28

Intelligent Value Chain Networks: Business Intelligence and Other ICT Tools and Technologies in Supply/Demand Chains

Evelin Vatovec Krmac
University of Ljubljana, Faculty of Maritime Studies and Transport
Slovenia

1. Introduction

All business sectors are witnessing the trend of increased global competition, which forces companies to improve their efficiency. Reduction of costs, improvement of operations, improvement of relationships with customers, suppliers, and partners, shortening of delivering times, streamlining and optimization of business (logistics) processes and operations always have been the main reasons for the adoption of new technologies. As a result of globalization and integration of different economies, and the formation of international global supply chains and clusters their importance has increased further.

The use of new technologies undoubtedly contributes to improved efficiency of supply chain management. *Supply chain management* (SCM) focuses on the inter-organizational management of goods flows between independent companies in a supply chain, such as raw material suppliers, component manufacturers, finished product manufacturers, wholesalers, and retailers. The Global Supply Chain Forum (Lambert et.al., 1998) has defined supply chain management as the integration of key business processes from end users through original suppliers that provide products, services, and information that add value for customers and other stakeholders. This integrated approach to planning, control, and monitoring of product flows, from suppliers to end users, aims at improved customer service at reduced overall costs, and leads to the development of important relationships with logistics providers, suppliers, and customers in order to enhance information exchange and the coordination of business activities, which are the key advantages of an integrated supply chain. The coordination of management processes and activities in a supply chain requires efficient information exchange between companies involved in the supply chain. The processes involved in SCM extend far beyond the domain of one company or decision-maker, so a collaborative system is essential to ensure that all interests are realized, sustained, and/or improved. As a result, collaboration among all participants in the value (supply and demand) chain is essential. To improve communication, data, information, and documents exchange between customers and suppliers, proper and effective information and communication technology (ICT) is a necessity.

ICT is generally seen as supportive technology (a tool) to human activities or human performance of business actions. The proper use of ICT enables faster completion of tasks and activities, accelerates data preparation and transmission times, increases reaction speed

to market needs, automates and thus lowers the costs of supervision and information processing, supports the decision-making processes, enables distributive operations enhancing efficiency, reduces data entry errors, improves the quality of customer service, reduces delivery times between the date of the order and availability, facilitates payments, and improves inventory management. Companies using advanced ICT are more capable of responding to a dynamic environment, and can reduce operation costs more easily. ICT technologies also constitute an essential aspect of the relationship with external partners in that they change the nature of the relations between companies by allowing for real-time exchange of information and documentation in electronic form.

In the context of maximizing supply chain visibility and agility various IC technologies, techniques, systems, strategies, their use and benefits will be presented. A classification based on their characteristics (functional tools and technology, integrative technologies) and their way of use and purpose (organizational, inter-organizational, core business systems, decision support systems, mobile computing, e-business technologies, web-based technologies, SOA (Service Oriented Architecture) strategy, cloud computing, A^3 (Anytime, Anywhere Availability) strategy, social networks, and others) will be designed and explained.

One of the strategic and most important goals of every business subject is timely and accurate decision-making. Right decisions depend on the availability of timely and accurate information and reporting environments. We have to cope with vast amounts of business data (from disparate operating systems and applications), rapidly changing customer needs and market conditions, but also with vast amounts of hidden information (documents, e-mails, know-how, voice records, external sources, etc.). Therefore, in order to create an intelligent value chain network, it is essential to integrate our core business information system with a set of modern analytical and artificial intelligence tools that enable the extraction of relevant knowledge from all of these sources, management of uncertainty, and creation of business intelligence as our main competitive advantage. In present chapter also the concept of business intelligence and business intelligence tools (scorecards, dashboard, analysis, OLAP tools, data marts or data warehouses, data mining, knowledge discovery and other), some artificial intelligence tools and technologies (expert systems, artificial neural networks, fuzzy logic, voice-based technology, robotics, etc.), and their use in SCM will be discussed.

Therefore, the scope of the chapter is the presentation of the most popular and the most frequently used examples of the broad range of information and communication technologies, techniques, strategies, software applications, and systems, and their possible uses as support to effective, accurate, and real time management of large amounts of business data, acquisition of information from these data, and data and information exchange among business partners involved in the supply/demand chain, operations like queries, reports, analyses, forecasts, and data mining which enable users to identify and analyze ongoing business trends and patterns (Shobrys, 2003) as well as provide support to decision-making, and other techniques and technologies that represent "added value" to the business. In addition to the presentation of each of these ICT tools, their use and role in advanced value (supply/demand) chain management and benefits are discussed.

2. Information technology in the supply chain

2.1 The purpose and benefits of information technology

Information communication technology (Vatovec Krmac, 2007) includes the application of hardware, software and networks to enhance information flow and facilitate the decisions-

making. It is one of the few aspects of supply chain that simultaneously offers both improved performance and lower cost. It enables companies to maintain key information in an accessible format, process requirements, and make operational and planning decisions. The adoption and successful implementation of important hardware, software and network technology is a prerequisite for supply chain success. The supply chain information capability that facilitates a seamless flow of information is a very important element in further enhancing the efficiency of supply chain activities.

Key activities in the supply chain are the logistics activities. They include planning, designing, implementing and managing the flow and storage of materials and information exchange in order to support basic logistics functions such as procurement, distribution, transportation, inventory management, packaging, and manufacturing. One of the strategic features of logistics service providers is the employment of customer service. In order to optimally achieve this goal they must use modern logistics tools and processes. ICT is the most important technology for improving logistics systems, because with its proper use the productivity of constituent activities of logistics systems could be significantly enhanced. Information technologies are seen as a resource of a company, as a source of its competitive advantage, and serve as a catalyst of change in a company. They are tools for control and management of all resources, internal and external. Adoption and successful implementation of ICT (hardware, software and network technology) are certainly prerequisites to logistics success.

With the growing trend toward the use of international supply chains and e-commerce, logistics service providers for product warehousing, transportation and delivery are placing greater emphasis on ICT in order to remain competitive globally. In the last decades, innovative ICT have deeply affected the way business is performed and the way that companies compete. Innovations in electronic commerce play a key role in managing inter-organizational networks of supply chain members. The internet represents a powerful technology for commerce and communication between supply chain participants as well as a technique for the improvement of supply chain management.

The fact that ICT has a positive impact on efficiency as well as the overall performance of every company that uses it, regardless of its primary activity, is already well known. Therefore, supply chain companies can also greatly benefit from the use of ICT. Nevertheless results depend mostly on the level and type of ICT usage, which are correlated to a company's size and availability of technology, the integration of business processes along the supply chain it's still possible just with proper use of right ICT tools and technologies. And a fact that the use of ICT requires redesign and reorganization of logistics processes, which can be seen as one of the most important barriers to ICT usage, can also be overcome in the same way.

Today's challenges and opportunities are so big and important that companies should be able to quickly adapt their business to changing end evolving markets, policies, regulations, and business models. So, the companies should be agile enough. (Oracle, 2008)

And again, one of the most important factors in this adaptation is information technology. Today we have a plenty of various technologies, tools and systems (solutions) on our disposal, but there is not one universal system or technology ("one-size-fits-all" (Tohamy, as cited in Stackpole, 2011) solution that covers all information and decision support needs of the company. Therefore, we have to combine or orchestrate various different technologies and make them converge to the same strategic business goals or objectives. The complete solution should be an integration of tools such as ETL, ERP, SCM, CRM, BI/Reporting,

vertical core applications, SOA based pools of accessible internal and external web services, and legacy systems. (UC4, 2010)

But before we start to select the right or appropriate set of tools, systems and technologies we have to know how each of them works, what are the prerequisites for its implementation, what are the associated benefits and risks, and obviously which of our business goals the solution covers. One of the important facts we also have to consider is the maturity of the solution.

According to (Slone, et.al, 2008 in Oracle, 2008) one of the "five pillars of excellence that form the foundation of the new supply chain agenda" is the technology. The success and efficiency of supply chain functioning depends on the fact if the right supply chain technology was used and if its implementation was successful.

Basic supply chain functions are steel transportation, warehousing, inventory management, and reverse logistics. But these functions or processes today extends end-to-end and also outside the company and include also the relationships with suppliers and customers on a global basis. (Dittmann, 2010) With globalization and outsourcing supply chains become more and more complex and therefore the need of supply chain visibility increase. So the way companies think about the modern supply chain has changed dramatically. Supply chains are becoming multi-tiered networks of suppliers, partners, customers, and other companies. Therefore new technologies and tools are required to gain and/or obtain stability and effectiveness of the supply chain.

