A New Approach for a Dynamic Enterprise Architecture Model using Ontology and Case-based Reasoning

Imane Ettahiri[1], Karim Doumi[1] and Noureddine Falih[2]
[1]ENSIAS, Mohamed V University in Rabat, Rabat, Morocco
[2]LIMATI Laboratory, Sultan Moulay Slimane University, BeniMellal, Morocco

Keywords: Dynamic, Ontology, Enterprise Architecture, Case-based Reasoning, Enterprise Ontology.

Abstract: To meet the demands of a dynamic and constantly changing environment, (DRP) Disaster Recovery Plans, (BCP) Business Continuity Plans, change management, agile activities, and best practice guides are developed with the ultimate objective of providing enterprises with the tools to deal with change rapidly and flexibly. Starting from the premise that Enterprise architecture remains the instrument ensuring this alignment Strategy//business//IT, dynamic aspects should be present in the EA representation but also should be perceived in the reaction of enterprises managing the change. On the other hand, ontologies offer a formal and a shared representation of the domain studied; EA in our case. Once formalized, the representation became computable so, all the EA reactions became dynamic towards the triggers of change. To benefit from the previous experiences, Case-based reasoning is introduced in our approach allowing a problem resolution via similarity and adaptation of knowledge to the current context.

1 INTRODUCTION

Today, companies are aware that their need for business/IT alignment must be in perpetual readjustment to follow the rapid changes impacting the internal and the external of the organizations. According to Gartner, organizations must have the necessary dynamism to adapt quickly to meet the need for business/IT alignment by bringing together the external and internal capacities of the company, or even any line-up couplet. Using the Enterprise Architecture to control their evolution, by maintaining the alignment between their business and IT (Doumi et al.,2011) The keywords will thus be speed of interception of the change factor and effectiveness of implementation of the resulting change process on the EA to ensure its consistency and continuity after the implementation of this change while keeping the enterprise IT alignment in a fluid and flexible way. To deal with this great challenge, an approach is proposed based on a key element: the notion of Enterprise Ontologies, to ensure a specification that is formally compliant and that can be used as a basis for machine language thereafter, thus gaining in speed and dynamic support consistency of intercepted changes.

In addition to ontologies, our model combines the advantages of the case-based reasoning too, to gain adaptability, reuse and evolution via learning new cases enriching the case base. This combination has been already proposed to deal with other problematic and has shown its advantages. In our paper, we tackle the research question related to what extent could ontologies and CBR respond to the problematic of dynamic aspect in enterprise architecture.

The paper is structured as follows: Section 2 presents fundamentals definitions of the concepts used in our work: Ontology, Case-based Reasoning (CBR), and dynamic aspect in EA. An overview of the relationship between EA and ontology is presented in Section 3. Section 4 exposes the architectural principles to which the proposed model has to comply. Some related works are presented in Section 5, as a ground for projection in our research question: can the ontologies give an answer to the dynamic aspect problematic in EA? In Section 6, we explain our proposed approach based on CRB and EA ontology. Section 7 illustrates the proposal through its instantiation on a concrete scenario. Finally, Section 8 concludes the paper and provides directions for future work.

Ettahiri, I., Doumi, K. and Falih, N.
A New Approach for a Dynamic Enterprise Architecture Model using Ontology and Case-based Reasoning.
DOI: 10.5220/0011079400003179
In *Proceedings of the 24th International Conference on Enterprise Information Systems (ICEIS 2022) - Volume 2*, pages 553-560
ISBN: 978-989-758-569-2; ISSN: 2184-4992

2 FUNDAMENTALS

2.1 Ontology Definition

According to (Studer et al., 1998), an ontology is defined as "an explicit and formal specification of a shared conceptualization, which is based on the well-known definitions of (Gruber, 1993) and (Borst,1997). According to (Guarino et al., 2009) and (Genesereth et al., 1987), conceptualization refers to "an abstract simplified view of the world", containing "objects, concepts, and other entities that are assumed to exist in a domain of interest and the relationships that exist between them ". (Studer et al., 1998) links "explicit" to the definition of "types of concepts used, and the constraints of use", formal, it is the fact that the conceptualization must be readable by the machine. Finally, "shared" means that the ontology "captures consensus knowledge".

