THE ROLE OF MODERN INFORMATION TECHNOLOGY AS AN IMPORTANT ASPECT OF BUSINESS INTELLIGENCE IN THE OPTIMIZATION OF LOGISTICS SYSTEMS

Dominika Crnjac Milić
Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, J.J. Strossmayer University of Osijek, Croatia
E-mail: dominika.crnjac@ferit.hr

Ivana Hartmann Tolić
Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, J.J. Strossmayer University of Osijek, Croatia
E-mail: ivana.hartmann@ferit.hr

Marina Peko
Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, J.J. Strossmayer University of Osijek, Croatia
E-mail: marina.peko@ferit.hr

Abstract

Business intelligence as set of methods for managing large amounts of information and knowledge about the internal and external business environment in which companies operate simplifies the decision making process and provides competitive advantage. However, business intelligence deals with a great quantity of information, which imposes the need for finding better ways of data structuring.

This paper is based on the hypothesis that the systems of business intelligence are specific and complex information systems where, apart from the constant need for the comprehensive and standardized development, an increasing need to adapt to particularities of business and specific processes of the particular organization occur, the same as for individual users. A comparison of different information systems that provide support in making business decisions and ontology as more recent concept of artificial intelligence is presented. A special emphasis of the paper is on the ontological structure of the data in the field of logistic operations.

A practical analysis is based on publicly available business data, documents and information available on the Internet provided by the companies that offer the complete systems of business intelligence as well as on the pre-established theoretical and scientific findings of other researchers.

The methods of description, induction, deduction and comparison are used in this paper.

Key words: business intelligence, information, data, ontology, logistic systems

1. INTRODUCTION

The goal of applying standards, promoting the automatic identification system and electronic data exchange in logistics processes is to improve the performance of business relationships as well as to strengthen and streamline business cooperation on the global market. Businesses become faster and more efficient, increase the entire supply chain monitoring, enable transparency of the operations and the work of each business phase and exchange, minimize errors, enable phase controls and reduce the costs of all participants in the global supply chain.

A manufacturer, retailer or distributor want and exactly must know where the items are located at any time. It is important for them to have information of where the shipment comes from and when and for whom it is intended. By applying ontology that enables the connection of different data, accurate and precise information are created and provided on all aspects of the supply chain, including transport and logistics, which are necessary for making correct and timely decisions during everyday work.

Today's Logistics Service providers (LSPs) take goods from various sources and bundle them for the same or similar destinations or sort them for different destinations. Sometimes, storage is not involved at all and goods are moved on immediately. At other times, LSPs even assemble retail displays.

For this kind of complex warehouse management it is necessary to have a close collaboration among all trading partners. Ontology help cooperation and coordination by allowing accurate real time information to be accessed by everyone involved in operational activities during business processes.

Product traceability from a manufacturer to a consumer today means competitiveness, but also reduces risk to companies as it provides product safety, product tracking, and timely withdrawal or recall orders if it is needed. Companies which are part of the food supply chain pays special attention to that, considering that they have to respect the set standards and conditions of regulatory bodies and the food industry around the world.

Today's technology helps them meet many product tracking requirements that are not always easy to meet at national, regional or global level. There is a constant need for the introduction and development of technology and the development of business intelligence in daily business. Ontological structuring of data in the domain of logistic operations facilitates the interoperability of different traceability systems and can provide precise answers to common business issues such as: does the delivery include all that has been ordered? Is the supply chain monitoring of the goods movement sufficient to optimize its movement through the supply chain? Are all the information available that are required in case of revocation or withdrawal of the product?

On the other hand, consumers want to know if the food they buy or consume is safe and contains exactly the ingredients that are declared on the packaging.(GS1 Croatia, n.d.)

Knowing the usefulness and necessity of using Information Systems (IS) in everyday work related to collecting, storing, processing and distributing information, companies strives to find and build the most optimal technological and business solution tailored to their needs. (Čerić & Varga, 2004) If we include microelectronics, computers, telecommunications and software that enable input, information processing and information displaying then we are talking about information technology. Throughout this paper, the term information system will also refer to information technology, because of today's technology development come in into all aspects of life. Therefore, we are talking about technology and information system synergy.

The business structure is conditioned by the type of business activity the company is engaged in, and there is no single information system that would universally solve the business organization. In practice, complete solutions are offered with program modules or an information subsystem (IPS) that is designed or adapted to the needs of users according to their needs. (Sekso, 2011)

Artificial intelligence has a major role in economy primarily because it helps in making business decisions. Its main goal is to provide knowledge to information systems that are expected to have people's knowledge and decides by predefined rules depending on which system is chosen as the best solution for business problems. While the information system is used for data storage from the enviroment.