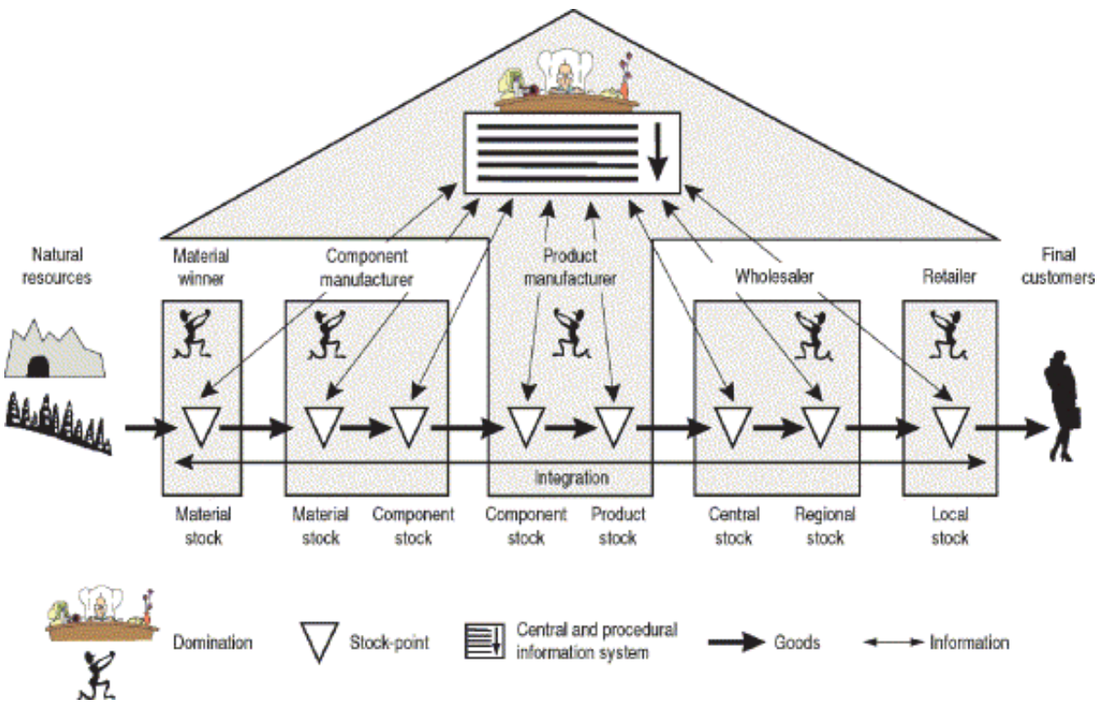

Fig. 1. Classic supply chain management (by domination of one organization over others). (Verwijmeren, 2004).

According to the (Chatterjee & Tsai, 2006) the objective of transportation logistics, as one of the key components of integrated supply chain management, is to compress time along the whole supply chain. It means a reduction of delivery time in shipments from suppliers of

raw materials, intermediate goods and components to factories, distribution of final products from factories to wholesalers, retailers and end users, and the distribution of spare parts for after-sales services. Nevertheless, transportation logistics has ceased to be limited only to the movement of goods across space and reducing time and costs along the supply chain. Its scope has expanded and now it is influencing decisions on what to produce, where to produce/store, in what quantities, who to choose as the logistics provider, etc., which are parts of strategic management. These improvements in transportation logistics are in great part results of new transportation and information technologies.

The benefits of an integrated supply chain are numerous, but on the other side the implementations of such a chain are very costly, time consuming and represents a great challenge not only for the individual company but also for all its partners in the supply chain. The partners have to make up a common strategy; there must be a high level of confidence among them. To achieve greater information exchange successful supply chain management requires effective management of strategic alliances, extensive data management capabilities and advanced inter-organizational information systems. Information communication technologies facilitate the transfer of more accurate and up-to-date information, which results in better visibility of demand and inventory throughout the supply chain, and are essential in the use of international supply chains and e-commerce.

ICT can have a positive impact on both front-end and back-end processing in a supply chain, because it provides to all parties in a supply chain better and real-time access to information, making logistics services more accurate, faster and cheaper. The reasons for a higher level of ICT should be the need for accurate information and higher quality customer service levels. Factors contributing to the level of ICT implementation are size of company, technology and policy, and types of logistics services.

ICT enablement may not be the remedy for all supply chain related problems. But, it is a strategic and capital-intensive issue, and its success lies in the readiness of supply chain partners to share information for their mutual benefit. So, mutual trust and confidential information, along with awareness and commitment of top management are considered indispensable for implementation of ICT software systems and tools between supply chain partners. Obviously, ICT tools that enable electronic communication between them have to be compatible, which mostly means another problem arises because of different levels of ICT implementation and use. As previously stated, the remedy for these kinds of problems could be independent third party web service providers that offer the possibility of the use of special services and tools without their internal implementation and the means for interconnection and real-time communication between supply chain participants, the precondition for effective performance of all logistics activities. In this way, just with proper use of right ICT tools and technologies, it is possible to overcome differences between supply chain or logistics partners, which are result of different levels and types of their internal ICT usage.

2.2 An overview of supply chain technologies

An overview of the supply chain ICT includes technologies that primarily deal with managing and controlling supply chain related data and activities, including information exchange within and between companies. They range from mature and widely used technologies to relatively new application systems and services. Some of them are essential for the business - they perform transactional processing and are called core technologies and system, while others represent only an added-value to the core business. Most of described

systems are used steel as monolithic applications, isolated or connected only "point-to-point". Concepts of service oriented architecture (SOA) and cloud computing are rapidly changing the ways these systems are developed and used by supply chain partners, but also the functionalities of these systems are changing. More and more applications are web-based and accessible from anywhere, anytime, not only through computers but also through different mobile devices. Supply chain visibility and collaboration pose new claims on supply chain software that should provide 360 degree view of the supply chain functionalities and establish a network of supply chain partners. Today business intelligence tools and systems are essential for decision making. And there are variety of other simulation and artificial intelligent software we can use to enhance and optimize supply chain functions.

As regards the purpose or usage of a particular technology (Vatovec Krmac, 2005), they can be divided into two main groups--functional technologies and integrative technologies. Functional technologies, which are mostly internally focused, include systems that are used to accomplish a particular function, and also systems that are used in a particular functional area, such as warehouse and transportation management systems. Integrative technologies, which are predominantly externally focused, coordinate and integrate information flow and activities within and/or between companies, such as enterprise resource planning systems (ERP) and supply chain planning systems (SCP).

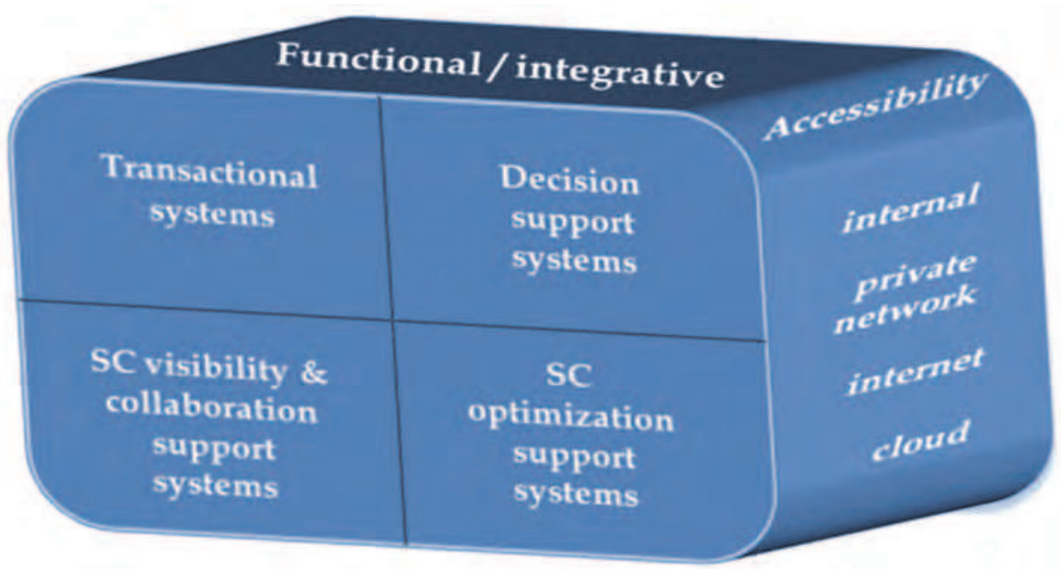

Fig. 2. Different classifications of supply chain information technologies and systems.

2.2.1 Functional technologies

Browsing web sites and studying the literature in the field of transport, logistics, and supply chain management in general we can discover a lot of different functional technologies or systems used to support and manage supply chains. Aside from bar-coding systems, warehouse management systems, computer-aided design, electronic commerce technologies, internet-based logistics systems, radio frequency systems, transportation management systems and geo-coded tracking systems there are also demand forecasting management systems, customer relationships management systems, product data

management systems, manufacturing execution systems, automated quality control systems and supply chain event management systems, and many others. They are shortly described bellow in alphabetical order.

Automated quality control systems: Automatic quality monitoring and inspection devices observe the quality of in-process work pieces in automated manufacturing systems, and are essential for effective production. They are used to determine the acceptance or rejection of a work piece or a specific production lot before work pieces are advanced to the next process. They are also used to monitor the calibration of fixtures and the conditions of cutting tools, and can be integrated into a feedback control system to directly influence the manufacturing processes.

Automatic identification technologies (AIT): Is a set of technologies and devices that capture, aggregate, and transfer data to information systems. Using automatic identification technologies significant reduction of administrative and logistics costs is possible. Because of error eliminations the data accuracy is increased, and transmission of data is speedier. Auto- identification technology also increases efficiency through reduction in labor costs, increases inventory accuracy, makes turnaround for delivery of products faster, and eliminates the need for physical inventorying of products.