2.2 Case-based Reasoning

According to (Leake,1996), CBR is 'reasoning by remembering'. It is a technology independent methodology (Watson, 1999) for humans and information systems. (Kolodner,1993) describes CBR in two ways: 'Case-based reasoning is both: the ways people use cases to solve problems and the ways we can make machines use them'. CBR can utilize the specific experience of previously solved, concrete problem situations (cases). A new problem is solved by finding a similar past case and reusing the solution in the new problem situation (Aamodt and Plaza 1994). As it explained, the Case-based Reasoning life cycle consisting of the following steps: (1) Retrieve the most similar case(s) from the case base, which contains historical cases, based on the characterization of the current situation used as query, using a similarity mechanism. (2) Reuse the lesson from the retrieved case(s) as the suggested solution for the new situation; adapt the retrieved lesson to the new situation, which becomes part of a new case. (3) Revise the new case after evaluating it in the new situation.

2.3 Dynamic Aspect in EA

The word dynamic is defined in the English dictionary oxford learner's as the characteristic (of a process, relationship or system) always changing and making progress. It is the opposite of static, and it is widely studied in different domains such as: mechanic, statistic, geophysics, hydrology, sociology, bacteriology and sociology….

As dynamic remains a complex paradigm (Saat et al., 2009), we tried in our previous study, to explore some facets of the dynamics in enterprise architecture (Ettahiri et al., 2021). As can be seen, the dynamic aspect in enterprise architecture differs depending on the prism of decomposition adopted: service view, perspective view (Zachman layer), dynamic design layer view, dynamic capabilities view, view zooming on the dynamic component, agility-centric view… This dynamic aspect is omnipresent across the different scales (inter-enterprise, intra-enterprise, holistic…EA vision, dynamic components…) And through the different action phases of the EA (Planning, analysis, modeling / Design, Implementation, or measurement). The advantages of each of our approaches oscillate between the consistency of the stability of the static aspect in EA and the agility and flexibility of the dynamic aspect. Explanatory approaches help to bring a better understanding: of complex EA reality for reliable representation, and a deep understanding of Dynamic EA capabilities to bring organizational benefits.

In our current study, we tried to constitute a model as comprehensive as possible, trying to resemble the maximum of advantages of the last work.

3 EA AND ONTOLOGY

3.1 Enterprise Ontology: EO

The development of an enterprise ontology has been initiated since the 1990s, especially in Canada and the United States (Jabloun, 2013). An ontology for business engineering was proposed by the University of Edinburgh to improve business modeling tools (Uschold et al., 1998). It is described both verbatim and in a semi-formal language (ontolingua). An activity ontology to support the model-driven business engineering approach has also been proposed by the University of Toronto (Tham et al., 1994). An open model (the Open Information Model of the OMG Group) has also been proposed by IT standardization organizations and is described in the company's technical and business metadata using UML (Prothman, 2000). After a comparison between the different proposals, a global ontology for the company is proposed in a hierarchical approach (Bertolazzi, 2001) which defines the "Core enterprise Ontology" .Other ontologies exist, such as: "Enterprise Process Handbook" developed by MIT, "TOVE" (Toronto Virtual Enterprise) developed by the University of Toronto, There are also works centered on knowledge and process modeling (KIF, PIF/PSL), with major contributions from Stanford University and "SymEnterprise," as well as research conducted by LEKS IASI-CNR. Recently, ontologies are increasingly seen as complementary to the use of EA meta-models. Indeed, the large size of the modern information system and the underlying multidisciplinary profession make it impossible to produce a single ontology for the multiplicity of fields covered. Thus, research has been directed towards the question of the alignment between the points of view (views) and the consistency between the models (Millet, 2008)

3.2 EA Issues Resolved via Ontologies

According to the literature review conducted by (Bakhshandeh, 2016) to constitute an idea about the application of ontologies on EA, we can note that ontologies since their primary role in terms of formalization and allowing human-machine communication, a step towards automation, ontologies are also used to solve problems of EA analysis and EA integration.