2. INFORMATION SYSTEM IN BUSINESS

Information technology development dement to the improvement of management and it has taken on the role of organizing, maintaining, deciding and introducing new business principles. In 2016, the Croatian bureau of statistics published the first release on the usage of information and communication technologies in companies: 92% of companies used computers, 91% had internet access and 69% companies owned a web site. The cloud computing is used by 23% of companies as a new technology of internet service. (Croatian Bureau of Statistics, 2016) Using Intranet and Extranet in companies enables the linking of business units within a business and linking business processes that contribute to the more efficient business. The speed of the Internet connection becomes an important factor in business. Thus, through a variety of user-friendly technologies, it facilitates communication and Internet business.

Information technologies reduce business costs, speed up administrative tasks, enable decision-making in business, and increase enterprise productivity, and make this work efficient and successful. The business information system is primarily used for further use. The data is stored in the databases from which reports are made to the company required for its business. For these reasons, good programming support is needed that will process the information that is stored in the database and will be able to handle this data in a legitimate manner. From this it can be concluded that the information system supports a business system. Investing in information technology (IT) makes a big share in total company investment. The information system with regard to business management level is classified into: transaction processing system (TPS), management information system (MIS), decision support system (DSS), enterprise resource planning (ERP). One of the business planning steps is deciding, between at least two options of making decisions of the business. Because of the need for successful and rapid business operations concepts of decision support system are related to artificial intelligence. Management support system (MSS) provides direct support to the decision and it is classified into (Čičin-Šain, 2009): decision support systems (DSS), group decision support systems (GDSS), expert system (ES), executive support systems (ESS).

2.1. Artificial intelligence in business

The artificial intelligence (AI) is a system programmed to remind the workings of the human brain. Russell and Norvig gave different definitions AI based on different approaches: (Russell et al., 2010)

- Thinking humanly: "The exciting new effort to make computers think … machines with minds, in the full and literal sense."
- Acting humanly: "The art of creating machines that perform functions that require intelligence when performed by people."
- Thinking rationally: "The study of mental faculties through the use of computational models."
- Acting rationally: "Computational Intelligence is the study of the design of intelligent agents."

AI is generally classified into expert system, artificial neural networks, evolutionary algorithms, fuzzy logic, hybrid system and data mining (Nordlander, 2001). The AI plays a great role in financial service and gives great importance to business applications. Some of the business applications are: mortgage risk assessment, project management and bid strategies, financial and economic forecasts, discovery of legitimacy in price movement security, non-payment and bankruptcy estimates, etc.

Expert system (ES) is a software support system that imitates the decision-making ability of human experts based on knowledge and conclusions (Ye & Wu, 2014). They are designed to store specific knowledge of experts to make it available for solving problems. The development of the ES is performed using specific software such as Expert System Shell program designed for fast development, AI programming languages such as LISP (List Processing), Prolog (PROgrammation et LOGique), but also using common programming languages such as Fortran, C ++, Java and similar (Nordlander, 2001). Expert systems are applied in almost all branches of human activity and vary according to activity (Mrkonjić, 2007): financial ES, medical ES, expert production systems, sales and marketing ES, education, public, scientific and other. The development of ES for commercial purposes began in the 1970s and continued to be used in various companies. There are a lot of business-based application based on the ES. Some of them are: Sales Personnel Assessment, Career Goal Planning, Market Advisor for Control of Process Control Systems, Credit Analyst Advisor, Loan Approval Predictor, Pension Fund Calculator, and many others.

Artificial Neural Networks (ANNs) are designed to copy the neural networks (NN) of the human brain. The NN is a set of mutually connected simple process elements. They solve class and prediction problems with a nonlinear connection of inputs and outputs and learn how to recognize the pattern through repeated minor changes on selected neuronal weights (Nordlander, 2001). They are most often used in pattern recognition, image and speech processing, optimization, simulation, processing of imprecise and incomplete data, etc. In the business world they try to predict the likelihood of different problems that are mutually connected. For these reasons, large companies use neural networks to analyze current trends and evaluate future patterns based on them. One such application is the credit scoring system developed by Hecht-Nielson Co. which learns how to identify good and bad credit risks (Smith & Gupta, 2000).

Evolutionary algorithms (EAs) are general-purpose search procedures based on the mechanisms of natural selection and population genetics (Dasgupta & Michalewicz, 2013). One of the paradigms is a genetic algorithm based on Darwin's theory of evolution. According to Ben-Gurion University, the genetic algorithm should be used in case when there is no other strategy for solving the problem and the definition of such a problem is a NP- complete problem (Nordlander, 2001).

Fuzzy logic (FL) is a human-like conclusion which uses prediction of information as well. The result can be expected in the continuous range of the segment [0, 1] and not only in binary form. FL is most commonly used for controlling the nonlinear systems and modeling complex systems when there is an inaccurate model or there is ambiguity or inaccuracy in the system (Kr Dhamija, n.d.). FL in business is most often applied for solving the problem of consumer credit scoring, for analysing the income flow using regression techniques, risk assessment, etc.

