Challenges and questions for enterprise modelling supporting DPP

F.-W. Jaekel [1], P. Gering [1]

[1] *Fraunhofer Institute for Production Systems and Design Technology (IPK), Pascalstr. 8-9, 10587 Berlin, GERMANY*

Abstract

How can enterprise modelling provide valuable support for the Digital Product Passport (DPP)? The DPP requires data from various sources and organisations. It defines a framework of regulations, IT architectures, data provision and associated ontologies. Enterprise modelling (EM) can serve as a tool to organise the various aspects into a common and integrated architecture. It supports the transparency of the associated implementation in terms of workflows and data infrastructure. Orchestrating actors, services and channels with the organisation's workflows could provide a faster and easier path to DPP compliance. One goal may be to certify and audit compliance with DPP regulations, as is already the case for ISO9001 and others. However, the effort required for modelling must be considered. Therefore, additional services are needed to reduce this effort, e.g. with automated data collection and data mining approaches. In addition, EM can serve as a design tool for DPP services by supporting organisations linked by reference models and templates and by ensuring compliance by orchestrating data, processes and responsibilities in accordance with DPP regulations. The goal of this paper is to motivate the validation of the needs, benefits and role of enterprise modelling in the context of DPP.

Keywords

Enterprise model, product passport, data and service network

1. Introduction

Enterprise modelling [1][2] has a long history in delivering transparency, supporting the implementation of regulations and creating finally confidence in the work of suppliers [3]. It also proves to be a valuable tool for successful implementation of IT systems and supporting the digitalization approached in Industry [4]. Enterprise modelling supports implementations from business process level to the execution [5]. It can deal as common data synchronization source for enterprise applications by its information model [6]. The cross organizational process approach (CBP) [7] provides a method to model processes and interfaces across different business partners. The ability for the orchestration and configuration of services is already discussed within "Model based Configuration of Platforms for Managing Cross-Organizational (Business) Processes" [10].

Concerning enterprise modelling the paper considered especially the integrated enterprise modelling in its implementation within MO²GO [8][9] as well as the definitions of constructs in the ISO 19440- 2020. However, other enterprise modelling methods and tools would fit in a similar way like for example ARIS [13] [14], GRAI [15], ADONIS [16], CIMOSA [17] following the principles defined in ISO 19440-2020. Enterprise modelling should not be reduced just to process diagrams or business process modelling at least it should provide in addition also a corresponding information modelling approach covering different and extendable views [1]. It should have an extensible meta-model that enables a comprehensive information model behind processes, business objectives, responsibilities,
performance indicators, etc. It is not restricted to one enterprise or specific type of enterprise. Enterprise modelling can be used across domains and organizations e.g. finance, government, production, service provision even hospitals and government services.

With regard to Digital Product Passport (DPP), the paper addresses the heterogeneity of the

12th International Conference on Interoperability for Enterprise Systems and Applications (I-ESA24), April 10th-12th, 2024, Chania, Crete, Greece
EMAIL : Frank-Walter.Jaekel@ipk.fraunhofer.de (F. Jaekel) ; patrick.gering@ipk.fraunhofer.de (P. Gering)
ORCID: 0009-0003-1247-0018 (P. Gering)

approaches and, in particular, the cross-dataspace and cross-domain perspective for various products. However, it also expresses open points in the management of such models. For example, CBPs provide an approach of data provision from “private view” to “public view” but the technical realization in terms of data exchange and management of different data sources and different data provisions are not deeply considered.

2. Discussion of challenges

Enterprise modelling supports already proved approaches to support the design, implementation and certification processes requested by DPP. The challenges are in the complexity, heterogeneity and amount of data across products, supply chains, infrastructures, regulations and cultures.

For the discussion we will focus on the different products and related data management in the enterprise model. We can have easily products within other products such as a battery within an electric motor with different product passports. Here we process sets which might be delivered together with products. This goes beyond cross-organisational process appraoch, as the process itself is part of the delivery. These can be embedded services that, for example, monitor the use of the battery and motor, but also manipulate their use to ensure their health. This puts in place sensors, routers, stable internet connection or offline capabilities. The product might have a process already combining the process for the battery together with the process of the motor to simplify the monitoring. With the introduction of repair, reuse and upcycling the passport will dynamically change in its bill of material. Also, subparts from one product might move to another product e.g. in terms of reuse and repair.