Ontologies are also considered as a modeling support allowing the sharing of knowledge represented by the ontology. A greater awareness of the importance of ontology in the field of Enterprise Engineering. Indeed, ontology has evolved from a simple knowledge arrangement model to a complement to the use of EA meta-models to support alignment. Additionally, the importance of ontology engineering techniques has become evident, considering the increasing number of use cases including software engineering (Happel et al., 2006). Among the analysis categories:

- Integration: Ontology provides an integrated environment, an interlingua, for information repositories or software tools.
- Semantic search (reasoning): In this scenario, ontologies are used to refine common (keyword-based) search algorithms using domain knowledge in the form of subsumption relations or logical constraints.
- Semantic Annotation: In this scenario, the purpose of ontology is to provide a controlled vocabulary, as well as a clearly defined classification and navigation structure for information items in a repository.
- Knowledge Representation: Ontology is used to formalize the type of objects related to a system or context.
- Semantic Rules: Ontology is used to express rules and logic and to add more expressiveness to the ontology.

4 ARCHITECTURAL PRINCIPALES FOR A COMPREHENSIVE MODEL OF DYNAMIC ASPECT IN EA

In this section, we describe and analyze the problematic addressed in our work. To embed our proposal in good practices, we have defined a list of architectural principles with which a solution to our problematic must comply. An architectural principle can be described as "a statement that prescriptively prescribes a property of an artifact's design that is necessary to ensure that an artifact meets its essential requirements" (Greefhorst et al., 2011). These principles are identified based on (Lumor et al, 2021) and (Antunes et al, 2014) to describe the architecture of our system. For the selection phase, we matched those principles with the list of advantages identified in our previous works about dynamic aspect in enterprise architecture. (Ettahiri et al., 2021). A list combining the advantages of the different approaches and studies related to dynamic aspect in EA was established, such as : Low coupling, Highly-cohesive, Coherence, Flexibility, Agility, Pragmatic, Semantic rigor for successful communication and documentation, Reactivity, Innovation, Tools to direct the transformation effort towards predictable and beneficial results, Deep understanding to delineate Dynamic EA capabilities to bring organizational benefits….and we tried to cover the maximum by matching them onto principles to ensure having the most comprehensive model as possible.

4.1 Architectural Principle N°1 – Flexibility and Adaptability

The architecture of the solution must be able to adapt to changing conditions and flexible to allow making the right decisions about the problems and opportunities. It is to highlight that architectures that are created with too much detail will often result in inflexible designs and implementations resulting in systems that cannot adapt to changing circumstances and environments.

4.2 Architectural Principle N°2 – Expressiveness

The architecture of the solution should be able to represent the concepts of the domain without ambiguity to ensure a clear communication. This implies the definition of a set of types and relationships to describe a domain. Although the need for multiple views of the system is recognized by the standard, the truth is that it is difficult to maintain these relationships when multiple meta-models and independent models are involved (Lankhorst, 2006). As such, some enterprise architecture modeling approaches attempt to be as comprehensive as possible up to a certain level of abstraction, providing a meta-model that addresses the different layers of an organization (Fischer et al.,2007) But the fact is that, many times, the integration of many meta-models is imperative in order to provide project-or domain-specific solutions to many problems (Zivkovic et al.,2007)

4.3 Architectural Principle N°3 – Extensibility

The architecture of the solution should be able to respond to the extensions as the modelling of a context implies the usage of multi perspectives for the same problem. This stems from the ability to respond to multiple concerns. Therefore, domain-specific and domain-independent models must coexist, and the overall architecture must cope with the transformation and integration of multiple models. A specific concern is that the architecture is extensible to new application domains.

4.4 Architectural Principle N°4 – Modularity and Reuse

The architecture of the solution must follow the principles of high cohesion and low coupling. Compliance with these principles contributes to the expressiveness and extensibility of the architecture. It is especially important that adding new domain-specific aspects to the model does not interfere with concepts already present in the model.