Hybrid Systems (HS) use multiple problem solving techniques. Actual development of the applications does not require only the acquisition of knowledge and conclusions from different sources, but also from the combination of various intelligent technologies (Mrkonjić, 2007). For example, a combination of NN and FL results in a hybrid neuro-fuzzy system. It is important to divide the job components needed to solve the problem so that appropriate techniques can be combined to produce a good HS. Each system has its own advantages and disadvantages. Table 5. Comparison of Expert System, Fuzzy System, Neural Networks and Genetic Algorithm shows a comparison of various intelligent technologies, where the gradient characters are: □ – bad; ■ - rather bad; ◊ - rather good; ▲ – good

Table 5. Comparison of Expert System, Fuzzy System, Neural Networks and Genetic Algorithm

	ES	FS	NN	GA
Knowledge representation	◊	▲	□	■
Tolerance to uncertainty	◊	▲	▲	▲
Tolerance to imprecision	□	▲	▲	▲
Adaptability	□	■	▲	▲
Ability to learn	□	□	▲	▲
Ability to explanation	▲	▲	□	■
Detecting knowledge and data mining	□	■	▲	◊
Maintainability	□	◊	▲	◊

Source: autors, based on Negnevitsky, M., *Artificial intelligence : a guide to intelligent systems* (Negnevitsky, 2005)

Data mining is a process of storing data that results in finding hidden trends, patterns and legality among data. Data mining is the ability to learn in databases, data archeology, data segmentation, finding information, etc.(Nordlander, 2001)

Data mining techniques derive from statistical methods and in business operations are kept from the very beginning of storing data in large databases. For these reasons, it is necessary for companies to have a skilled analysts who will manage databases and use business intelligence, what is unfortunately not the practice today. The development of the information systems raises the question whether the data contained in databases can be used to create models that could be used to analyse past trends in business systems/subsystems and assess future business system trends over a time period.

Data mining is the most common form of use of AI in business because of its primary task: storing data and establishing legitimacy among the data. Data mining is part of business intelligence that combines a set of methodologies: data warehousing, OLAP (on-line analytical processing) - data processing, data mining.

Business Intelligence (BI) is a set of applications designed to organize and structure business information data on a regular business transaction in a way that provides analysis useful in decision making and business activity of the company. From a macroeconomic point of view, it represents a complex aggregated category that is generated by an untargeted collection of the data on macroeconomic trends in a given environment, by their organized and structured storage, searching, logical and computer-processed interpretation for the purpose of detecting macroeconomic trends or tendencies, and predicting and forecasting processes and events in macroeconomic systems. (Panian, 2005)

Supply chain optimization is based on the collection of supply chain data with radio frequency identification (RFID). BI technology in all management levels can obtain and handling information with decision support system and required data integration and useful utilisation of RFID data in logistics.(Baars et al., 2008) Information support for enterprises to real-time tracking orders, economic decision-making, and general data warehouse and online analytical processing and data mining is part of business intelligence. Typical applications based on business intelligence are intelligent warehousing management system (WMS), intelligent transportation system, individuation analysis, logistics software. (Zhao & Huang, 2009).

3. ONTOLOGIES AS CONCEPT OF AI

The process of building a knowledge base is called knowledge engineering. A knowledge engineer is someone who investigates a particular domain, determines what concepts are important in that domain, and creates a formal representation of the objects and relations in the domain. Often, the knowledge engineer is trained in representation but is not an expert in the domain at hand. The knowledge engineer will usually collaborate with the real experts to become educated about the domain and to elicit the required knowledge, in a process called knowledge acquisition.

To help focus the development of a knowledge base and to integrate the engineer's thinking at the three levels, the following five-step methodology can be used. (Russell et al., 2010):

- Decide what to talk about. Understand the domain well enough to know which objects and facts need to be talked about, and which can be ignored. Many knowledge engineering projects have failed because the knowledge engineers started to formalize the domain before understanding it.
- Decide on a vocabulary of predicates, functions, and constants. That is, translate the important domain-level concepts into logic-level names. This involves many choices, some arbitrary and some important. Once the choices have been made, the result is a vocabulary that is known as the ontology of the domain. The word ontology means a particular theory of the nature of being or existence. Together, this step and the previous step are known as ontological engineering. They determine what kinds of things exist, but do not determine their specific properties and interrelationships.
- Encode general knowledge about the domain. The ontology is an informal list of the concepts in a domain. By writing logical sentences or axioms about the terms in the ontology, we accomplish two goals: first, we make the terms more precise so that humans will agree on their interpretation. Without the axioms, we would not know, for example, whether Bear refers to real bears, stuffed bears, or both. Second, we make it possible to run inference procedures to automatically derive consequences from the knowledge base. Once the axioms are in place, we can say that a knowledge base has been produced.
- Encode a description of the specific problem instance. If the ontology is well thought out, this step will be easy. It will mostly involve writing simple atomic sentences about instances of concepts that are already part of the ontology.
- Pose queries to the inference procedure and get answers. This is where the reward is: we can let the inference procedure operate on the axioms and problem-specific facts to derive the facts we are interested in knowing.

