Integrated Enterprise modelling to achieve interoperability

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Abstract

The paper targets the use of an integrated enterprise modelling approach to analyse and overcome the gab of understanding of interoperability challenges across and between enterprises. It discusses the use of enterprise modelling to support the decision about new technologies identifying benefits in relation to the investment. This includes the potentials of the enterprise models to derive directly enterprise application services such as integrated management support or shop floor IT execution management. The goal is a review of these approaches in the discussion within the workshop "A Future Vision of Flexible Configurable Manufacturing in a Digitised World".

Keywords 1

Enterprise modelling, interoperability challenges, new technologies

1. Introduction

The injection of new technologies into the administrative and industrial workflows become a big challenge for industrial companies. Companies need to decide on time, cost, and market opportunities taken into account expectations about benefits of new technologies. This can differ between application areas, workflows and company cultures. Therefore, methods are required to provide clearer directions regarding the effects of new technologies in terms of benefits, challenges and drawbacks. A specific challenge is the interoperability of cyber physical systems (CPS), internet of things (IoT) and enterprise applications. This includes decisions about the right selections in a large bench of technologies and standards. The challenge increases with the rise of artificial intelligence (AI) and specifically the interoperability concerning semantics and pattern recognition.

Industry uses already enterprise modelling to identify requirements for IT system implementation, to ensure process quality, document and manage risks, and to optimise the organisation as well as to understand effects of enterprise networking, outsourcing and joint ventures [1]. Enterprise models are the source for transparency of enterprise structure [2], its management [3] and execution [4]. In terms of interoperability, it allows to identify pattern, artefacts, and the clarification of interoperability demands within processes, organisations, infrastructures and IT systems. This provides a prerequisite to improve processes and system concerning their interoperability.

Samples are available from industry related to an integrated business process management like ISO9001 for quality and ISO 14001 for environmental, the implementation of IT systems, lean factory methods and integration of machinery into an IoT infrastructure. Different stakeholders useably address such topics separately. Each of these stakeholders has their own methods and notations. This creates challenges in the reuse of models as well as in a cross-domain analysis of interfaces for interoperability. Therefore, a common information base between stakeholders is necessary.

The paper will provide examples of the use of an integrated modelling to incorporate the different stakeholder views and application areas into one modelling approach.

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2. Demand of enterprise interoperability

Digital transformation, artificial intelligence, autonomous manufacturing, digital twins require horizontal and vertical enterprise interoperability in technical and semantic sense. This implies interoperability on business, organisational, legal, culture, application, data and IT infrastructure. The Institute of Electrical and Electronics Engineers (IEEE), the European Telecommunications Standards Institute (ETSI) and Interop-VLAB provide related definitions such as „The ability of two or more systems or components to exchange data and use the exchanged information“ [5].

Challenges for industry are

- Many interfaces,
- Different data structures with similar meanings,
- Overlapping of data and functions in enterprise applications,
- Different realizations of digital machine interfaces in terms of protocols and architectures.

Many approaches try to deal with the challenges. Standardisation approaches and reference architectures arises in ISO, ETSI, VDMA/DIN, OPC foundation such as OPC-UA, oneM2M, industrial IoT (IIoT), reference architecture model Industrie 4.0 (RAMI4.0), etc.. This creates an additional challenge because industry needs to decide which approach is the most appropriate and sustainable way to follow. The risks are high investment and loss of market shares. If the decision is wrong. Moreover, risks arises concerning networks of IoT components connected to the production in terms of security and robustness. This can trigger for example unexpected data transfer, automatic legally binding transactions, losing data ownership and IT product defects blocking manufacturing.

An initial step to manage the risks is to identify it with its effects to the enterprise structures and processes. The integrated enterprise modelling supports the extension of the modelling constructs and metadata to represent this information in an integrated enterprise model. It also provides applications for the management of risks.

3. Usage of integrated enterprise modelling

Industry uses the MO²GO system (www.moogo.de) applying integrated enterprise modelling (IEM) [2] since decades. During the usage of the IEM it has been continually adapted to application demands and can be called today extended IEM (eIEM). The foundation is an object-oriented approach that allows a metamodel extension via subclasses, attributes and part-of relations. This is part of the current method in MO²GO. The adaptation of the class structure is done simultaneously during the enterprise modelling process. New concepts are added to the class structure together with their graphical representations to be used immediately within the process diagramming. Users can simply create classes and attributes within the class structure. Users can move classes across the class structure in terms of restructuring and providing new viewpoints in the model. MO²GO provides subtyping of processes, resources, orders, products and logical connectors.