Considering this, the creation of computable representations for enterprise architecture models emerges as a relevant need (Martin et al., 2004). The combination of computable models with the application of dependencies brings benefits for enterprise architecture, such as information retrieval, management and processing. An example of these benefits is dependency analysis, which can be used to assess the alignment between business and IT concepts.

4.5 Principe Architectural N° 5 – Durability and Prediction

The durability of the architectures and resilience to different changes that might occur over the lifetime of the architectures, are a very important criterion of our model, that should preempt as much as possible the future conditions and environments.

4.6 Principe Architectural N° 6 - Viewpoint-Orientation

The architecture of the solution should support different views of its concepts. To facilitate communication and management of models. Views will make it easier to address multiple concerns and can improve decision-making by isolating certain aspects of the architecture in views as needed by decision makers. In this sense, viewpoint specifications can be as simple as a filter applied to the overall constellation of enterprise architecture models, or as complex as an algorithm that uses the information contained on the models to perform a calculation determined. (Antunes et al.,2014)

5 RELATED WORKS

In this section, we explore through a literature review, the related works that have already dealt with ontologies and CBR, separately or combined. Thereafter, we focus on the EA domain, with a purpose of identifying the advantages of this combination, followed by a projection in our research question about the dynamic aspect in EA: can the ontology and CBR respond to our architectural principles predefined for dynamic EA.

Several works have already combined ontologies and CBR; (Daz-Agudo et al.,2001) and (Wang et al.,2003). Especially, in medical and clinical domain that has been prominent in the recent past in the field of OBCBR: Ontology-based Case Based Reasoning (martin et al.,2016). we list here some examples: (Shen et al.,2015) propose an OBCBR and multi-agent-based clinical decision support system. The used ontology employs the domain knowledge to ease the extraction of similar clinical cases and provide treatment suggestions to patients and physicians. (Sene, et al.,2015) propose an OBCBR approach based on taxonomic reasoning for telemedicine in the oncology domain with the inclusion of natural language processing (NLP). (Delir Haghighi et al.,2013) introduce a development and evaluation of an OBCBR system in medical emergency management.

If we move to other fields, (Amailef et al.,2013) introduce an OBCBR implementation for intelligent m-Government emergency response services. It is notable that this implementation gives end users the possibility to adjust extempore certain similarity weights during retrieval phase and allows them to evaluate the proposed solution (outcome) during retaining phase.

In the EA field, and as presented in section (3.2), many EA issues have been resolved via ontologies such: analysis, integration, sematic search, semantic annotation, knowledge representation. (Ding et al., 2021), proposed an ontology-based technology to mine the core knowledge of successful projects with the purpose of improving the quality of application project and making an enhancement for development efficiency, through building a common library to extract knowledge from the process of project building with standard pattern for high-quality software application delivery. From precious experiences of each successful projects, he defines two ways of ontology-based domain knowledge pattern, first is for application project management, and second is for software engineering process. To decompose the project knowledge from the same application domain with tree structures. The results of this paper reduce development and requirement cost, and user satisfaction is better than without ontology, we don't need an experienced project leader so often, because the ontology model will teach us how to face difficulty.

The combination of ontologies with the CBR has been also tackled in (martin et al.,2016) according to him ontologies and CBR are used in EA with the aim of enriching the knowledge bases of projects and improving the results of CBR by an ontological representation allowing a better calculation of similarities, this varies depending on the different viewpoints and the company's stockholders. He used the structure given by the enterprise ontology named ArchiMEO, that is a partial realization of the Enterprise Architecture Framework (EAF) Archimate. And to apply the new ORCBR approach to different viewpoints, he used the case viewpoint model derived from the ISO/IEC/IEEE 42010 standards.