The term ontology has been used in many different ways in the literature (Guarino, 1998; Guarino et al., 2009; Uschold & Gruninger, 1996), so in this section we characterize ontologies for the purpose of this work.

According to its original meaning in Philosophy, an ontology concerns the study of being or existence (Gruber, 1993; Guarino et al., 2009), so it concerns things that exist in the real world. In this paper, we use ontologies to capture mental images of the real world, the so-called conceptualizations. However, such a conceptualization has to be based on concepts, which can be instantiated for each real world situation that we may have to conceptualize. For example, a "container" can be a concept in logistics, which can be instantiated to represent specific containers used in certain logistics operations. Conceptualizations exist in principle in the mind of those whose produce them, but they have to be unambiguously communicated to others. Therefore, an ontology as an engineering artefact requires a language that allows the conceptualizations to be represented and communicated as concrete descriptions (specifications). This language should be suitable to represent instances of the ontology concepts and should have a formal semantics, which allows not only unambiguous interpretation but also rigorous analysis and reasoning.

In relation to enterprise interoperability, ontologies are potentially beneficial for the following three main purposes (Daniele & Ferreira Pires, 2013):

1. improve communication and re-use of knowledge, by providing a shared understanding that reduces ambiguities and misunderstanding in the terminology adopted in a certain domain;
2. facilitate the integration of existing systems, by providing a reference model that allows translation and matching, possibly automatically, among multiple heterogeneous systems that have been developed based on different semantic representations; and
3. support the engineering process of software solutions, by providing a basis for automated specification, analysis and consistency checking of software under development.

3.1 Ontologies in logistics operations

In order to facilitate the process of data analysis, the usage of the ontology is proposed as a model of financial knowledge about the analysis of indicators. Logistics organizations should now be able to share and reuse data across other organizations, instead of keeping proprietary data in several and, often, inconsistent versions. Therefore, not only a logistics organization may want to be able to expose its own data outside its boundaries, but also needs that the meaning of this data, or semantics, is correctly interpreted by others, otherwise the collaboration among organizations may lead to ambiguities and serious mistakes. In other words, there is a need for semantic interoperability among logistics organizations. The ontologies are used to create the necessary knowledge models for defining and explaining functionalities in analytical tools. Using ontologies and semantic networks for a visual interface to support an information search in the BI system may help to reduce the following weaknesses of management information systems (Dudycz & Korczak, 2016):

- lack of support in defining business rules for getting proactive information and support in consulting in the process of decision making;
- lack of a semantic layer describing relations between different economic topics;
- lack of support in presenting the information of different users (employees) and their individual needs;
- difficulty in rapidly modifying existing databases and data warehouses in the case of new analytic requirements.

We have adopted approach proposed by (Daniele & Ferreira Pires, 2013), which proposes a core ontology that specifies the main concepts commonly used in logistics operations. This core ontology can be further extended for the purpose of specific logistics applications and our further development is given here. The ontology presented is being developed in the context of the iCargo (www.i-cargo.eu) and CASSANDRA (www.cassandra-project.eu) projects, which are both co-funded by the European Union under the Seventh Framework Programme for ICT. We regard a proper ontology as an engineering artefact that consists of a set of concepts and definitions used to describe a certain reality, relations among these concepts, plus a set of axioms to constrain the intended meaning of these concepts (Guarino, 1998).

After detailed analysis of existing BI software for logistics and after thorough and detailed conversations with experts from logistics domain, we have been able to agree on common terminology that is used among them to describe relevant objects for logistics. The highest level of general objects in logistics would be container type, cargo type inside container and means of transport. Although "container" can be a concept in logistics, it can be instantiated to represent specific containers used in certain logistics operations, like refrigerated container, container for medicine, hazardous cargo, etc.

Single common ontology is almost impossible to create as it would get too complex and difficult to maintain. Therefore, we propose approach of networked ontologies that have in common one core ontology, which specifies the main concept for logistics domain and all case specifics would be separated in "child" ontologies.

Since ontology development is never trivial task, we could agree on informal definition that applies to logistics: "logistics is all about transporting something from a place of origin to a destination in a certain time and under certain conditions", so the key words "transport", "something", "place of origin", "destination", "time" and "conditions" are already hints to what type of concepts can be included in such a core ontology, regardless of its specific application in logistics (Daniele & Ferreira Pires, 2013).

In order to propose core ontology, we have followed approach based on top-down and bottom- up practices for ontology engineering. From a top-down perspective, the upper level concepts are specialized as defined in the DOLCE+DnS Ultralite ontology (Ontology design patterns, n.d.) for the purpose of logistics. In this way, a classification is provided for most of the relevant objects that are involved in logistics operations (for example, actors, facilities, product classes, packages, pieces of equipment and transport means) and the relationships among these objects. From a bottom-up perspective, classification of transport means, packages and dangerous goods is done, among others.

