IOP Conference Series: Materials Science and Engineering

Using ontological and architectural approaches for the vehicle fleet management in the enterprise engineering context

IOP Conf. Series: Materials Science and Engineering **760** (2020) 012016 doi:10.1088/1757-899X/760/1/012016

Using ontological and architectural approaches for the vehicle fleet management in the enterprise engineering context

V M Kurganov[1], M V Gryaznov[2], A N Dorofeev[3], O B Nastasyak[4], D V Pervukhin[5]

[1] Tver State University, 33, Zhelyabova st., Tver, 170100, Russia
[2] Nosov Magnitogorsk State Technical University, 38, Lenin St, Magnitogorsk, 455000, Russia
[3] Financial University under the Government of the Russian Federation, 29, Leningradskiy Ave., Moscow, 125167, Russia, National Research University Higher School of Economics, 33, Kirpichnaya St. Moscow, 105187, Russia
[4] Gazpromavia Aviation Company Ltd, 71/32, Novocheremushkinskaya str., Moscow, 117420, Russia
[5] National Research University Higher School of Economics, 33, Kirpichnaya St. Moscow, 105187, Russia, Financial University under the Government of the Russian Federation, 29, Leningradskiy Ave., Moscow, 125167, Russia

E-mail: adorofeev@hse.ru

Abstract. The transport activities at a large industrial enterprise are usually an auxiliary process. Therefore, its optimization with information technologies is often neglected. As a result, the cost accounting for the transportation of goods for various purposes is often a weighty problem due to inconsistent information flows. The method considered in this article combines the ontological and architectural approaches for the enterprise activities modeling intended to equalize occasionally a somewhat significant gap between business expectations and TMS functionality.

1. Introduction

The practical experience of implementing various information systems shows that this process is often accompanied by considerable difficulties, since IT specialists and business users have knowledge in different areas. This problem has been repeatedly described in literary sources [1, 2, 3, 4] and is particularly typical of specific activities, such as motor road cargo transportation. It is believed that the most complete return on investment into the information system is achieved when business and IT are initially synchronized at the strategic level for implementation of the enterprise mission. For this purpose, various models allowing improving interaction between business and IT in practice have been created in recent years. For example, Strategic Alignment Model (SAM), Model Driven Architecture (MDA), Business and Information Systems MisAlignment Model (BISMAM), etc. acquire currency [5]. However, Transportation Management System (TMS) remains at the periphery of all IT problems in a rapidly changing external environment of vehicle management at industrial enterprises, where cargo transportation is an auxiliary business process solving the issues associated with the flexible adaptation. In this regard, TMS usually solves a narrow range of operational tasks related to the maintenance of mandatory daily document flow without affecting the scope of strategic decision-making, thereby not creating any new value for the business.

Indeed, the automation of industrial enterprises primarily solves the issues of classic MRP/ERP systems related to the planning of production, finance, inventory management and human capital. The tasks of supply chain management are considered primarily in terms of optimizing the cargo transfer, reducing costs and time of transportation. The informational support for the direct operation of vehicles at its best consists of the implementation of GPS/GLONASS monitoring of vehicles and fuel consumption. This, in many cases, limits data collection on the participation of vehicles in the general production processes of a large enterprise. Certainly, fuel consumption by various estimations amounts to 50% of the total cost of vehicle operation. However, expenses on spare parts and vehicles repair should also be considered to ensure trouble-free operation in cargo transportation [6, 7]. It is obvious that a sudden failure of equipment due to low-quality or untimely repair may lead to unplanned failures in the work of the whole enterprise. Thus, the vehicle fleet that often enjoys the least attention during digitization becomes one of the key elements of ensuring sustainable operation of the whole facility [8, 9].

2. Vehicle fleet management as a multidisciplinary system of knowledge and practice

At the same time, the specifics of vehicle fleet digitalization requires profound knowledge in the area of motor vehicles operation from any IT specialist. On the other hand, we could also expect profound knowledge in the information technologies from a transport manager who would be able to create a perfect model of future TMS, or, at least, describe detailed requirements to it. However, as a rule, such questions cause insuperable difficulties in most cases, since transport workers are very poorly aware of the implementation of their business processes in the information system. Thus, the collection of requirements to TMS in practice comes to this: the IT specialist is having hard time perceiving the ideas and proposals of the transport worker, while the transport worker, in turn, sincerely wonders how one doesn't understand things he/she considers to be so simple. The study of paper documents flow does not help a lot in the research of information flows related to the operation of vehicles, as managers of transport departments at different enterprises use different sets of indicators and facts necessary to solve management problems. Thus, it is quite difficult to establish a "reference" model of the document flow. This process is further complicated by the fact that many managers come up with different forms of documents in Excel, which also significantly complicates document formalization process and, subsequently, the information exchange [10].