In the light of what precedes, we can note that a correlation is possible between our predefined architectural principles in one hand, and the coverage ensured by a hybrid use of the two concepts ontologies and CBR in the other hand. Expressiveness (principle 2) is the main advantage of ontologies, ensuring a formal representation for a clear communication between the different stockholders even with different viewpoints (principle 5). This ability to respond to multiple concerns (viewpoints, domain, new concepts, …) is allowed by the distinction between domain-specific and domain-independent or upper ontologies that should co-exist to ensure extensibility (principle 3), flexibility and adaptability (principle 1), as well as modularity and reuse (principle 4) .Those two last principles (1,4) are enhanced by the CBR through the Case base, that is filled and enriched by the couplets (problem, solution), but also adapted while applying the algorithm and requesting for similar cases. Thus, allowing the maintain of a rich, durable and a dynamic case base (principle 6) ensuring a rapid response to a given new case.

6 PROPOSED APPROACH: REPRESENTING DYNAMIC ASPECT IN EA USING ONTOLOGIES AND CBR

To meet the need for a representation that allows the modelling of the dynamic aspect in the different stages of enterprise architecture, and that meets with our architectural principals, our proposal assumes that ontologies can represent, extend, and enrich the dynamic aspect in the models of enterprise architectures in order to allow a dynamic and fluid reaction of the enterprise in front of a change. We propose to start from existing ontologies in terms of enterprise architecture and enrich them with new concepts relating to the dynamic aspect and the response to changes.

According to (Dongwoo et al.,2010) the enterprise architecture is made up of the components of the EA and the relationships between them. The figure below, Fig. 1, demonstrates this with a simplified model.

The Enterprise Architecture is modeled into three components: Strategy, Business, and Application.

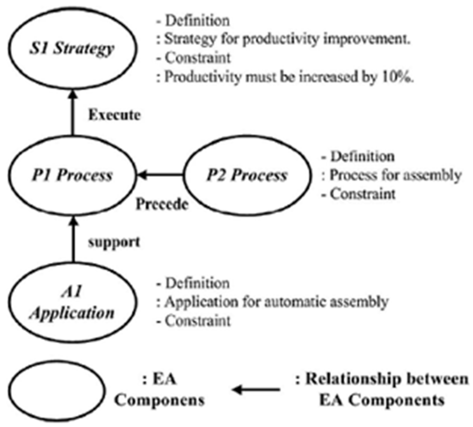

Figure 1: Simplified EA model (Dongwoo, 2010).

To represent the ontology of each components and their relations, we choose to use ArchiMEO in our study that is an ontological representation resulting from the transformation of ArchiMate concepts and relations. Archimate is an enterprise architecture framework, providing a modelling notation which intentionally resembles the UML notation (The Open Group, 2012). We add the ontological representation of three fundamental concepts to our approach: change, EA version and transformation plan.

The proposed approach presents the variation between micro versions of enterprise architecture, symbolized $\boldsymbol{\delta EA_j}$ reproducing the states at the strategy, business, and application levels to follow up on transient changes whose summation represents the transformation plan for taking charge of the change factor until the final state of $\boldsymbol{\delta EA_{Target}}$. is obtained.

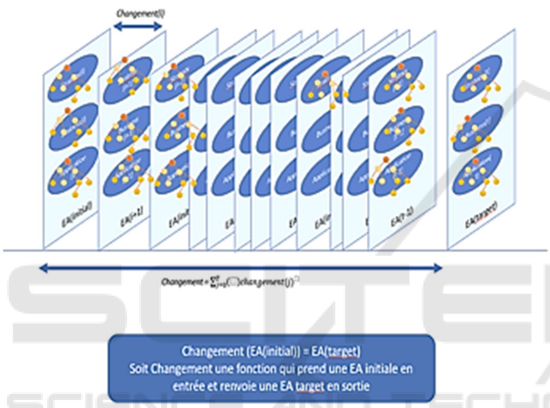

Figure 2: Evolution of EA versions after a change.

The interception of change is the entry point of our model (either by detection or prediction from information sources, social networks, government sources, which saves time in the study and decision-making before we are faced with a fait accompli…), it is the (new case) in our logic of CBR.

The second phase is the identification and categorization based on the case characterization, formalized by an ontological representation. So, according to the internal case base of the factors of change, and their association to the successions of EA versions to achieve the target EA, it is at this point that a process of reasoning by case begins to bring together via ontological techniques the similarities between the current case and the cases already recorded in the database to determine the part of the EA affected by this change, the target state desired by this change and identifying the EA intermediaries and the transformation plan to achieve it. The steps of the proposed approach are represented in the flowchart above (Fig.3).