This approach allows extensibility to allow further growth of the core ontology for the purpose of specific logistics applications. For example, we could extend our core ontology with company logistics ontology, which would define all main activities and events important for companies demanding logistics services. This extension would provide definitions of special request that companies would have, for example, order of container fulfilment (for example, first heavier product and lighter on the top), special place and time of delivery, package sizes, delivery priority (FIFO or LIFO) etc. Analogously, we could extend our core ontology with a logistics documents ontology that represents all the documents exchanged in the logistics operations.

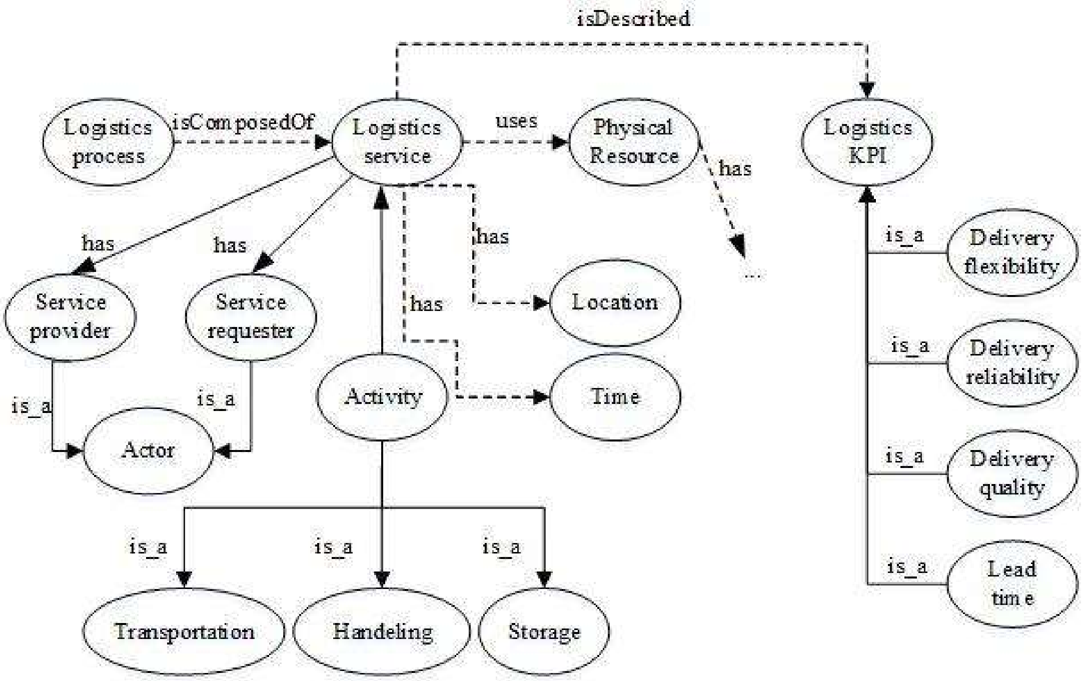
One other important feature is maintainability. It enables the process of identifying and correcting defects, accommodate new requirements, and cope with changes in logistics ontology. The minimum requirement is that a new module, which can be extended, in the network of ontologies must comply with our core ontology.

Separation of the design of the ontology from its implementation is proposed. In the design phase, concepts of the ontology are defined using natural language. These concepts and their relations are specified using UML class diagrams, and formal axioms that capture the intended meaning of these concepts are defined. UML is a popular general-purpose language that allows representation of ontology at a high abstraction level, i.e., abstracting from the ways the ontology might be implemented in actual applications. In this way focus on the concepts, relations and axioms that we wanted to specify is given, ignoring the issue of selecting the most suitable language to express them. In the implementation phase, ontology is specified using OWL DL, which allows automated reasoning to validate the correct use of axioms and relations, and make queries against ontology.

Logistics can be considered as the set of activities that take place among several actors in order to deliver certain products at the right time, right place and under the right conditions, by using suitable resources. Therefore, logistics ontology upper level concepts are presented in Figure 1 and should be:

- Activity, which denotes some action that is relevant for the purpose of logistics and provides value for a potential customer. Activities are, e.g transport, transhipment, load, discharge, storage and handling. The latter activities are fundamental activities and can be used to compose more complex activities.
- Actor, which represents companies, authorities or individuals that provide or request activities and operate on resources related to these activities.
- Physical Resource, which represents physical objects that are used in the logistics activities, such as, for example, the moveable resources used during the activity of transport, i.e. the transport means and equipment used to move items to their destination.
- Location, which represents the geographical area or geographical point used to define the place(s) relevant for logistics activities. Location can be coarse-grained for scheduling, since in long term planning it is sufficient to specify approximately the place of origin and destination, such as, e.g. the Netherlands or the port of Rotterdam. However, location needs to be fine-grained for delivery, since one has to specify the precise address to which a certain item must be delivered.
- Time, which represents the start time, end time or time interval associated to activities. Since time is a basic (foundational) concept relevant for logistics, but common to other domains, the representation of time proposed in the Time Ontology (http://www.w3.org/TR/owl-time) could be reused instead of creating new ontology.
- Key performans indeks (KPI) is used for performance measurement ensures that are always evaluating logistics business activity against a static benchmark. This means that fluctuations are immediately visible and if performance moves in the wrong direction, action can quickly be taken to address the situation. When a KPI shows that performance consistently meets or exceeds the required level, it be can decided to raise the bar and set a higher standard to aspire. For example, in logistic it is important for inventory levels, stock losses and/or damages, costs of transportation, warehousing, order capture, etc. KPIs are also essential for any business improvement strategy because it provides visibility of business performance and allow objective quantitative and qualitative evaluation. (Logistics Bureau, n.d.)

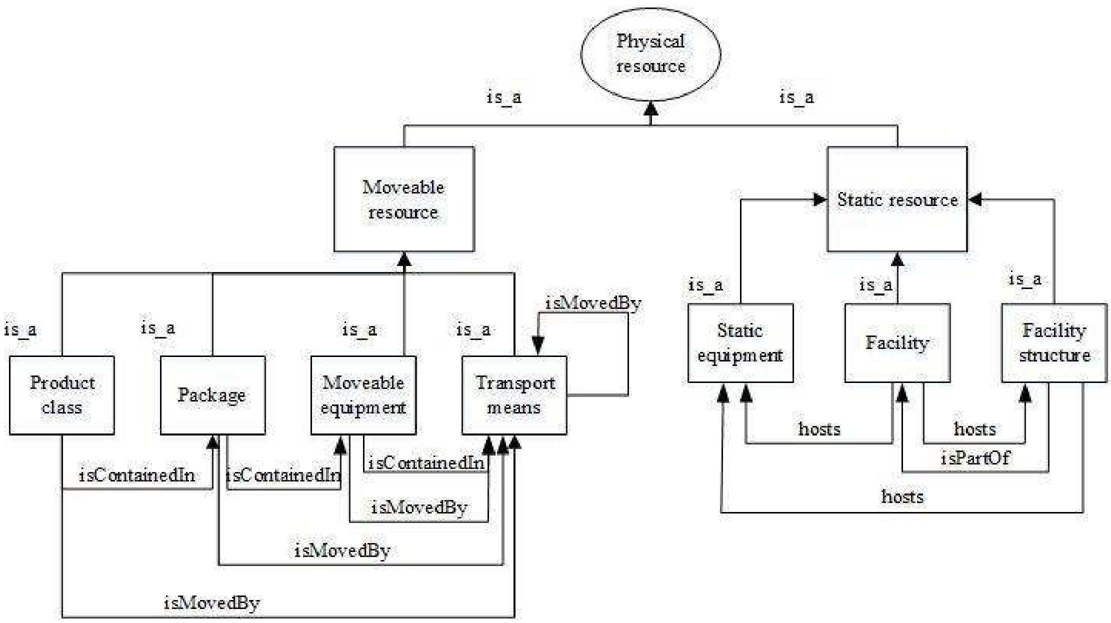
Figure 1. Part of core ontology for logistics



Source: Authors

Figure 2 shows part of core ontology, which focuses on the specialization of the concept of Physical Resource. A Physical Resource is specialized in a Moveable Resource, which is characterized by the capability of moving on its own or being contained for the purpose of transportation, and a Static Resource, which is used to handle moveable objects in a facility prior to their transportation.

Figure 2. Part of core ontology for logistics, focused on the concept of Physical resource



Source: Autors, based on (Daniele & Ferreira Pires, 2013)

In order to clarify parts of Physical resource concept, i.e. what is expected in implementation, here are definitions and properties:

- Product class: Object used to select proper package, moveable equipment and transport means for several logistics activities, especially for transport. The selection is based on relevant properties of the product class, such as its physical state (solid, liquid, gas), required temperature, dangerousness, etc. Properties are: Type (regular, perishable, flammable, organic, toxic, heavy machinery, bulk, medicine, expired deadline for food etc.), State (solid, liquid, gas), isRefeer (Boolean value), isDangerous (Boolean value), isOversized (Boolean value)
- Package: material used for containment, protection and movement of product classes. Properties are: Type (carton, box, crate, barrel, pallet, container, etc.), Quantity, Volume
- Moveable equipment: Reusable resource used for containment, protection and movement of product classes with or without package. A moveable equipment cannot move on its own (unpowered vehicle), but can be pulled or contained in a transport means. Properties are: Type (container, pallet, railway wagon, trailer, etc.), ID, Volume, Quantity
- Transport means: Reusable resource that facilitates the activity of transport and moves on its own (powered vehicle). Properties are: Type (aircraft, vessel, truck, train), Capacity
- Static equipment: Reusable resource that is used in a facility to handle moveable resources. Properties are: Type (crane, etc.), Facility
- Facility: Static resource (usually a building) built, installed or established to facilitate related activities in a point location. A facility can be part of a facility structure (for example, a terminal is part of a port). Properties are: Type (terminal, warehouse, etc.), Location, FacilityStructure
- Facility structure: Static resource built, installed or established to facilitate related activities in a geographical area. A facility structure may host several facilities. Properties are: Type (port, airport, etc.), Location (GeoArea), Facility