It should be noted that modern approaches to modeling the activity of the enterprise try to consider its sociocultural and organizational features, where a significant share of overall efficiency may depend on behavior of each individual employee and their personal qualities. For example, vehicle fuel consumption essentially depends on the skills of driver in the transportation process. Accordingly, when modeling the activities of the transport department, you should define the main business actors and factors that motivate them to achieve their business goals, the things they operate and the types of relations between them [11, 12]. It should be noted that the interaction between specialists of different departments, for example, the logistics, marketing or accounting department, often ends up in a mutual misunderstanding, as these specialists use different conceptual apparatus. For example, when considering repairs, the transport manager conceives the structure of the entire vehicle as a whole and conceives a nature of interaction of systems, components and assemblies of the vehicle, their influence on its operation. For an accountant, the main indicator is usually the cost of the part, not its lifetime. Thus, when making decisions on the purchase of spare parts, a transport worker will reason the need to acquire quality parts, though at a higher cost. And the accountant will reason the need to purchase cheaper spare parts. Accordingly, the accountant needs an understandable and accessible model which, on the one hand, would not go too deep into the theory of vehicle operation, and on the other hand, would reflect the essence of impact of part cost on the extent of their wear and, therefore, on their fault tolerance.

Thus, the example shows at least two points of view on the TMS implementation — transport and financial (economic). In practice, they have to constantly face such multidisciplinary tasks when introducing an information system for vehicle fleet management at various enterprises. We propose to use a combination of ontological and architectural approaches to model the activities of a transport company. This combination is growing more and more popular among IT specialists as related to the Enterprise Engineering concept, where an organization is also considered as a social system. In this regard, improvement of management efficiency can be achieved, inter alia, by improving interaction between employees. It is TMS that should support the improvement of this interaction. In the context of considered example, you can also add a driver who directly operates this vehicle and may notice a malfunction. However, he can either report it or not report; so, as a result, the vehicle may be laid up for repairs. Consequently, the driver may be out of work for some time. Although, it is obvious that this malfunction can turn into a failure during the operation of the vehicle, which may result in serious consequences.

So, in this example, we see that three different employees, the accountant, the manager of transport department and the driver should agree among themselves and exchange agreements on the possibility of further operation of this vehicle. The accountant should understand that transportation of cargo on this vehicle is possible, but it is necessary to invest in spare parts and repair to prevent failure. The transporter determines the criticality of fault according to the driver's story and diagnostics results. The driver should carefully operate the vehicle and report the malfunction in time. From the point of view of Enterprise Engineering, the decision based on agreements is made at the ontological level.

It should be noted that different organization of business processes and vehicles repair in each particular enterprise affects the document flow and, accordingly, information flows. The repairs can be carried out both by the enterprise's own resources and at third-party vehicle service facilities. In the case of using enterprise's own resources, a diagnostic procedure should be preliminarily performed, then a decision is made on the possible further operation of the vehicle. Then the necessary spare parts are purchased and subsequent repair is performed. However, the organizational structure can significantly differ in the different companies, inter alia, it may be geographically separated. This, respectively, will have a significant impact on the document flow and accounting of these cost items as a whole. Thus, it is necessary to determine all documents, their form and content, which will ensure the exchange of agreements between all interested business actors at the infological level [13]. And actually, the design of the entire TMS as a whole takes place at the data level. Thus, first of all, the organizational structure of the company, business processes, actions of specific performers and their motivation should all be linked in order to effectively use TMS.

3. The study of the structure of the modified lead-tin-base bronze the combination of ontology and architecture of the enterprise to model its activities

Obviously, any transport activities in the enterprise associated with the movement of cargoes, except for internal industrial logistics, are also subject to the regulatory framework regulating it from the point of view of legislation. Thus, decision-making depends on their compliance with the law at the ontological level. At the infological level, the documents must comply with all legal requirements, if any. Accordingly, in addition to economic and technical concepts, it is also necessary to consider the legal concepts and the nature of legal norms influence on the transportation process. So, we see that the semantics of interaction among different entities when performing cargo transportation is described by ontologies of various fields of knowledge.

At present, the lack of a single ontology is a significant problem for the motor transport industry. There have been several attempts to describe separate fragments of the transportation activities. These include the ontology of urban logistics, the ontology of road safety and some others. We have presented the ontology of the business model of a transport company using A. Osterwalder's framework, where the reliability of the transportation process is presented as a value proposition [14]. Thus, the first step to the integration of economic and transport domains was made in this work. In the course of transport ontology development, the main emphasis was made on the improvement of its segments associated with the costs, which also actually affects the reliability of transportation process.