This allows focusing on specific stakeholder interests without losing the connection to the whole enterprise structure. Therefore, different stakeholders can easily discuss and use the model.

An important element of the method regarding interoperability is the definition of process interfaces as well as the focus on process thinking. This brings the process and its interface in the focus of enterprise process design and analysis. Figure 1 provides an example of system orientation on the left side and process orientation in IEM on the right side. The elements “customer order” and “create schedule” illustrate the interfaces. The element “create schedule” stands for the activity or process. The IEM resource on the right sight illustrates the IT system and the organisational unit. This is an extension of the meta-model, which is visual via the small icons in the elements.

In the work with companies, an early finding is still the absence of so-called “process thinking”. The answer to the question “how you do a process” is quite often, “who does the process” or “what does the process”. Figure 1 illustrates it on the left side. Question: How you do the scheduling? Answer: The production unit with excel. It is difficult to model operative interfaces if the processes are not clear

or behind functional or system views. The identification of process interfaces requires the understanding of the processes given by a transparent representation.

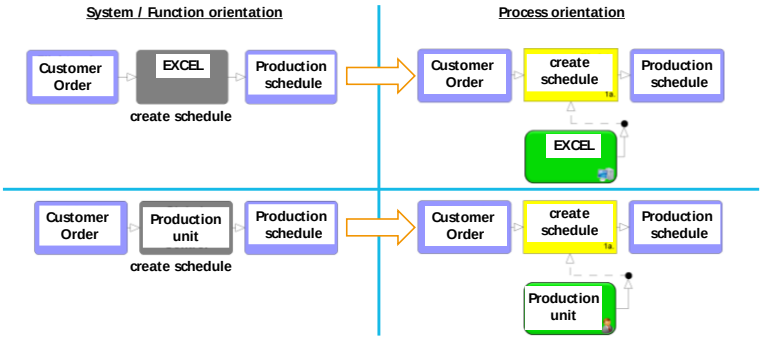

Figure 1: Process thinking and interfaces

The scope and level of detail of the interface description depend on the targets of the model. An example from the shop floor illustrates detailed interfaces to control a production step using a robot (Figure 2). In IEM any detail can be managed from high-level business strategy to detailed IT or machinery processes.

Current industry projects with multiple sub projects require integrating the different views and interfaces into one integrated enterprise model. An example is the simultaneous implementation of subprojects like the implementation of new enterprise applications such as supply chain management and manufacturing execution systems together with finding solutions to improve manufacturing processes and at the same time implement a new advanced production system.

An integrated enterprise model ensures a synchronised work in terms of interfaces and interoperability. The model helps to locate methods, risks, targets, key performance indicators, enterprise applications and interfaces within the process and organisational structure of the enterprise. It also helps to receive a better imagination of the return off invest of changes and use of new technologies. In addition, the configuration of applications are derived from the enterprise model such as for management systems or the execution of the shop floor [4].

Figure 2: Example of detail interfaces from shop floor

4. Demands of enterprise modelling related to effort

The use of enterprise modelling has benefits in terms of achieving interoperability. However, it requires time and investments in terms of training and its application. Therefore, the targets of the enterprise modelling needs to be clearly defined and should be measurable.

Methods such as mining technologies for enterprise modelling, smart user interfaces and artificial intelligence technologies should provide a faster and less resource consuming way of modelling. The generation and monitoring of enterprise models should be in the background of the enterprise workflows. This is already done by process mining but specifically for processes available in IT systems

like enterprise resource management (ERP) and manufacturing execution systems (MES). The related monitoring supports the check between the modelled process and the real process.

A future approach is an AI based tracking of the real processes from different sources and to derive specific pattern to visualise and monitor the processes. This requires an interface as a communication base between the AI and the humans.

An interim step is the creation of the enterprise model from free text, gesture and voice. The target is the simplification and fasten of the modelling process. It will need pattern to find in unstructured text model pattern and to create the right content in the model.

5. Future work and conclusion

The paper provides spots of usage and future of enterprise modelling and its support for interoperability for the discussion within the workshop "A Future Vision of Flexible Configurable Manufacturing in a Digitised World". An initial set of questions related to interoperability and to be discussed related to the use of enterprise modelling are the following:

- What is the role of interoperability in the scope of the use of artificial intelligence risks and benefits?
- How a company infrastructure should look like taken into account standards and quasi standard?
- Which requirements in value and supply networks using cloud infrastructures arises concerning interoperability?

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