Some axioms that apply to the ontology fragment in Figure 2 are the following:

- If a moveable equipment e isMoved by a transport means tm, then tm moves e (i.e., the relation moves is the inverse of isMoved);
- If a product class pc isContained in a package p, and p isContained in a moveable equipment e, then pc isContained in e (i.e., the relation isContained is transitive);

4. DEVELOPMENT OF THE NEED FOR APPLICATION OF BUSINESS INTELLIGENCE SYSTEM AND DEVELOPMENT OF ONTOLOGIES IN ORDER TO MEET TRENDS IN LOGISTICS OPERATIONS

Market needs impose synchronized work of digital platforms that in a daily tasks have to link a big number of data and channelized at the right time and in the right place the valuable information needed for a successful business.

The traditional way of operation in logistics operations are getting more and more virtual and business intelligence is particularly important because its use results in creating competitive advantages for companies.

The opening up of the Republic of Croatia to the global market has created a need for outsourcing of logistics services, and for the increasing use of ICT in daily work. Sophisticated technologies enable a high level of supply chain optimization, enabling multiple activities to be performed in a shorter time, while minimizing costs, but impose the need for continuous investments, modifications and advances.

In transporting goods, there are increasing needs for the implementation of telematics systems in order to ensure better resource planning and traceability of goods.

In order to speed up the exchange of data using these systems it is important that availability of data through the cloud exists.

Inventory tracking and related data collection enables them to better manage and provide better „cash-flow“ of companies.

The use of various types of transport, such as road, rail, water, and air in the continuous logistics process of goods delivery defined by the term Intermodal Logistics which is becoming increasingly trendy, requires the connection of a large number of different qualitative and quantitative data.

Using of various types of transport, such as road, rail, water, and air in the continuous logistics process of goods delivery defined by the term Intermodal Logistics which becomes trend, requires the connection of a large number of different qualitative and quantitative data. Intermodal transport provides a consolidated service and develops the "Value Added Services" market. In order to increase product distribution efficiency in the supply chain, GPS Vehicle Monitoring and Geo Location (vehicles and packages) are used to optimize traffic routes, but also timely control of driver operation. Informatization has also enabled the use of dynamic systems for rout planning, which generate numerous savings in work that can be achieved with shorter deadlines and delivery accuracy, more efficient utilization of the fleet, etc. In warehouse logistics, Warehouse Management Systems (WMS) enables to measure the efficiency of all warehouse operations. The use of the collected data and their ontological linking enables to indicate work errors timely and possibility for optimization warehouse work. This system of operations allows the reduction of total costs of manipulation and warehousing of goods, reducing energy consumption, time, storage capacity and workforce.

Online retailing which becomes bigger part of the retail trade has led to new trends in the workplace, such as the use of intelligent Warehouse Execution Systems (WES), which task is to optimize equipment and human resources by pointing to the prioritization of sorting, packaging and shipping goods at the right location with minimal time.

The trend of development of e-commerce has resulted in growth and development of packet delivery, and an increase in such distribution. This type of logistics is extremely dynamic and success in this type of work is followed by respecting the phrase "time is money", but also from the awareness that timely delivery of the necessary information means an advantage ahead of the competition. The range of products delivered is very wide, inventory stocks are often or are not small, and this imposes special adjustments in the work of logistics companies. The range of products delivered is very wide, there is no stock goods at the warehouse or they are small, so it imposes special adjustments in the work of logistics companies. The use of BI and ontology of data in this segment of logistic business is reflected in the use of a transparent tracking system „Track & Trace" of package, SMS notifies of delivery expiration, online delivery announcements, payments on the web and support of working with new forms of delivery networks such as "Click & Collect". It provides optimal use of resources and business processes to minimize costs. Particularly important in this type of business is the rapid transfer and processing of data on the goods being delivered and the time of delivery.

5. CONCLUSION

The paper presents an analysis of the types of artificial intelligence that are increasingly intertwined with a good business system and make business intelligence.