In a factory the number of processes of each production facility and its inherency with the product can create further complexity. Management of complexity is one feature of enterprise modelling but still a multi-dimensional enterprise model interlinking different sub models in terms of process diagrams and information models might become very complex them self. The associated business process management can also be overloaded with increasing numbers of processes and related sub targets.

CBP provides useful principles like the connection of different process modelling methods and tools by connectors on the public level but did not consider the technical realization to manage such complexity. Of course, such model can be created across data spaces, infrastructures, product domains and related processes. These can be interlinked and organised within an enterprise model and its information model. The questions about consistency, validity and manageability of the model as well as usability keeps persistent. Currently the DPP is still arising. Therefore, some questions might be not discovered and appears with the need of transparency and automatic interconnection and synchronization of processes as well as related certifications in the future.

3. Model creation and support of data access

A general challenge for the enterprise modelling not only for DPP is the effort required to create, extend and maintain the model as well as feed it with data to allow further benefits of its usage. From the previous discussion the automatic interconnection and synchronization of models linked to other models seems mandatory and is still not generally used even it has been considered already 20 years ago in the synchronisation and management of different distributed enterprise models (SDDEM) [20] [21].

However, a major obstacle is the effort required for enterprise modelling and the maintenance needed to keep the model alive. Fortunately, the benefits of enterprise modelling have been proven in the specific case of ISO 9001-2015 certification in the industry. In general, it is essential to reduce the effort required to create and maintain a business model. This might be the semi-automatic modelling, automation of data recording or the automatic comparing to related real-world data.

4 years ago, we worked on the creation of enterprise models using voice processing. The major barrier at that time was the fast and accurate interpretation of the human voice using open-source artificial intelligence (AI) technologies [11]. In parallel process mining technologies are analysed to create enterprise models. In fact, to create just process diagrams from process mining is state of the art [12] but the interrelation with different data assets such as organizations, machines, responsibilities, key performance indicators (KPI), manual work flows etc. are difficult to extract from

the mining ddata providede.g. by IT log files.

A current work emphasizes the enrichment of enterprise models by data collection via a scraping approach (Figure 1). Data sources such as web pages are identified, analysed and relevant data are further processed via a language processing (spaCy [18]) to extract data for the enterprise model. A case is the data of supply chain partners and their products. The product description could be more standardised using the upcoming DPP data in the future specially to check availability of supplier to avoid the risk of missing material or intermediate products. This can also lead to further functions like alerts in terms of detecting deviations within the supply chain and semi-automatic restructuring the supply chain identifying suppliers with similar DPP product data. This could work on a bill of material of DPPs forming a final product and the related process description along the supply chain by an enterprise model integrate responsibilities, regulations, data demands, locations etc.

Currently the scraping of data in Figure 1 is configured using ontologies that can be loaded in the information model of the enterprise model as required. Therefore, in the future related DPP ontologies can be used. Application cases of the use of recorded data are matching of partners, KPI analysis, certification approaches and risk analysis.

The information can be used from public and private information sources such as Webpages, company portals, in the future also available DPP information. In terms of private information trust concepts are required. An example could be the trust cycles scratched in “Decentralized, Autonomous Setup and Access to Data of Independent Partners in a Hyper Connected Ecosystem” [6] [19]. This creates different trust levels for specific supply chains related to the product life cycle and partner involvement. This requires the management of access rights to private data, but these concepts are general and not specific for the enterprise model. However, if such privileges stored in the enterprise model the security has to be able to follow related company regulations. Usually, the data security and protection and especially these privileges should be handled outside the enterprise model data and might be a specific server. The paper assumes that such a service is available for secure access to partner data.