1. **Bar-coding technology:** Is one of the most commonly used methods of electronic auto-identification. It is a low-risk technology consisting of systems or products that are used in conjunction with many of the other technology systems to produce or use either linear or two-dimensional bar codes.
2. **Radio frequency (RF) technologies:** RFID (Radio Frequency IDentification) has only recently been introduced to the consumer goods supply chain. It requires the creation and adoption of industry-wide standards, integration with internal business systems, and a significant investment in RFID tagging and reading equipment as well as supporting technology infrastructure. Initial costs of RF technologies are significantly higher than bar-coding costs. RF technologies use radio waves to transfer detailed information from tags, programmed with a unique number and attached to items, cases, or pallets, to a company's information system. RF tags are superior to bar-coded labels in that they allow significantly more information to be stored and have the capacity to easily update or alter information at any point along the supply chain without having to change the tag. Another advantage over bar-coded labels is its capacity to reliably operate in harsh and dusty environments; but current RFID tags are not always reliable and will not work with some products or in certain situations. The main advantage and the greater potential of RFID is its possibility to trace products, collect and access the information about products via RFID tags during each step of the logistics chain.
3. **Biometric identification system**: It is a system for uniquely recognizing human beings from momentary information, gained from "scan" of a part of human body (fingerprint scan, hand geometry, palm vein authentication, retina scan, iris scan, face recognition, signature, voice, and DNA analysis) that is compared with the biometrical data stored in a database of biometric data. It is used for human identification and access management and control.
4. **Video and audio identification systems**: These are systems for identification of things (vehicles, objects, etc.) and humans. With analyses of content the system creates a "fingerprint" and it compares with fingerprints in a database to determine if there is a match.

Computer-aided design (CAD) systems: CAD systems are generally stand-alone design tools that are used to design everything from parts to tools and fixtures. With design software company can develop better products that more effectively meet the needs of their customers.

Customer relationships management (CRM) systems: CRM systems are computer-based applications used to manage company's interactions with its customers and therefore to improve the selling and revenue generation process of a company. They provide support for the provision of a service to a customer by collecting customer data and providing information and knowledge about customers and their behavior. They help companies to become more customer-oriented in the face of increased global competition. Their main goals are increasing customer satisfaction, finding new customers, reduction of marketing and client service cost.

Demand forecasting management (DFM) systems: It is an important information system, which represents an integrated part within the framework of enterprise resource planning systems. It is a centralized forecast system capable of satisfying all of a user's information requirements. The DFM system has the ability of providing forecast information for numerous users, improves forecast accuracy and enhances decision-making. Today's demand forecasting management systems are part of collaborative planning, forecasting, and replenishment (CFRP) systems, which are web-based tools for coordinating the various supply chain management activities, including production and purchase planning, demand forecasting, and inventory replenishment between supply chain trading partners.

Electronic commerce technology: Provides the means for more efficient communication between buyer and supplier, and more accurate transmission of orders by enabling computer-based business transactions via private, proprietary networks such as electronic data interchange (EDI) or the publicly accessible internet. Electronic commerce can reduce the costs of closely integrating buyers and suppliers and through electronic networks; companies can achieve an integration effect by tightly coupling processes at the interfaces between stages of the value chain (McIvor & Humphreys, 2004). Electronic commerce technologies include interactive web sites, web portals, electronic mail, extranets (to promote electronic ordering with suppliers), intranets (to facilitate internal knowledge sharing) and EDI systems.

EDI is the most common form of an inter-organizational information system, an electronic commerce technology that improves customer service and lowers costs by facilitating communication and document exchange between supply chain partners, and has a positive impact on inventory levels and inventory management. Local systems linked by EDI support the flexibility of networked companies.

Internet-based logistics systems: They are replacing classical electronic data interchange (EDI) systems. They can handle everything from order management and scheduling to delivery, and are designed to help companies cut costs by automating the processes of booking shipments, keeping customers informed, and making sure that goods arrive on time. Supply chain management has been literally reinvented by the internet and other networked technologies and the practices they facilitate; i.e., e-procurement, e-logistics, collaborative commerce, real-time demand forecasting, inventory management, true just-in-time production, customer interface, web-based package tracking, etc.

Manufacturing execution systems (MES): MES are known also as "shop-floor-control systems". Their aim is to provide a single, flexible platform for managing production, quality, inventory, and process controls. These systems also enable real-time visibility and

control of manufacturing operations and help businesses to respond effectively to unexpected customer requirement changes. They are seen as a strategic tool for manufacturers to provide customer-specific, innovative, and cost-effective products in the increasingly competitive environment that is the result of globalization. MES is a dynamic information system that drives effective execution of manufacturing operations. Using current and accurate data, MES guides, triggers, and reports on plant activities as a result of various events. It also manages production operations from point of order release into manufacturing to point of product delivery into finished goods. MES also provides critical information about production activities to others across the company and supply chain via bi-directional communication. (Strategic Direction, 2004) Some of the major benefits of implementing the MES system are higher productivity, higher revenue and sales, higher process capability, reduced manufacturing cycle times and order-to-ship cycle times, stronger agility for handling Just-In-Time deliveries, etc. MES aims to provide an interface between an ERP system and shop floor controllers by supporting various execution activities such as scheduling, order release, quality control, and data acquisition. Adoption costs of manufacturing execution systems are high, and integration with other systems is very complex.

Order management systems (OMS): Companies use OMS to keep track of orders from customers, stock level maintenance, packaging and shipping. OMS are electronic systems developed to execute orders in an efficient and cost-effective manner (filling orders for various types) and to track the progress of each order throughout the system. Modern OMS integrate various orders entry channels, for example e-commerce, phone call center order entry and customer service, Business-to-Business e-commerce, and web sales. Order management encompasses sales functionality, inventory control, payment processing, marketing, and customer relationship management.

Product data management (PDM) systems: PDM serve as the catalyst of a process of re-engineering and optimizing a company's processes, to improve competitiveness through greater speed and responsiveness (Obank et.al., 1995). A major benefit of PDM is the reduction of time to market, as a consequence of control of the product introduction process, which also results in reduction of product introduction costs. Such systems remove barriers to information flow and allow critical information to be accessed by the relevant people. They also improve communication and consistency within companies because everyone has access to the same information. So, PDM systems are important tools for gaining control of information, and consequently obtaining greater control of a business.

Supply chain event management (SCEM) systems: SCEM is a relatively new supply chain application that improves a company's ability to share information across departments or company boundaries and encompasses event management, workflow management, enhanced information capabilities and business analyses. It enables a company to access supply chain information in real time and immediately responds to unplanned events.

Tracking systems:

1. ***Service-tracking system*** provides customers a mean to realize the status of their requests and to anticipate and plan actions. For a manufacturer downstream in a supply chain, this service provides real-time information that enhances the effectiveness of raw material planning and scheduling. Service tracking systems provide the order and delivery status of the products and services; users of the system can make decisions based on the actual status. The internet-based techniques offer users easy access to real-time status information via web-based tracking systems, which have the advantage that information exchange and transmission are not geographically restricted.

2. The ***geo-coded tracking system*** is a technology for tracking transport vehicles, formed of satellite or cellular tracking devices most commonly used in trucks or trailers to ascertain position and feed the information to ancillary systems such as transportation management systems or warehouse management systems and via internet to customers, who can track their goods on-line.

Transportation and warehousing are major logistics activities and major cost factors in logistics services. The primary goal of ICT use in logistics activities is therefore reduction of such logistics costs.

Transportation management systems (TMS): Transportation function is a critical strategic element within the supply chain, and consequently the transportation management system is the key element in a logistics and/or supply chain because it provides links among separated logistics activities. If our aim is to take full advantage of logistics, we have to have also a well developed, efficient and effective transportation system. The influence of the transportation system on the logistics system is the logical consequence of the fact that transportation generates one-third of the amount in the logistics cost. (Tseng et.al., 2005) TMS offer sophisticated algorithms for transport booking, monitoring and planning, and represent one of the primary systems used by logistics service providers, forwarders and carriers. They support information transfer, route and mode planning, choosing and delivering of products, electronic identification, mobile communication, managing claims, and physical automation, tracking and tracing (long distances, multimodal transport). In combination with mobile and wireless technology, communication networks and identification technologies can also help in better fleet visibility, reduction of paper work, and efficient communication with warehouses, providing real time data for the use of management and decision-making. Systems like TMS can enhance the level of customer service, accuracy of all collected data (customers, products, etc.), exploitation of equipment, time and manpower; i.e., all basic preconditions for the effective operation of company.

Warehouse management systems (WMS) or inventory tracking systems: Provide (Kirk …) the software to track and control the movement of inventory, from receiving to shipping, through the warehouse, managing the utilization of warehouse resources such as space, personnel, and material handling equipment to improve productivity and efficiency. They are developed to support decision makers by providing consistent, timely, subject-oriented information at the required level of detail (information on inbound and outbound flows, weight and volume of stored products, type and cost of inventory, information on product design, assembly, packaging, electronic tagging, etc.) (Winter & Strauch, 2004). Three main benefits of these technologies are reduction of shipping errors, increase in productivity, and inventory tracking ability. Logistics service providers and wholesalers are the primary users of these systems. Even better results could be obtained if WMS and inventory management systems would be supplemented by automated guided vehicles, sorting devices and automated storage and retrieval systems. In this way loading and unloading in the warehouse could be much easier and more efficient.

2.2.2 Integrative technologies

Integrative technologies are information systems used to coordinate and integrate information flows and activities within and between company boundaries to allow the company to effectively manage procurement activities to rapidly meet customer needs. These tools provide excellent algorithmic and technological features to support management decisions, allowing customized planning procedures and optimization algorithms. The goal

of both types of systems is the same: to be able to enter information from any source into the computer system only once and have the information made available for all. Two widely known supply chain integrative technologies are enterprise resource planning (ERP) systems and supply chain planning (SCP) systems.