In the modern business world, many companies become dependent on intelligent systems to quickly and efficiently solve complex problems and even though they are sometimes unaware of it. In order to business successfully and to compete within the great number of companies, it is necessary to respond quickly and adequately. In these cases, they can be assisted by decision-making software that makes decisions based on past successful decisions.

The paper emphasizes the importance of applying business intelligence and ontological structures to the logistics segment, because the application of advanced technology solutions shows significant results in this part of the business. They manifest as safer, more accurate, cheaper and more quality organization of goods transport with a greater connection between manufacturers and logistics centers, which today take on a large part of their business with quality assurance. They have profound effect to the organization of the warehouse, in particular in the function of more efficient utilization of warehouse space, acceleration of operations in warehouse in particular of flow of the reserves and their reduction, reduction of labor costs, increased delivery accuracy and finally greater satisfaction of customers and services provided.

6. REFERENCES

Baars, H. et al. (2008). Combining RFID Technology and Business Intelligence for Supply Chain Optimization Scenarios for Retail Logistics. In *Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008)*. IEEE, p. 73–73

Croatian Bureau of Statistics. (2016). *Usage of information and communication technologies (ICT) in enterprises, 2016, first results*. Zagreb. [available at: http://www.dzs.hr/Hrv_Eng/publication/2016/02-03-01_01_2016.htm , access May 26, 2017]

Čerić, V. & Varga, M. (2004). *Informacijska tehnologija u poslovanju*. Element.

Čičin-Šain, D. (2009) Osnove menadžmenta. *Visoka škola za turistički menadžment*. [Available at: http://www.unizd.hr/portals/4/nastavni_mat/2_godina/menadzment/predavanja_menadzment.pdf , accessed May 29, 2017]

Daniele, L. & Ferreira Pires, L. (2013). An ontological approach to logistics. In *Enterprise Interoperability, Research and Applications in the Service-oriented Ecosystem, IWEI 2013*. Enschede: ISTE Ltd, John Wiley & Sons, Inc., p. 199–213. [available at: http://doc.utwente.nl/88351/ , access May 26, 2017]

Dudycz, H. & Korczak, J. (2016). Process of Ontology Design for Business Intelligence System. *Information Technology for Management*. [available at: http://link.springer.com/chapter/10.1007/978-3-319-30528-8_2 , access May 26, 2017]

Gruber, T.R. (1993). A translation approach to portable ontology specifications. *Knowledge acquisition*, 5(2), p.199–220

GS1 Croatia. GS1 Croatia - Sljedivost. [available at: https://www.gs1hr.org/hr/gs1-standardi/primjena/sljedivost , access May 26, 2017]

Guarino, N. (1998). Formal ontology and information systems. In *Proceedings of the 1st International Conference on Formal Ontology in Information Systems (FOIS)*. Amsterdam: IOS Press, p. 3–15

Guarino, N., Oberle, D. and Staab, S. (2009). What is an Ontology? In *Handbook on ontologies*. Springer Verlag, p. 1–17

Dhamija, A. (2006), A. Business Intelligence with AI Methods. [available at: http://akdhamija.webs.com/consultancy/cm_tem_paper.pdf , access May 29, 2017].

Logistics Bureau. KPI - Key Performance Indicator - Supply Chain and Logistics. [available at: http://www.logisticsbureau.com/kpi-key-performance-indicator/ , access May 26, 2017]

Mrkonjić, M. (2007). *Utjecaj informacijskih sustava za podršku odlučivanju na uspješnost poslovanja poduzeća*. Sveučilište u Zagrebu, Ekonomski fakultet Zagreb

Negnevitsky, M. (2005). *Artificial intelligence : a guide to intelligent systems*. New York: Addison Wesley/Pearson

Nordlander, T.E. (2001). *AI Surveying : Artificial Intelligence In Business*. De Montfort University

Ontology design patterns. Ontology:DOLCE+DnS Ultralite - Odp. [available at: http://ontologydesignpatterns.org/wiki/Ontology:DOLCE+DnS_Ultralite , access May 26, 2017]

Panian, Ž. (2005). *Informatički enciklopedijski rječnik*. Zagreb: Europapress holding.

Russell, S.J., Norvig, P. and Davis, E. (2010). *Artificial intelligence: a modern approach*. Prentice Hall

Sekso, M. (2011). Uloga informacijskih sustava u upravljanju materijalima i zalihama. In *Zbornik radova Međimurskog veleučilišta u Čakovcu*. Čakovec, p. 125–133

Smith, K.A. and Gupta, J.N.D. (2000). Neural networks in business: Techniques and applications for the operations researcher. *Computers and Operations Research*, 27(11–12), p.1023–1044

Uschold, M. and Gruninger, M. (1996). Ontologies: Principles, methods and applications. *The knowledge engineering review*, 11(2), p.93–136

Zhao, L. and Huang, X. (2009). Research on the Application of Business Intelligence in Logistics Management. In *2009 International Conference on Management and Service Science*. IEEE, p. 1–4