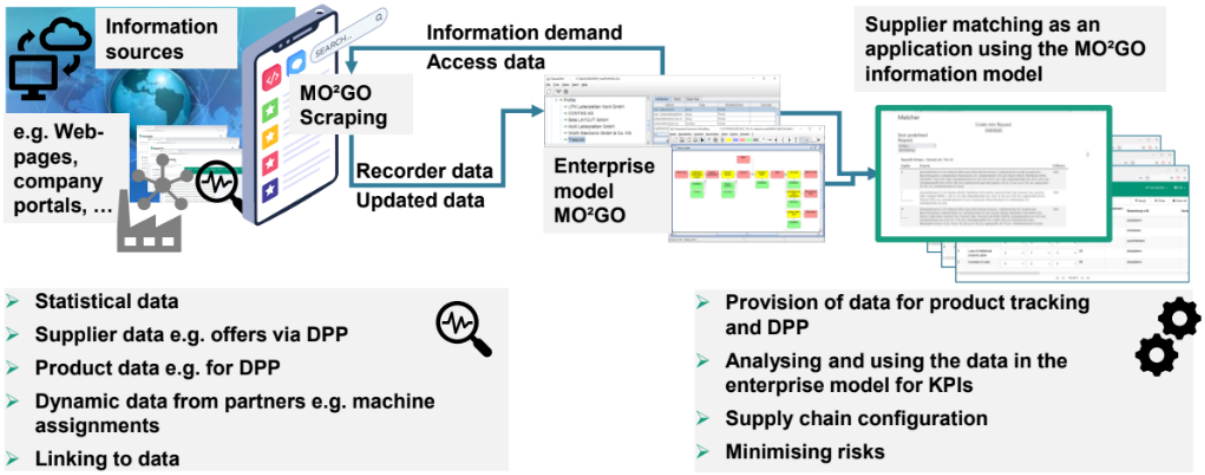

Figure 1: Sample for the use of AI based scraping service for the enterprise model

A next step could be the combination of mining, scraping and language processing to speed up the modelling process, but also to reduce the modelling effort. In the last two years, the available AI solutions have matured, in particular better and more powerful language models are available. This leads to initial work on the automatic process design. For example, you can ask ChatGPT [22] to create a process. However, this is only an artificial process that may not reflect the actual process of the it can be justified if the process is used and the KPIs become worse.

organisation. There is also the question of the effectiveness of this workflow, and the question of how

Another way could be to use enterprise models to train the AI. This could help to control and manage the complexity within the enterprise model. On the other hand, AI technology can be used to consider not only texts for enterprise model data but also figures and films. Even direct human interaction that expresses certain aspects in the model is conceivable. One example is AI for processing images on smartphones, which simply select certain features by labelling them.

The question arises, if we have all these nice features, why do we still need enterprise models, but

in the end, we need an asset that correlates all this information in a manageable information model. The enterprise models already have the required structures and relationships as well as the enterprise architecture in terms of organisation, processes, orders, machines and other dimensions.

4. Conclusion and questions for the workshop

The target of the paper is the motivation of a discussion of the usage of enterprise models for DPP and ahead in terms of the implementation and usage of DPP in industry. It scratches some already known capabilities of enterprise models also useful for DPP but starts discussing open points of enterprise modelling which might be essential for DPP and gives an idea to improve the management of complex enterprise models by artefactual intelligence.

Starting with the identification of data sources and enrich the model with such data. Examples are statistical data or data about production facilities using for partner search [6]. Voice recognition and generative AI might also allow to build enterprise models e.g. in terms of a data source for other services and discussion base for decision making. A potential effect might be the automatic monitoring of the model and an alert function in case of mismatches or inconsistency related to knowledge of the AI service. Related to the DPP it could help to integrate new processes coming with new production facilities into a factory by identifying mismatches and connection points with the already existing factory infrastructure. Nevertheless, an essential benefit of the enterprise model will be an acceleration and repeatability of audits and certifications related to DPP and linked regulations in the product life cycle.

But what if we don't use enterprise modelling for this topic, what can we use instead, is there a better solution?

Declaration on Generative AI

The author(s) have not employed any Generative AI tools.

References

[1] F. Vernadat. Enterprise modelling: Research review and outlook. IN: Computers in Industry Volume 122, November 2020, 103265.

[2] ISO19440-2020 Enterprise modelling and architecture - Constructs for enterprise modelling. International Standard published 2020-05.

[3] K. Mertins, M. Schwermer, F.-W. Jäkel. Confidence in a Network of Cooperating Companies -- QM-Documentation for Certification. Springer Nature, Jan 1, 1997.