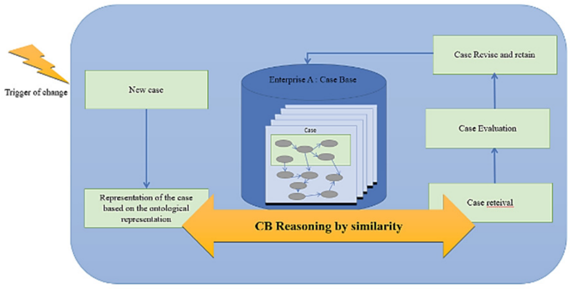

Figure 3: Steps proposed for the model.

7 CASE STUDY

To illustrate our proposed approach, we take the example of the dynamic behavior of a Moroccan enterprise “enterprise A” in the face of covid-19 variants and its impact on the mode of work: office working, remote working or hybrid mode.

In our case base, we consider that we have accumulated behavioral experiences since the apparition of the pandemic in December 2019, the reactions facing the delta variant, arriving today at the omicron variant. We can consider that for an instantiation of our model in a Moroccan context, the interception of the variant omicron was made via prediction, as long as on the news, the variant has already appeared in other countries, which gives more time to react. To describe the application of the proposed method on the case studied, we will do it by steps: In the beginning, the enterprise “A” has to represent the new case in accordance with the standardised representation based-ontology, taking into account: the characteristics of the trigger of the change: omicron variant in our case: such as (spreading rate, transmissibility, the tag given by the OMS, severity, risk factors for company staff,...). The variation on EA resulting from this change, is deconstructed to micro variations from δEA_i (with i= initial), δEA_{i+1}, δEA_{i+2}…until δEA_{target}, in each iteration, we emphasis a micro variation of one level: strategy, Business for example (alternatives for Business Processes not completely automatized…) application: (laptop availability, VPN configuration, …) the summation represents the transformation plan. The second step is to retrieve the most similar cases from the case base, which contains historical cases, based on the characterization of the current situation used as query, using a similarity mechanism. The next step is reusing the lesson from the retrieved cases as the suggested solution for the new situation; adapt the retrieved lesson to the new situation, which becomes part of a new case. And finally, revise the new case after evaluating it in the new situation, and enrich the case base with the new results.

8 CONCLUSIONS

In this paper, we explore the opportunity of using ontologies as an approach giving a dynamic push to enterprise architecture models. Coupled with case-based reasoning, to retrieve and maintain existing knowledge. A set of architectural principales was proposed as a requirement of the proposed model. Ontologies and Case based reasoning were combined with the Enterprise architecture to respond to our architectural principles, finally a use case is presented to illustrate our proposal.

As future work we plan to implement semi-automatic reuse (Adaptation OWL/Rule reasoning /inferencing and machine learning) and enhanced automatic retention (case learning and ontology learning, adding to elements to domain ontology, OWL/rule reasoning). Additionally, we plan to enhance this model with natural language-processing technology to overcome incomplete case descriptions and add a new change prediction component.

REFERENCES

Aamodt, A. & Plaza. E. 1994 Case-based reasoning: Foundational issues, methodological variations, and system approaches. AI Communications 7(1), 39–59.

Amailef, K., and J. Lu. (2013). Ontology-Supported Case-Based Reasoning Approach for Intelligent M-Government Emergency Response Services. Decision Support Systems 55 (1): 79–97. doi:10.1016/j.dss.2012.12.034

Antunes, G., Bakhshandeh, M., Mayer, R., Borbinha, J., Caetano, A. (2014) Using Ontologies for Enterprise Architecture Integration and Analysis,2014

Bertolazzi, P., C. Krusich, et M. Missikoff. 2001. An Approach to the Definition of a Core Enterprise Ontology: CEO. OES-SEO 2001, International Workshop on Open Enterprise Solutions: Systems, Experiences, and Organizations- pp.14-15.