Enterprise resource planning (ERP) systems: ERP system represents an information backbone of every business. ERP aims to automate an entire cross-functional business process. It "integrates internal and external management information across an entire company, embracing finance/accounting, manufacturing, sales and service, CRM, etc. Its purpose is to facilitate the flow of information between all business functions inside the boundaries of the company and manage the connections to outside stakeholders." (Bidgoli, 2004) ERP offer a centralized information control system to integrate all company departments and functions and provide integration for supply chain management. It's an integrated set of application software modules or packages (capacity planning, customer service, cost and accounting, sales order processing and distribution, manufacturing, material procurement, production management, quality management, inventory, human resources, distribution, logistics, and finance), which work together as an integrated unit by bringing the visibility of real-time information to all departments and thereby focusing on the business as a whole. ERP software is the dominant strategic platform for supporting enterprise-wide business processes. (Light et. al., 2001) One of the important modules of the ERP system is the inventory management module, which provides functions to calculate safety stock and the reorder point for each item contained in the database based on the item's demand history. Thus, it provides ways to analyze the demand history, make forecasting recommendations, and suggest safety stock levels. (Razi & Tarn, 2003)

The two of the most important parts of typical ERP system are in real-time operating integrated system, and the common integrated transactional database, that supports all applications. With maturity of the Internet and simplification of external communication also functions dealing directly with customers (i.e. front office functions) such as customer/supplier relationship management (CRM/SRM), or all kinds of e–business systems were integrated with all other functions that did not directly affect customers or public (i.e. back office functions).

Advanced ERP systems are integrated also with business intelligence tools and applications and therefore offer management portals or dashboards, scorecards, customizable reporting, searching functions, document and workflow management, and functions that allow external access (web services, wiki, messaging, etc.).

There are a lot of general advantages (regardless the type of the business it supports) of ERP system: integrating a very large number of business processes the company can save time and reduce costs; proper decisions can be made more quickly and easier because real–time information is available to management anywhere, anytime; data becomes visible across the company; multiple (sub)systems are automatically synchronized; integrated database provides a comprehensive view of entire company. Other supply chain management tasks and activities that benefit from the ERP: sales forecasting, resulting in inventory optimization; order tracking (from acceptance through fulfillment); revenue tracking (from invoice through payment); matching orders with inventory receipts, and the vendor invoice.

But there are also disadvantages. The greater of them are very high initial investment, integration of independent businesses results in unnecessary dependencies, problematic customization, re-engineering of business processes that have to fit the ERP system, and others. To overcome all these problems and disadvantages ERP and other software systems should be transferred in the "cloud".

Supply chain planning (SCP) systems: SCP deal with long-term strategic issues between collaborating partners by coordinating material and capacity resources across networks of suppliers, customers, facilities, and trading partners. These systems integrate diverse applications and functions such as planning (demand, sales, operations, supply, and forecast planning), scheduling, distribution, and transportation. One of these systems is the CPFR system, which is used to replace the approach of electronic data interchange (EDI). The objective of the CPFR system is to exchange selected internal information on a shared web server in order to provide for reliable, longer term future views of demand in the supply chain. (Fliedner, 2003) This leads to benefits such as increased sales, faster order response times, lower product inventories, higher order fill rates, direct material flows, improved forecast accuracy and lower systems expenses.

As stated in (Vatovec Krmac, 2005) the distinction between ERP and SCP systems is somewhat blurry. ERP generally covers the full range of manufacturing, sales and accounting software, sufficient to perform virtually all of the information technology transactions required by a company, and provides information and decision support for most of the core processes as well. SCP, on the other hand, is more oriented toward specific logistics functions with specialized systems devoted to demand forecasting, production, transportation, delivery and distribution.

The integrative technologies provide extra intelligence for coordination between partners and greater flexibility, which is needed for this cooperation between networked companies. They have to provide basic communication between the systems and users in the supply chain (data communication, message conversion, flow control, etc.), transparent information (stock visibility, track and trace and report), and advanced management throughout the systems and among the users in the supply chain (inventory management, production management and distribution management). (Verwijmeren, 2004)

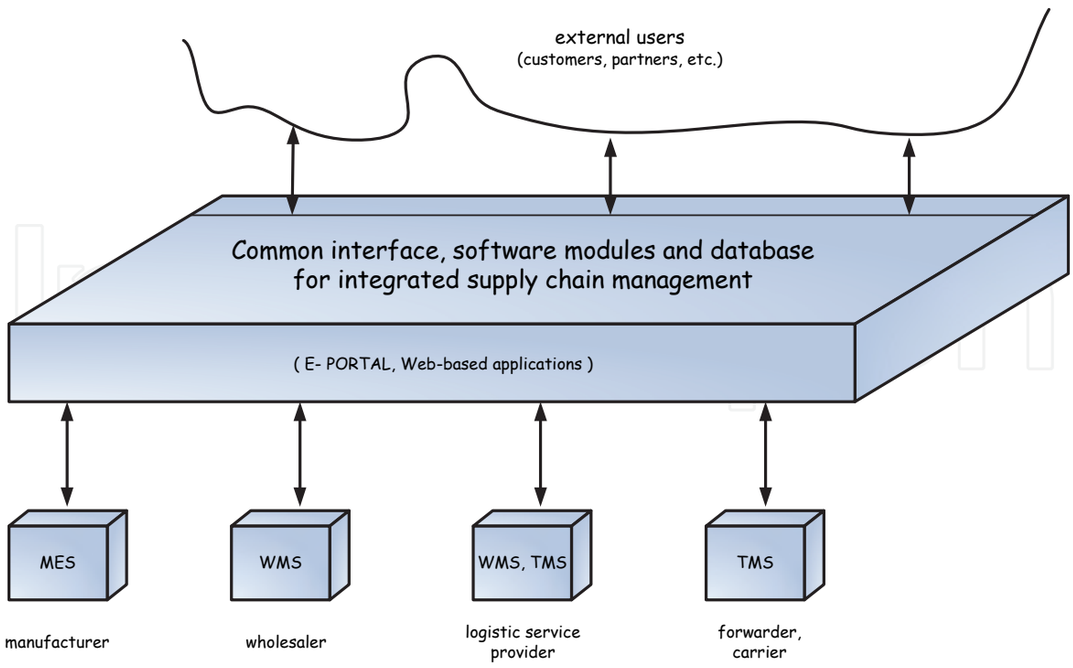

Fig. 3. Modern integrated supply chain management. (Vatovec Krmac, 2005).

Yet there remains one non-technical condition that must be fulfilled in order to achieve all the benefits that modern tools for management of intelligent supply chain actors offer; this is the need for sharing common databases with partners, or the so called "trust factor", which could be the primary factor delineating failure or success. Shared information is the key to assuring that decisions can be made as soon as demand is realized. And this is the first step toward achieving the global goal of modern supply chain management tools and systems, which is improved customer service.

2.3 Internet or web-based applications and strategies

The internet (Lancioni et. al, 2003) provides a low cost network for business-to-business commerce transactions, so can be successfully employed to improve management of supply chain systems. The main benefit of the internet is its capacity to facilitate or speed up the integration of business processes along the supply chain by facilitating the information flows that are necessary to coordinate business activities. It also allows companies to customize service solutions for their customers, which enhances the overall value and competitive position throughout the supply chain network. It allows real-time communication and interoperability between supply chain participants. Inter-company information transfer via the internet can reduce the costs of order tracking and logistics as shipments can be located *en route*.

The internet is seen as a business resource and network technology for the integration of technology at all levels of business practice. (Daniel et. al., 2004) Applications of the internet; i.e., e-procurement, e-logistics, collaborative commerce, real-time demand forecasting, inventory management, true just-in-time production, customer interface, web-based package tracking, etc., can greatly impact business practices in supply chain management.

Internet and web services promise also the ability to reduce time and costs involved in developing, supporting and integrating the internal information systems within a single company and to quickly and effectively integrate information systems with those of customers, suppliers and other business partners, the primary need for cooperation between supply chain participants. As companies linked together are numerous, the connections become many-to-many, so facilitations and services of independent third parties are required (security applications, performance measurement applications, billing and payment applications). But there are some special conditions third party web service providers have to fulfill: they must be industry based (logistics service providers), providing specialized software and services, trusted by users, and offer their services at reasonable prices.

2.3.1 SOA (Service-Oriented Architecture) services/systems

SOA is an architectural approach that "facilitate the creation of loosely coupled, interoperable business services (Web services), that are easily shared within and among enterprises" (Oracle, 2008), and it is a set of design principles for systems development and integration in computing, based on reuse of applications and services, and agility that is the consequence of the loosely-coupled approach. SOA offers business processes and location-independent interoperable services across multiple, separate systems and platforms from several business domains. Its benefits lay in ability to quickly meet customer demands, in lowering of technology costs, in reduction of expensive custom development costs, and in making business rules more visible and easier to transform.