[4] A. Bajric, K. Mertins, M. Rabe, F.-W. Jaekel. A Success Story: Manufacturing Execution System Implementation. In: Popplewell, K., Harding, J., Poler, R., Chalmeta, R. (eds) Enterprise Interoperability IV. Springer, London. https://doi.org/10.1007/978-1-84996-257-5_33.

[5] F.-W. Jaekel, J. Torka, M. Eppelein, W. Schliephack, T. Knothe. Model Based, Modular Configuration of Cyber Physical Systems for the Information Management on Shopfloor. In: Debruyne, C., et al. On the Move to Meaningful Internet Systems. OTM 2017 Workshops. OTM 2017. Lecture Notes in Computer Science, vol 10697. Springer, Cham. https://doi.org/10.1007/978-3-319-73805-5_2.

[6] F.-W. Jaekel, E. Eyser, R. Schwengber-Walter, R. Harms, K. Grunert. Decentralized, Autonomous Setup and Access to Data of Independent Partners in a Hyper Connected Ecosystem. In: Terzi, S., Madani, K., Gusikhin, O., Panetto, H. (eds) Innovative Intelligent Industrial Production and Logistics. IN4PL 2023. Communications in Computer and Information Science, vol 1886. Springer, Cham. https://doi.org/10.1007/978-3-031-49339-3_23.

[7] U. Greiner, S. Lippe, T. Kahl, J. Ziemann, F.-W. Jäkel. Designing and Implementing Cross Organizational Business Processes - Description and Application of a Modelling Framework. I ESA 2006: 137-147

[8] K. Mertins, R. Jochem. Quality-Oriented Design of Business Processes. Kluwetr Academic Publishers 1999.

[9] Fraunhofer IPK. www.moogo.de. 19.02.2024.

[10] T. Knothe, P. Gering, I. Glodde, U. Ahle, J. Böttger, N. Döberitz. Model based Configuration of Platforms for Managing Cross- Organizational (Business) Processes. I-ESA Workshops 2022 https://ceur-ws.org/Vol-3214/WS2Paper2.pdf
[11] A. Poletai. Entwicklung eines Sprachassistenten für das Modelldesign zur Unternehmensmodellierung. Bachelorarbeit TU Berlin, Fachbereich 4: Informatik und Wirtschaft, Berlin, 21.07.2020.
[12] W.M.P. van der Aalst. Process Mining: Data Science in Action. Springer-Verlag, Berlin, 2016.
[13] August-Wilhelm Scheer, Wolfram Jost: *Aris in der Praxis*, Verlag Springer DE, 2002, [14] ARIS Enterprise. Software AG: https://www.softwareag.com/en_corporate/platform/aris/process management.html. Last access 19.03.2024.
[15] Girard, Philippe, and Guy Doumeingts. "GRAI-Engineering: a method to model, design and run engineering design departments." International Journal of Computer Integrated Manufacturing 17.8 (2004): 716-732.
[16] ADONIS. BOC Group: https://www.boc-group.com/en/adonis/. Last access 19.03.2024. [17] K. Kosanke, F. Vernadat: CIMOSA – a Reference Architecure for CIM, (1992). https://www.sciencedirect.com/science/article/abs/pii/B9780444894656500090 [18] SpaCy, https://spacy.io/usage/spacy-101- last access 19.03.2024.
[19] Jäkel, F.-W., Gering, P., Knothe, T.: Hyperconnected Ecosystems für industrielle Netzwerke. Zeitschrift für wirtschaftlichen Fabrikbetrieb 116(12), 872–876 (2021). https://doi.org/10.1515/zwf-2021-0212
[20] Campos C., A. Candlot, M. Dassisti, F.W. Jaekel, N. Perry, J. Ziemann (2005), TG1 InterOp Delivrable: Report on Generic Approaches and SDDEM Life Cycle Model / TG Synchronisation of models for interoperability.
[21] Jaekel, F.W., Perry, N., Campos, C., Mertins, K., Chalmeta, R. (2005). Interoperability Supported by Enterprise Modelling. In: Meersman, R., Tari, Z., Herrero, P. (eds) On the Move to Meaningful Internet Systems 2005: OTM 2005 Workshops. OTM 2005. Lecture Notes in Computer Science, vol 3762. Springer, Berlin, Heidelberg. https://doi.org/10.1007/11575863_74
[22] ChatGPT. openai.com. Last access 19.03.2024.