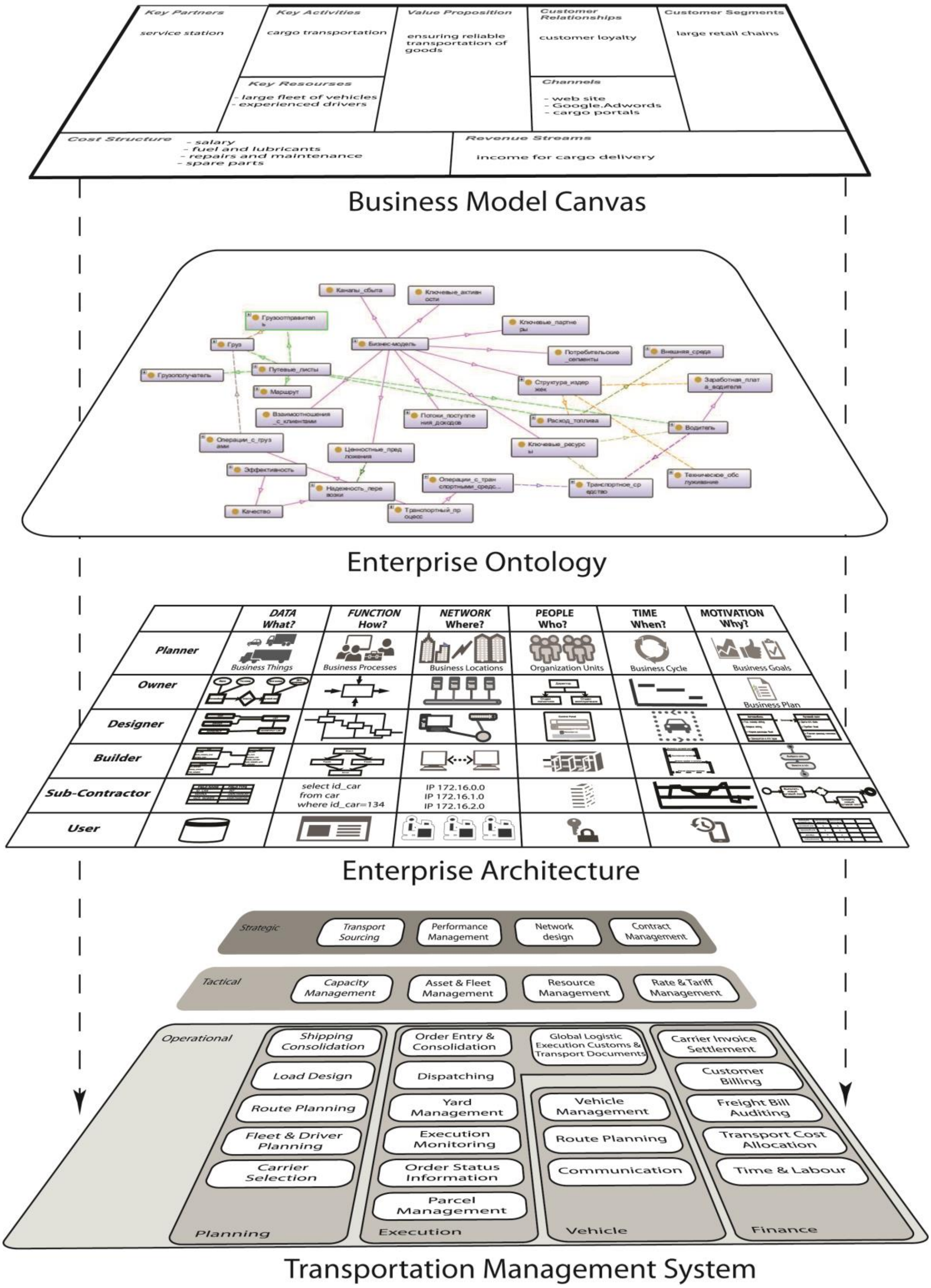

Figure 1. The combination of ontological and architectural approaches in the design of TMS

In this case, as you know, the cost segment is also included in the outline of A. Osterwalder's business model. As a result, an ontology describing the entities influencing fuel consumption, as well as the ontology describing the technical operation of vehicles, including repairs and maintenance, was developed. Thus, with the help of ontologies, we have described the "inner world" of the transport enterprise, the entities involved in the transportation process, the nature of their interaction with each other, as well as the business actors and the nature of their behavior to achieve business goals, and what the enterprise should do to make money [15, 16].