SOA separates functions into services (each service implements one action), accessible over a network. Users can combine these services and reuse them in the proper development of applications. The communication between services and consumers is realized by "passing data in a well-defined, shared format or by coordinating an activity between two or more services" (Bell, 2010).
In many decision-making processes or reporting tasks we need integration of data and information from disparate data sources what SOA makes possible. SOA also facilitates cooperation among different companies, and therefore represents an important feature for supply chain partners' interoperability. It enables networked data-sharing and analysis tools sharing and so makes the analyzed data available to multiple users in real time. As stated in (Epicor, 2009), "SOA provides a modern model of application support across an enterprise without regard to who, what, where or when."
Many companies still rely on batch or background processing (processing is shifted to times when computing resources are less utilized) to support their existing applications. This kind of processing is appropriate for very large amounts of data or transactions where small delays in delivery of information are acceptable. Traditional background processing has changed and evolved in the so called Just-in-Time processing, appropriate for data that does not have real-time requirements. If companies want to move to SOA architecture or to combine Just-in-Time processing with SOA transactional processing they need to overcome the dependency on batch processing. This is possible with implementation of *intelligent service automation* which provides a necessary bridge between SOA and legacy applications, allowing for the inclusion of batch processes into the SOA business processes which requires initiation on time, calendar, and events. Intelligent service automation therefore provides web services to initiate, monitor, and manage background processes. So, the main purpose of the intelligence service automation is to provide an automation engine that supports SOA processing initiation in the background and can be seen as an integral technology in business process execution. (Oracle, 2008)

2.3.2 Web 2.0 / Web 3.0 tools and services

The web is a "tool for improving customer service, decreasing the time to market, and accelerating every kind of interaction" (Epicor, 1999). Combined with concepts of SOA, A^3, mobile computing, and cloud computing it represents an infrastructure for information transfer and collaboration between partners.
Web 2.0 is an extensive set of web tools and applications (so called web-based applications) that improve and enrich the user experience of the Web ("information sharing, interoperability, user-centered design, and collaboration on the World Wide Web" (Shelly & Frydenberg, 2010)). It encompasses social networking sites and social bookmarking, blogs, wikis, podcasts, RRS (Really Simple Syndication) feeds, various forms of publishing, video sharing sites, mushups (process of integration of data from independent applications to produce new information), folksonomies, web applications, searching capabilities, and many others that facilitate creativity, collaboration, and sharing among users.
The main difference between websites (Web 1.0) and Web 2.0 sites lays in the fact that websites limit the user on passive viewing of the content that was prepared for him while Web 2.0 sites allow user to interact and create the content of the site. Web 2.0 is somehow a new form, a new version of World Wide Web because redefines the ways that end-users and also software developers use the Web (the inventor of the World Wide Web, Tim Berners-Lee, call it "Read/Write Web" (Wikipedia, 2011c)).

This set of tools is not yet widely used to support the business, but the promises are very good, because these tools implement new ways of providing information to decision makers. The social computing/networking and Web 2.0 have already resulted in new forms of online collaborative work and information sharing in various companies. Through social networking persons can easily connect and do business, they can use these opportunities for marketing and advertising of proper products and/or services, or only for communication and coordination of business activities. In Gartner predictions for 2012 (Gartner 2010) Facebook, as already today the biggest social network in the world, is seen "too big for firms not to factor it into their B2C strategies". Gartner group see the Facebook as a huge support for advertising, communication, marketing and client support. Considering the compatibility of Web 2.0 with more and more often used SOA concept and their suitability for the supply chain integration and management of various different, disparate companies that should/have to share real-time data, information, and applications, it is logically to consider these technologies as future infrastructure for all other information technologies used to support business.
Web 3.0 or semantic web will represent the next step of the evolution of Internet and web applications. With regard to the fact that Web 3.0 is still "under construction", we can rely only on to promises like: the main improvements in searching capabilities will be done (social bookmarking as a search engine); all information will be categorized and stored in such a way that a computer could understand its meaning as well as a human (artificial intelligence added to the web); it will increase the popularity of mobile Internet devices. The promises are good also for the use in the future business.

2.3.3 Cloud computing

As Internet has matured it has become a useful infrastructure also in business. Today more and more applications, data and services are transferred from the user's computers to the "cloud". These computational resources (applications, databases, files, file service, emails, storage capacities, processing capacities etc.) are available to the users on demand. They can access these resources via a computer network.

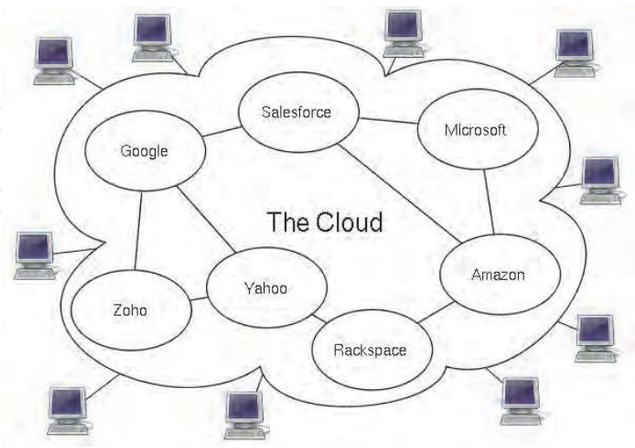

Fig. 4. Cloud computing conceptual diagram. (Wikipedia, 2011b)

The client (an end user) need only operating systems and the applications used to access the cloud via web browser installed on his computer or other mobile device, and it can access

computational resources from anywhere, anytime. For end user there is no need to know the physical locations and configurations of computer systems he uses in the cloud.
Components of the cloud computing are cloud application services or "Software as a Service (SaaS)", cloud platform services or "Platform as a Service (PaaS)", and cloud infrastructure services or "Infrastructure as a Service (IaaS)".

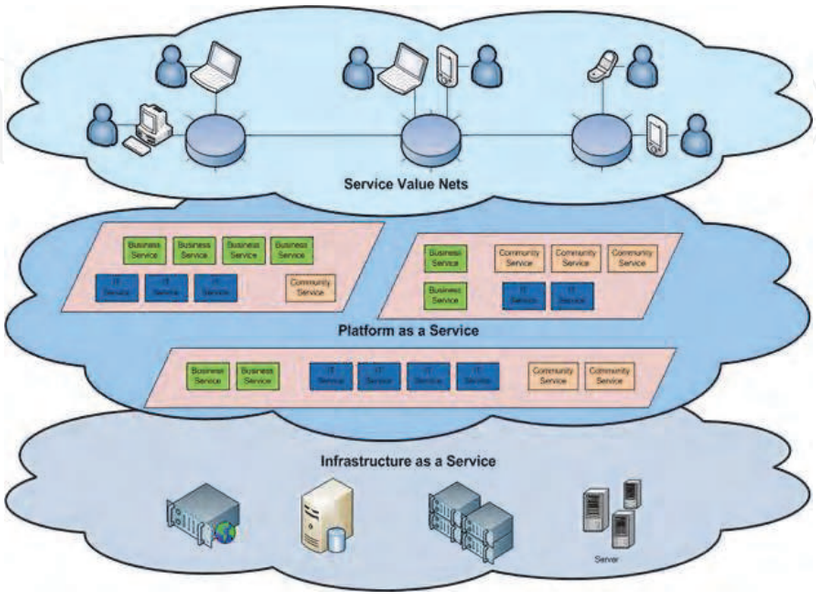

Fig. 5. The structure of the cloud. (Karisruhe Institute of Technology, n.d.)

SaaS (Software-as-a-Service): is often called also on-demand software. Software as a service is a software model. Associated data are hosted centrally, very often in the Internet or cloud. Users can access these software and data via web browser. In the business the term SaaS is used for business applications that are installed in businesses' computer networks (applications including accounting, collaboration, customer relationship management (CRM), enterprise resource planning (ERP), invoicing, human resource management (HRM), content management (CM) and service desk management) (Shally & Frydenberg, 2010).
Software as a service solutions normally utilize a multi-tenant architecture (single version of the application with single configuration is used for all customers), in which the application is designed to serve multiple businesses and users, and partitions its data accordingly. Saas applications therefore not support an application customization like traditional enterprise software. Normally the SaaS applications are updated more frequently. Many SaaS applications offer features that let its users collaborate and share information (like Web 2.0 tools).
Infrastructure-as-a-Service (IaaS): are cloud infrastructure services. IaaS deliver computer infrastructure (platform virtualization environment) as a service. Instead of purchasing all hardware and software equipment (servers, software, data-center space or network equipment), users can fully outsourcing these services. Suppliers typically bill such services on basis of usage (amount of resources consumed).
Platform-as-a-service (PaaS): cloud platform deliver a computing platform as a service, using cloud infrastructure and sustaining cloud applications. It forms a web-based development environment. It consists of computer hardware, including multi-core

processors, and computer software products designed for the delivery of cloud services, including cloud-specific operating systems.

Regarding privacy, security and financial concerns, company's needs, the organization of cloud services etc. various types of clouds are possible (public, private, community, combined cloud). A type of cloud that could be very useful and appropriate for supply chain users is a community cloud. This type of cloud represents an opportunity in the case where several companies have similar requirements and seek to share infrastructure so as to realize some of the benefits of cloud computing.

To support supply chain visibility and collaboration integration of supply chain partners' software is needed. Linking up all ERP and supply chain systems from different supply chain companies is rather impossible. So called "point-to-point" integrations between different enterprise systems are very difficult and time consuming. Therefore, cloud is a good solution in the case where information sharing, orders, goods, and payments tracking along the supply chain are essential. One possible use of a cloud is that all partners simply upload their reports into the cloud and in this way availability of real-time information is reached. Other, much better solution is sharing the same applications and/or databases installed in the cloud.

More and more applications used by supply chain partners is becoming cloud-oriented. Two good examples of the cloud computing in supply chain management are SaaS transportation management systems (TMS) and SaaS warehouse and inventory management systems (WMS).