Borst, W. (1997) Construction of Engineering Ontologies. PhD thesis, Institute for Telematica and Information Technology, University of Twente, Enschede, The Netherlands.

Buschle, M., Ullberg, J., Franke, U., Lagerstrom, R., Sommestad, T. (2010), "A tool for Enterprise Architecture analysis using the PRM formalism," in CAiSE Forum 2010, Hammamet, Tunisia, June 7-9, 2010, Selected Extended Papers, 2010, pp.108-121. Available: http://dx.doi.org/10.1007/978-3-642-17722-4_8

Delir Haghighi, P., F. Burstein, A. Zaslavsky, and P. Arbon. (2013). Development and Evaluation of Ontology for Intelligent Decision Support in Medical Emergency Management for Mass Gatherings. Decision Support Systems 54 (2): 1192–1204. doi:10.1016/j.dss.2012.11.013.

Díaz-Agudo, B., and P. A. González-Calero. 2000. "An Architecture for Knowledge Intensive CBR Systems." In Advances in Case-Based Reasoning. Vol. 1898 of Lecture Notes in Computer Science, edited by E. Blanzieri and L. Portinale, 37– 48. Berlin, Heidelberg: Springer.

Ding, J., Tang, T., Zhang, Y., & Chi, W. (2021): Using intelligent ontology technology to extract knowledge from successful project in IoT enterprise systems, Enterprise Information Systems, DOI: 10.1080/17517575.2021.1913240

Dongwoo, K., Jeongsoo, L., Sungchul, C., Kwangsoo, K., (2010), An ontology-based Enterprise Architecture, Expert Systems with Applications 37 (2010) 1456–1464

Doumi, K., Baina, S., Baina, K. (2011): Modeling Approach Using Goal Modeling and Enterprise Architecture for Buisiness IT Alignment.Model and Data Engineering, sept.2011, p 249- 261.

Dragan, G., Kaviani, N., Milan, M. (2009). Ontologies and software engineering. In Handbook on Ontologies, pages 593-615.Springer.

Ettahiri, I., Doumi, K., Zellou, A. (2021): Towards a dynamic model of Business IT Alignment using Enterprise architecture: a comparative study.ICSSD'2021, October 2021.

Fischer, R., Aier, S., Winter, R. (2007). "A federated approach to enterprise architecture model maintenance", In Enterprise Modeling and Information Systems Architectures, Vol. 2, Issue, 2, 2007, pp. 14 - 22.

Genesereth, M., R., Nilsson, N. J., (1987). Logical Foundations of Artificial Intelligence. Morgan Kaufmann, Los Altos, CA.

Greefhorst, D., Proper, E. (2011) Architecture Principles: The Cornerstones of Enterprise Architecture. Springer, Available: http://dx.doi.org/10.1007/978-3-642-20279-7

Gruber, T. R., (1993) "A translation approach to portable ontology specifications," Knowledge Acquisition, vol. 5, 1993, pp. 199-220. Available: http://dx.doi.org/10.1006/knac.1993.1008

Guarino, N., Oberle, D., Staab, S. (2009) "Handbook on Ontologies." In: Springer Berlin Heidelberg. Chap. What Is an Ontology? pp. 1–17, 2009.

Happel, H., Seedorf, S. (2006). Applications of ontologies in software engineering. In Proc. of Workshop on Sematic Web Enabled Software Engineering"(SWESE) on the ISWC, pages 5{9. Citeseer.

IDEAS, 2003. Ontology state of the art. Deliverable D1.1. Public reports. www.ideas-roadmap.net.

