: effective modeling in RDFS and OWL”. pp. 1-510, May 2011.

[31] M. Poblet, et al. “Assigning Creative Commons Licenses to Research Metadata: Issues and Cases”. In: Pagallo U, Palmirani M, Casanovas P, Sartor G, Villata S, editors. AI Approaches to the Complexity of Legal Systems, vol. 10791, pp. 245–256, October 2018.

[32] M. Horridge, et al. “A practical guide to building owl ontologies using protégé 4 and co-ode tools edition1”. vol. 2. pp. 1-107, March 2011.

[33] A. Gangemi, C. Catenacci, M. Ciaramita, and J. Lehmann. “Modelling ontology evaluation and validation”. The Semantic Web: Research and Applications: 3rd European Semantic Web Conference, ESWC. Budva, Montene, pp. 140–154, June 2006.