The opportunity for **SaaS TMS** (Gonzales, 2009) comes from one of the most critical aspects of TMS, the need for communication, collaboration, and information exchange with a network of other partners (carriers, suppliers, customers, logistics service providers, and other trading partners). In the Saas TMS there is only one software and hardware setup of TMS for different users. The network provides shippers with access to relevant carriers to satisfy their transportation needs in less time and with lower costs. There is no need to establish and test all classical EDI and other types of electronic communications anymore, because all trading partners are already part of the network. The costs, efforts, and time for frequent updates of TMS are minimal, because there is only one application to upgrade and is available to everyone. SaaS TMS also facilitates benchmarking and inter-enterprise collaboration, because the data about performance of all companies of the network are available to everyone, so an external benchmark can be done easily and quickly. Regarding payment of use of the application there is only a monthly subscription fee to pay.

Saas WMS (Business Software, 2011) and inventory systems empowers companies to gain real-time visibility into warehouse operations ensuring greater customer satisfaction, improved productivity, and better inventory accuracy. They offer all needed key features like inventory tracking, that offer real-time visibility into supply chain operations, checking goods into inventory and establishing real-time inventory accuracy, streamlining the receiving, put-away, and picking process for optimal operational efficiency, easily locating and picking orders in sequence to improve employee productivity, automating the shipping process to decrease shipping costs and reduce order fulfillment time, and integrating into companies ERP systems. In this way all trading partners can share timely information about inventory levels, orders statuses, payments, and other important information. Warehouse systems are increasingly expected to perform more and more functions—assembly, manufacturing, repair. These capabilities are part of extended value chain processes that include transportation management, procurement, manufacturing, order management,

spare parts and repair operations, asset management, and maintenance, so the collaborations between partners and supply chain visibility are the demands.

2.3.4 A3 (Anytime, Anywhere Availability) and mobile devices

In today business there are really great claims on access of data and information at anytime from anywhere in the world, regardless the used device. A framework that provides anytime, anywhere availability means that "any user can gain access to a consistent set of accurate, up-to-date information in their native language from applications and servers spread around the world." (Epicor, 2009) To realize a framework for A^3, SOA environment is needed, because it provides the capability of editing and examining for errors the captured information, and allows a user interface to handle the language aspects. The concept of A^3 leans on conviction that "everyone should be able to deal with the data in the way that is easiest for them." (Epicor, 2009)

The phenomenon A^3 means "the universal connectivity" (Gates, 1999), i.e. bringing together all needed information and services and make them available regardless of where you are, what you are doing, or the kind of device you are using. Gates (Gates, 1999) called this concept the concept of convergence - "convergence of the computer, consumer electronics, and telecommunications industries and the merging of gadgets such as the PC, TV, telephone, and smart devices".

Maybe the most critical aspect of the A^3 environment is the security. The fact that service or software is available anywhere means that there are many points of entry, that must be controlled and supervised. To increase the security of A^3 methods like "Single Sign On" (allows persons to access multiple, independent applications with the same username and password) and "Role Based Access" (access rights are associated immediately based on the individual's role in the company) were developed.

The access should be available only for employees or maybe also for supply chain partners, or even customers. They can access from remote desktops, or mobile devices like laptops, tablets, iPads, handhelds, mobile phones, or other smart and wireless devices. The collaboration of these devices is possible only if they are able to communicate effectively with each other, and this is possible through the use of open internet protocols and standards.

Anytime, anywhere access allows employees to be efficient and effective from virtually anywhere, whether they are working from home or on the road. This convergence is very important also for the supply chain partners, who have great opportunities of communication between them and to gather needed business data and information (like data regarding orders, processing of orders, inventory statuses, shipments, payments, etc.) anywhere and anytime, and have therefore the possibility to react more rapidly and shorter delivering times and consequently reduce overall costs.

2.4 Supply chain visibility and agility

One of the important goals of supply chain management we can also obtain via technology is the improvement of supply chain visibility and its flexibility or agility.

Supply chain visibility or end-to-end visibility, called also 360-degree view of company means that company is able to have a clear view of everything that happens across the entire supply chain and also how well this happens. The meaning of the supply chain visibility (Stackpole, 2011) depends on what kind of manufacturer the company is, on the companies' role in the supply chain, on industry that company serves, and on that where the need for

visibility is most serious. For a manufacturer this can be a visibility from supply-side perspective (rapid planning, control of contract partners – contract outsourcing, having a real-time visibility into interruptions, managing customer expectations, reduce returns, improve overall services, etc.), for the consumer products manufacturer this is a visibility from a demand-side (optimization of inventory and sales, better forecasting, improvement of order fill rates, etc.), furthermore it can be seen from logistics point-of-view (tracking a product and a transportation mean, tracing issues, etc.).

The most commonly cited business pressures driving visibility adoption include the need to improve on-time performance, the need to proactively alert customers of late shipments, and the desire to reduce lead times and lead-time variability. Visibility into the supply chain is primarily based on "snapshots in time" rather than "real-time" information. Therefore, tools or solutions that support and enable the supply chain visibility have to provide a company with consistent, reliable and timely information and offer sophisticated reporting tools to help the company make better strategic decisions.

Choosing or developing a solution for supply chain visibility should start by defining the business needs, problems and the kind of required visibility. Strictly speaking, it is not a matter of one, "one-size-fits-all" (Tohamy, as cited in Stackpole, 2011) solution but rather a set of various solutions – product categories that should be connected and interrelated (integrated).

Traditional enterprise software systems like ERP or SCP are not adapted end equipped to provide this end-to-end visibility on the whole. ERP systems are very good tools to give us a good visibility into everything inside our company, but not outside the company. Starting outsourcing and establishing network connection with various partners companies don't need only internal processes visibility but also the access to information outside the company. Modern SCP and ERP systems already address features for demand planning and forecasting with retail partners and also for planning and collaboration across supplier networks, but they lack the ability to give a visibility of how company is executing against its plans.

Business intelligence (BI) tools offer a sophisticated set of reporting tools, but also a possibility to establish an adequate level of supply chain intelligence, which is indispensable for improving overall operational performance. BI tools allow monitoring all processes and provide alarms and notification before the potential problems evolves in troubles or even disasters.

Network solutions, which offer services for connection of supply chain partners, should also be adapted for the supply chain visibility need. Traditional value added networks (VAN), electronic data interchange (EDI) tools and business-to-business e-commerce platforms are experiencing changes in the direction of developing capabilities that let companies track everything from order to payments.

In last few years we are facing with a growing number of new, web-based, software-as-a-service (SaaS) products that offer services of connection of a supply chain network and provide capabilities for supply-side and demand-side collaborative order management, inventory planning and logistics planning. In addition they serve up integrated business intelligence, business process management and real time exception management. (Stackpole, 2011) Tools like SaaS offer also the possibility of synchronization of multiple enterprises connected in the supply chain network.

There are also many applications that focus on particular supply chain visibility problem. The global trade management solution is one of them. Its purpose is delivering of view into

international inventory and shipment status. The purchase/use of these applications is reasonable only in case the manufacturers have a well defined visibility problem.
Another possibility to solve the visibility problem is the development of custom integration between multiple software packages and legacy enterprise systems. But to gain end-to-end visibility this integration has to be connected with external systems (systems used outside company) what is very difficult, time consuming and costly task.

2.5 Supply chain collaboration

One of the prerequisites for the effective and optimized supply chain management is the supply chain cooperation - cooperation and information exchange among supply chain partners. Collaboration requires adequate infrastructure. Therefore, individual partners should adopt software solutions "based on common architectures and data models" (Horvath, 2001), or based on opened architectures like SOA. Anyway, the infrastructure should acts as an intelligent network that enables e-business transactions.
Collaboration among supply chain partners requires access to networked supply chain management application (via internet or virtual private network), large and flexible database, capable to store large amounts of data from different sources, integration of systems and access applications, improved business intelligence, value-added, and e-commerce capabilities (analyzing capabilities, supply and demand chain planning, electronic billing and payment, digital certification, etc.) (Horvath, 2001).
Business Process Management (BMP) is a strategy that forms a necessary collaborative environment for the efficient execution of complex business interactions and activities among supply chain partners. It "represents a strategy of managing and improving business performance by continuously optimizing business processes in a closed-loop cycle of modeling, execution, and measurement" (Oracle, 2008), "is a holistic management approach focused on aligning all aspects of an company with the wants and needs of clients" (Brocke & Rosemann, 2010). Its aim is to enable a company/business process to be more effective, efficient, flexible, and agile, therefore to optimize its business process continuously. The main benefits of BPM are higher customer satisfaction, product quality, delivery speed and time-to-market speed, what are also the main challenges in supply chain management.
BMP per se is a result of convergence of various technologies and strategies and represents an integrated solution that satisfies a company's lifecycle of achieving proper business goals providing knowledge workers with easy access to information, improved communication, and greater collaboration technologies. (Oracle, 2008) BMP life-cycle consists of various activities: vision (design of functions and their processes aligned with strategy and business goals of the company), design (identification and design of existing processes), modeling (what-if analyses on the processes), execution (automation of business processes through software applications and business rules), monitoring (tracking, evaluation and analyze of individual processes), and optimization (retrieving and identifying of eventual problems, finding possible improvements and applying them in the design).
We can say that establishing a strategy for BMP is the first and basic step on the way to realize an effective and efficient information and decision support of the core business functions (internal) and also the prerequisite for establishment of the information chain that underlies the global supply chain of which our company is a part (belongs). Before choosing of the right technology well understanding of the business is necessary and well defined business models are needed. Obviously, the chosen technology should well fit company's business needs and objectives.