Jabloun, M., Sayeb, Y., Ben ghezala, H. (2013) Enterprise Ontology oriented comptence,2013

Kolodner, J. L. (1993). Case-Based Reasoning. San Mateo, CA: Morgan Kaufmann Publishers.
Lankhorst, M. (2006) "Enterprise architecture modeling - the issue of integration", in Advanced Engineering Informations, vol. 18, Issue 4, 2006, pp. 205-216.
Leake, D. B. (1996) CBR in context: The present and future. In Leake, D. B. (ed.) Case-Based Reasoning: Experiences, Lessons & Future Directions. MIT Press, pp. 3-30.
Lumor, T., Hirvonen, A., & Pulkkinen, M. (2021). The Role of Enterprise Architecture in Building and Sustaining Information Technology: Enabled Organizational Agility. In Proceedings of the 54th Hawaii International Conference on System Sciences (HICSS 2021) (pp. 6057-6066). University of Hawai'i at Manoa. Proceedings of the Annual Hawaii International Conference on System Sciences. https://doi.org/10.24251/HICSS.2021.732
Martin, A., Emmenegger, S., Hinkelmann, K., Thönssen, B. (2016) A viewpoint-based case-based reasoning approach utilising an enterprise architecture ontology for experience management Enterprise Information Systems, DOI: 10.1080/17517575.2016.1161239
Martin, R. A., Robertson, E. L., (2004) Springer, "Architectural Principles for Enterprise Frameworks: Guidance for Interoperability", In Proceedings on the International Conference on Enterprise Integration Modelling and Technology 2004 (ICEIMT 2004), Toronto, Canada, 2005, pp. 79-91. Available: http://dx.doi.org/10.1007/0-387-29766-9_7
Millet, P. (200). «Thèse Une étude de l'intégration organisationnelle et informationnelle Application aux systèmes d'informations de type ERP». L'institut national des sciences appliquées de Lyon. Laboratoire de recherche: LIESP, Laboratoire d'Informatique pour l'Entreprise et les Systèmes de Production.
Prothman, B. (2000) Meta data: Managing Needles in the proverbial haystacks. Potentials, IEEE 19, no. 1-pp.20-23.
Saat, J., Aier, S., Gleichauf, B.(2009): Assessing the Complexity of Dynamics in Enterprise Architecture Planning – Lessons from Chaos Theory .American conference on information systems.
Sene, A., B. Kamsu-Foguem, and P. Rumeau. (2015). Telemedicine Framework Using Case-Based Reasoning with Evidences. Computer Methods and Programs in Biomedicine 121 (1): 21–35. doi:10.1016/j.cmpb.2015.04.012.
Shen, Y., J. Colloc, A. Jacquet-Andrieu, and K. Lei. (2015). Emerging Medical Informatics with Case-Based Reasoning for Aiding Clinical Decision in Multi-Agent System. Journal of Biomedical Informatics 56: 307–317. doi:10.1016/j.jbi.2015.06.012.
Studer, R., Benjamins, R., Fensel, D., (1998) Knowledge engineering: Principles and methods. Data & Knowledge Engineering, 25(1‑2):161‑198, 1998.
Tham, K. D., M. S. Fox, et M. Gruninger. 1994. A cost ontology for enterprise modelling. Dans Enabling Technologies: Infrastructure for Collaborative Enterprises, 1994. Proceedings., Third Workshop on, 197- 210 http://ieeexplore.ieee.org/iel5/970/7827/00330502.pdf
Uschold, M., M. King, M., Moralee, S., Zorgios, Y. (1998) The Enterprise Ontology. The Knowledge Engineering Review 13, no. 01-pp.31-89.
Wang, Y., T. Hu, and S. Zhang. (2003). Ontology-Based Reconfigurable Case-Based Reasoning System for Knowledge Integration. In SMC'03 Conference Proceedings. 2003 IEEE International Conference on Systems, Man and Cybernetics. Conference Theme – System Security and Assurance (Cat. No.03CH37483), Vol. 5, 4878–4883. New York: IEEE. doi:10.1109/ICSMC.2003.1245755
Watson, I. (1999). "Case-Based Reasoning Is a Methodology Not a Technology." Knowledge-Based Systems 12 (5–6): 303–308. doi:10.1016/S0950-7051(99)00020-9.
W3C, OWL 2 Web Ontology Language Structural Specification and Functional-Style Syntax (Second Edition). World Wide Web Consortium Recommendation, 2012. Retrieved
Zivkovic, S., Kühn, H., Karagiannis, D. (2007) "Facilitate modeling using method integration: An approach using mapping and integration", In Proceedings of the 15th European Conference in Information Systems, St. Gallen, Switzerland.