The enterprise architecture concept is designed to answer the questions "Who?", "How?", "When?", "Where?" and "Why?" performs these or those operations for the solution of business tasks [17]. The Enterprise Architecture consists of several layers:

- Business architecture reflecting business activities, business processes that create value for the consumer;
- Application architecture describing the information landscape, i.e. IT services, information systems and information flows;
- Technological architecture that provides integration of business processes, data and applications;
- Infrastructure Architecture which directly reflects the software and hardware configuration;

The work [18] proposes to use the Ontological model as a prototype for Business Architecture. This approach assumes the transfer of semantically related entities of the transport enterprise ontology, including vehicles, documents, drivers, mechanics, etc. into corresponding business objects, business roles that perform certain business processes in a certain location to achieve specific business goals. The development of this approach in relation to transport activities enables to use objects and concepts from different fields of knowledge in the modeling (vehicle management, logistics, human capital management, legislation, economics) by semantically linking them to form the concept of how the enterprise can make money in the best way (Fig.1). By defining the totality of these entities and the nature of their interaction and influence, you can put together the Business Architecture by formalizing business processes and business activities that will be performed by specific business actors according to their business roles [19].

4. Conclusion

The proposed approach in relation to design of transport activities can be used in TMS implementation to ensure flexibility and adaptability, allowing reconstructing a system "on the run". At the same time, various specialists of the enterprise can provide their vision and make their proposals for the project, harmoniously synchronizing them with the strategic goals of the enterprise. Thus, the comprehensive cooperation between all interested persons and subdivisions of the company is ensured. Accordingly, the information flows that seamlessly pass through the operational, tactical and strategic levels of company management can be transformed into management decisions creating new business value. This approach also enables to synthesize value for the company from the informal knowledge of employees and considers their experience in organization model design.

References

[1] Ye F and Wang Z 2013 Effects of information technology alignment and information sharing on supply chain operational performance *Computers & Industrial Engineering* **65** 370–377

[2] Mikalefa P, Patelia A, Batenburgb R. and Weteringb van de R 2013 Investigating the Impact of Procurement Alignment on Supply Chain Management Performance *Procedia Technology* **9**, 310 – 319.

[3] Haes S D and Grembergen W V 2008 Analysing the Relationship between IT Governance and Business/IT Alignment Maturity *The 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)* 428-428

[4] Qrunfleh S and Tarafdar M 2014 Supply chain information systems strategy: Impacts on supply chain performance and firm performance *Int. J. Production Economics* **147** 340–350

[5] Stahl T, Völter M, Bettin J, Haase A and Helsen S 2006 Model-driven software development - technology, engineering, management
[6] Tyszko A, Templin T and Oszczak S 2007 GNSS systems in vehicle fleet management *Transport Problems*, **2** 11–16
[7] Wycoff D F 2009 Implementing an SAP Transportation Management System Solution: a Case Study
[8] Daithankarand J and Pandit T 2014 Transportation Management with SAP TM 9. A Hands-on Guide to Configuring, Implementing, and Optimizing SAP TM
[9] Dorofeev A 2013 Development of Internet-Based Applications for Fleet Management and Logistics *The 15th IEEE International Conference on Business Informatics* 428-433.
[10] Carrese S, Gemma A and La Spada S 2013 Impacts of driving behaviours, slope and vehicle load factor on bus fuel consumption and emissions: a real case study in the city of Rome *Procedia - Social and Behavioral Sciences* **87** 211–221
[11] Dietz J L G 2006 Enterprise Ontology.Theory and Methodology
[12] Janssen T, 2017 Enterprise Engineering. Sustained Improvement of Organizations
[13] Fox M S, Barbuceanu M, Gruninger M, and Lin J 1997 An Organization Ontology for Enterprise Modelling *Simulating organizations* 131-152
[14] Kurganov V, Gryaznov M and Dorofeev A. 2018 Management of transportation process reliability based on an ontological model of an information system *Transportation Research Procedia*, **36**, 392–397
[15] Kang D, Lee J and Kim K 2010 Alignment of Business Enterprise Architectures using fact-based ontologies *Expert Systems with Applications* **37** 3274–3283
[16] Kudryavtsev D and Grigoriev L 2011 The Ontology-based Business Architecture Engineering Framework, New Trends in Software Methodologies, Tools and Techniques. *The 10th International Conference on Intelligent Software Methodologies, Tools and Techniques*, 233-252
[17] Lapalme J, Gerber A, Van der Merwe A., Zachman J, De Vries M. and Hinkelmann K 2016 Exploring the future of enterprise architecture: A Zachman perspective *Computers in Industry* **79**, 103–113
[18] Hinkelmann K, Karagiannis D, Thoenssen B, Woitsch R, Gerber A and Van der Merwe A 2016 A new paradigm for continuous alignment of business and IT: combining enterprise architecture modeling and enterprise ontology *Computers in Industry* **79** 77-86
[19] Kurganov V and Dorofeev A 2016 The Practice of Business and IT Integration in the Transport Company Using Enterprise Architecture Framework *The 7th International Conference on Operations and Supply Chain Management* 377-392