Good BPM toolset therefore supports transactional business processes incorporating business intelligence features and allows the monitoring of business performance and its real-time measurement, discovering possible problem solutions and optimizations answering what-if questions based on real data or simulations, and consequently find the points (bottlenecks) in our business where we should invest more.

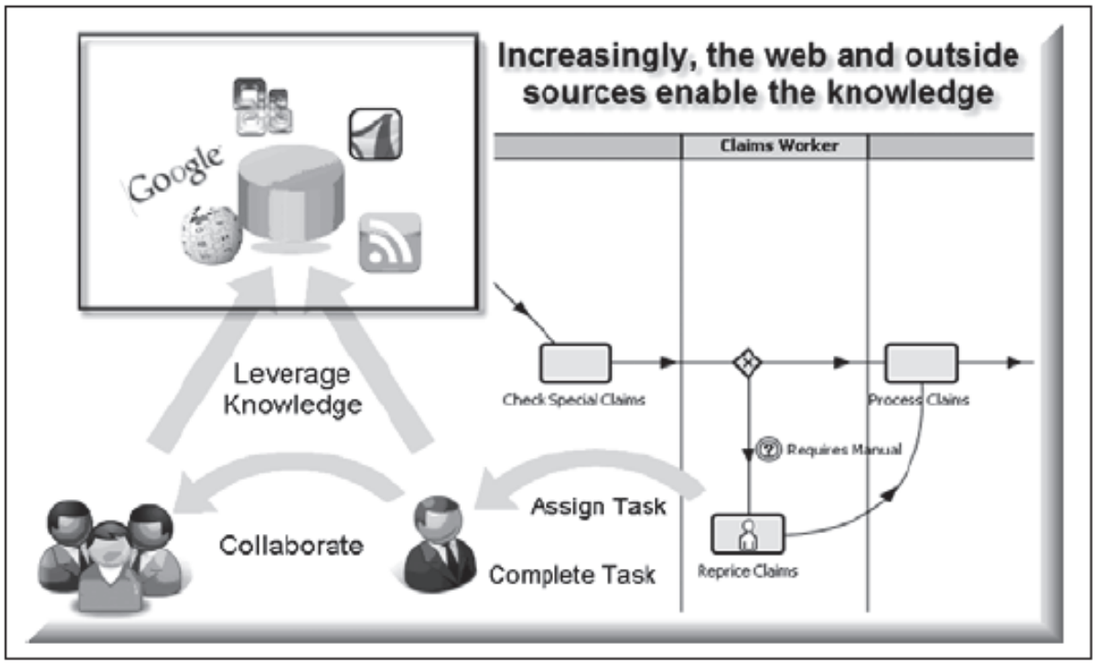

Fig. 6. "BPM is applied to the complex interactions and unstructured activities within knowledge worker collaborative environments." (Oracle, 2008)

BPM not only facilitates discovering of existing information and decision making but, using a variety of tools and resources within and outside the company often also creates new information. Besides of managing complex tasks and unstructured activities in harmony with business processes, it offers a set of well orchestrated tools (templates, portals, collaboration, Web 2.0, SOA services and technologies) that form a necessary collaborative environment for the efficient execution of complex business interactions and activities.

2.6 Supply chain intelligence (Business intelligence - BI)

Today's demands in doing business are increasing every day, regardless of what kind of business a company is involved in. Companies are facing with keen competition, with the need for reducing operational, product and service costs, the need for increasing functionality, flexibility and the ability to take (make) right decisions, based on information gained from operational and historic data, in right time. To take right decisions we need timely and accurate information and reporting environments. We have to cope with a vast amount of business data (from disparate operating systems and applications), rapidly changing customer needs and market conditions, but also with a vast amount of hidden information (documents, e-mails, know-how, voice records, external sources etc.). ERP systems have also been designed to capture all these data, but their grater limitation lays in the fact that ERP do not support ad

hoc querying and reporting, and simulations on data. Therefore, we need integration of our core business information system with a set of intelligent tools, intelligent information systems and modern analytical and artificial intelligence tools to discover relevant knowledge from all of these sources, to manage uncertainty, and to create and reach our business intelligence as our main competitive advantage.

It is very important that users are able to explore and analyze data, and make different reports, but it is also important they can predict the behavior of customers, products and processes. Business intelligence tools are tools that can help users to reach all these goals – via querying, reporting, analyzing, visualization, uncovering patterns and correlations and relationships hidden in data. But, the real future of the business intelligence is in right use of these tools. They have to be guided and used by users who understand the business, the data, and the general nature of the analytical methods involved and are familiar with the software environments.

One of the most significant factors influencing the realization of these goals (Vatovec Krmac, 2009) and way of doing business and collaborating with trading partners effectively is information and communication technology, which enables fast and reliable internal and external communication, permanent storing of business data and activities needed for current business and planning future business activities. In uncertain environments, where data from external sources are needed for strategic planning, it is even more important that we know to explore all these data, process them in the way to produce knowledge and find hidden patterns, relationships and correlations that help us in strategic decision making, forecasting trends and possibilities.

These capabilities, related technologies and tools are seen as promising future technologies (Gartner, 2009) and prerequisites to survive or beat the recession (Pincher, 2009). Business intelligence, data content, and data knowledge are emerging technologies that are expected to have innovative potential in the next years.

2.6.1 Definition of business intelligence

Summarizing numerous definitions of business intelligence we can say that business intelligence is a set of intelligent (software) tools and systems that help (facilitate) a company to better understand, analyze, explore and predict what is occurring in the company and also in the broader environment. These tools and systems help the company to turn data, usually collected and saved in databases, into useful and meaningful information, which is then distributed to those who need it, when they need it, wherever they need it for improved and timely decision making. Business intelligence tools also allow a company to see, use and combine large amounts of complex data from different sources - internal and external, normalized or denormalized, structured and unstructured, and to represent the integration of these data in various reports and graphical 3D views. (Schiff, 2010)

Business intelligence helps a company not only to monitor its operations by querying, analyzing, reporting, performing in-depth analyses of what is going on, what helps find and resolve potential problems, identify and leverage new opportunities, predict and plan for the future, align the operations with strategic goals. Indeed, "Business intelligence usually refers to the information that is available for the enterprise to make decisions on". (1keydata, 2011) Because of this it has become a synonym for decision support. In addition, because of the fact that business intelligence is often (but not obligatorily) used with data warehousing it has also become a synonym for this term. However, data warehousing only is a component for achieving business intelligence.

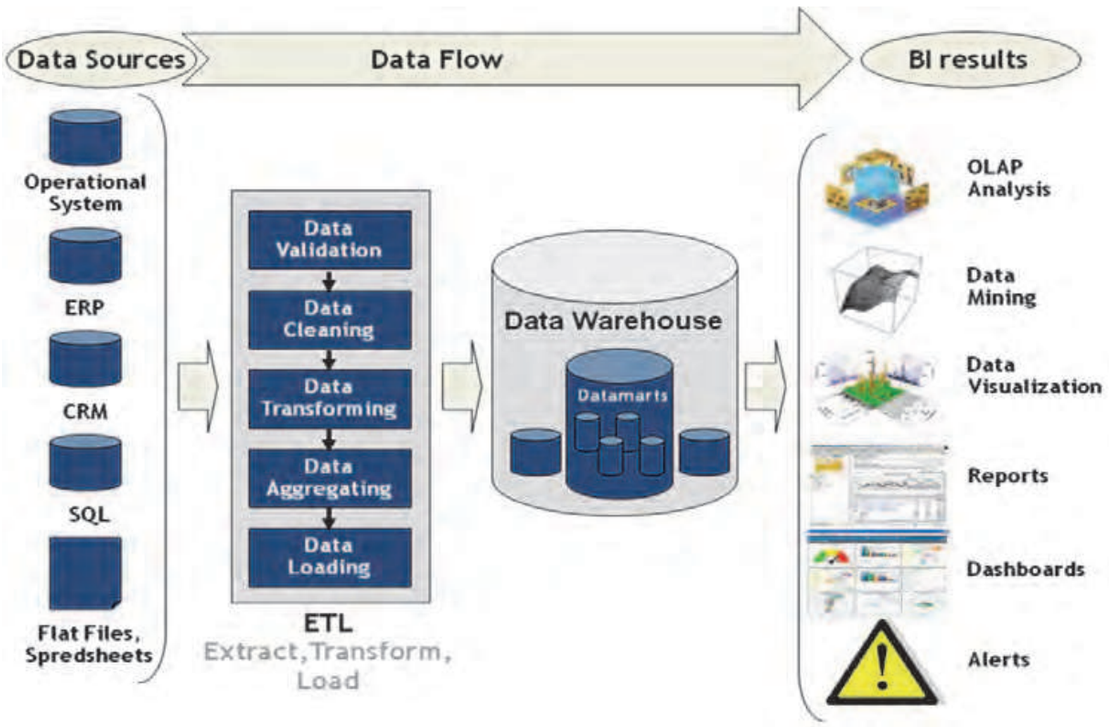

Fig. 7. Through ETL - Extraction, Transformation, and Loading processes, data from various sources are validated, cleaned, transformed, aggregated and loaded into data warehouse, special sort of database system, optimized for reporting. And through use of special software tools we can produce various dynamic analyses of data, known as BI results.

2.6.2 Business intelligence tools and technologies

Business intelligence tools are tools commonly used for implementing business intelligence. This does not mean that business intelligence tools are making non-trivial decision by themselves. "Decisions are made only and business intelligence is garnered only with the combination of the output of the business intelligence tools, human judgment and intuition, and the ability to put the information spit out by tools into a context of information that is much wider than any data warehouse, transaction processing system, knowledge repository can handle. (SDG Computing Inc., n.d.) The term business intelligence tool represents software that enables business users to see and use large amounts of complex data. (Schiff, 2010)

The spectrum of business intelligence tools and functionalities is very broad. They differ significantly regarding their cost, functionality, business intelligence complexity and number of total users. The most common business intelligence tools are as follows.

Spreadsheets

The most common, popular and used business intelligent tools are spreadsheets (or we can say Microsoft Excel files). The reasons for this are numerous: it is relatively cheap, easy to use, well known in the business area, it has/includes almost all functionalities that users need to display data, and quite all other reporting tools have export to Excel and Import from Excel. The most common use of Excel is reporting and goals tracking.

Query, reporting and data visualization tools

Answering predefined questions, a query tool offers to users a static view of information to be analyzed, combined with information from other sources or exported for use with other tools. The next group of tools are reporting tools that are either custom-built or commercial (the determination whether to buy or build a reporting tool has to based on a number of reports, the desired report distribution mode, and the need for ad hoc report creation). Reporting tools are more flexible compared to spreadsheets, and enable each user to create, schedule and run their own reports. This is the software that allows the user to ask (ad hoc) questions about patterns or details in the data. Visualization tools include a set of graphical tools, dashboards and scoreboards. The most common application of visualization tools is the visual interpretation of complex data relationships that facilitate decision making.

OLAP tools

OLAP (On-Line Analytical Processing) tools are used for multidimensional analysis ("slicing and dicing" of the data). They provide users with the ability to look at the data from a variety of different dimensions. OLAP means also "the use of computers to run the on-going operation of a business" (Schiff, 2010).

Data mining tools

"Data mining tools predict future trends and behaviors, allowing business to make proactive, knowledge-driven decisions." (LGI Systems Incorporated, n.d.) A data mining tool is the software that automatically searches for significant patterns or correlations among different factors in the data using sophisticated statistical and other techniques. It comprises various artificial intelligence tools and techniques like neural networks, machine learning, genetic algorithms, decision trees, knowledge management, rule induction, information extraction and information retrieval systems and other.

Fig. 8. The various BI solutions allow users to create reports, dashboards and web portals that visually displays the corporate data the user need to monitor in order to get quick understanding of the health of the business.

Core business intelligence technology (query, reporting, interactive analysis) is used to view or analyze what is occurring or has already occurred (business operations reporting – weekly or monthly reports), while data mining and predictive analysis allow users to predict what may occur in the future (this ability can be a competitive advantage in today's uncertain economy and global crisis) (Schiff, 2010).

2.6.3 The selection of appropriate business intelligence tools

Before we select an appropriate set of business intelligence tools for our business we have to know our business intelligence needs. We have to decide what types of business intelligence tools we would like to have, than choose a right vendor, and finally implement these tools in our business in the right way.

When selecting a business intelligence product we have to consider a lot of important factors. Among them (Schiff, 2010) are specific product features, ease of use, ease of implementation and administration, scalability, user-interface options, the ability to access and integrate a wide variety of disparate data sources, strong search functionality, and how well it integrates into existing and future platform environment (integration with desktop software, operating system). (Sheriff, 2006)

When implementing business intelligence we can choose to do it gradually or "all at once". Gradual implementation means that we first implement tools for operational purposes like databases, reporting and analyzing tools, and when business users have become familiar with them and our business has grown up and expanded, in the second step we implement business intelligence tools for deeper analysis, such as data warehousing and data mining. The strategy of implementation of business intelligence tools depends primarily on the funds at our disposal and also on the expertise or familiarity of business users with different software systems. (Schiff, 2010)

Before choosing a set of business intelligence tools that are most appropriate for our company we have to decide whether to buy or build them from scratch. According to various sources of business intelligence knowledge (1keydata, 2011; Sheriff, 2006; Shiff, 2010) when making the decision of building or purchasing a reporting tool we have to consider our requirements regarding the reports we need, the distribution mode of reports, and the need for ad hoc report creation. If there is a need for a high number of reports, then it is better to buy a reporting tool because it already has a report management system which makes maintenance and support functions easier. If users will access reports through a variety of different channels (not only email or using a browser), then buying a reporting tool, that comes packaged with these distribution modes, is probably the right decision. If we have users that are able to create their own ad hoc reports, then purchasing a reporting tool is a better decision.

2.6.4 Applications of business intelligence in supply chain

The implementation or use of business intelligence tools can help in various ways to achieve goals of every supply chain partner and supply chain as a whole. Some of the applications of business intelligence in supply chain activities (predominantly in transportation and warehousing, and order management as a key activities of supply chain and the activities where most savings can be obtain), are listed below (Chatterjee & Tsai, 2006; Sheriff, 2006; SDG Computing Inc., n.d.; LGI Systems Incorporated., n.d.; Tseng et.al, 2005):

- Achieving a cost-effective means of transport. (Business intelligence software can facilitate a fast and easy selection of the best means of transport considering a vast

number of factors (the key factors to consider in selecting the means of transport are physical characteristics of the load, the number of loads to be moved, the distance to be covered, the required speed of movement, the required proof of delivery, cost of building/dismantling loads, packaging costs, space requirements, interface with other storage, transport and handling systems and housekeeping issues) and considering also historic data and past experience.)

- Reducing transportation costs, increasing efficiencies, and improving customer service with route optimization – routing and scheduling. (Route optimization software helps us route multiple vehicles (means of transport) simultaneously considering business rules regarding vehicle capacities, customer-committed time windows, and vehicle costs, work day rules, pre-assignment of orders to vehicles and other.)
- Cargo load optimization software helps us find the best loading patterns for the same shipments, select the best vehicle to match a given shipment, determine how many vehicles are needed for large shipments, determine the exact costs of shipments.
- Analyzing transport operations - routes can help us identify potential problems or inconsistencies in daily operations (or some departments), and compare costs of same shipments on different routes to establish the best one.
- Managing inventory efficiently and effectively by determining of the inventory level of a product or part.
- Managing orders efficiently and effectively to increase customer satisfaction.
- Recognizing trends and understanding how they affect the business.
- Evaluating the operations performed in the company (generating reports), evaluating strategic factors (internal and external) and identifying patterns of business and operational behavior (using data mining techniques).
- Identifying customers that are cutting back on their purchases so that special inducements can be offered to retain them.
- Implement dashboards and scoreboards so that executives and supervisors can quickly recognize operational exceptions or key performance indicators (KPI) that fall outside of accepted ranges. Some of the important KPIs could be planning accuracy, capacity utilization, resource utilization, load balancing, route utilization, scheduling accuracy, vehicle availability, vehicle loading time, average transit time, cost of transportation per ton, on time vehicle arrival, vehicle unloading time, order receipt accuracy, percentage of goods damaged, total order delivery time, on time deliveries, goods delivery rate, transportation costs and other. (Gartner, 2009; Pincher, 2009)
- Establishing and monitoring performance metrics and taking corrective actions if we see they will not be met.
- Comparing year-to-date sales for this year with last year and forecast sales for the entire year.
- Tracking customer orders.
- Integrating operational, spreadsheet, and historic data for analysis purposes to provide consistency for the company.
- Providing business users with the ability to perform their own ad hoc analysis and reports.
- Aligning daily operations with strategic objectives and quickly recognizing when they are not in agreement.
- Analyzing transportation means to verify cost-effectiveness.

- Making independent analyses of marketplace transportation costs to determine if our freight rates are competitive and to negotiate lower transportation costs if we are outsourcing transportation services.
- Forecasting economic and service impacts as consequences of changes in our transportation model, which permits us to find the optimal operating strategy.

2.7 Optimization and decision-support tools and techniques in supply chain

The broad set of tools and techniques, used for decision-support, fall in artificial intelligence domain. The scope of artificial methods, tools, and systems is to create intelligent machines (agents), develop methods and systems that are able to simulate human intelligence in problem solving, living organism, and human brain. Intelligence (Kasabov, 1998) "is the ability to learn effectively, to react adaptively, to make proper decisions, to communicate in language or images in a sophisticated way, and to understand." The central problems of AI include are reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. (Russell & Norvig 2003, Luger & Stubblefield 2004, Poole, Mackworth & Goebel 1998, Nilsson 1998, as cited in Wikipedia, 2011a). Typical examples of AI methods are image and voice recognition, language and speech processing, planning, and predictions. Typical approaches used in AI are symbolic computation, artificial neural networks, fuzzy systems, knowledge engineering, genetic computation, game playing, robotics, and experts systems. All these methods and approaches can be successfully used also in improvement of supply chain activities.

Symbolic computation includes techniques as propositional logic, predicate logic, and production systems. This approach is suitable for exact and complete representations. Neural networks and fuzzy systems are paradigms for processing of inexact, incomplete, corrupted and uncertain data and information, frequently present also in supply chain management. Knowledge engineering is a combination of symbolic, neural, and fuzzy computation. Its main purpose is producing of knowledge (a kind of very condensed information) from large amount of data from disparate data sources, using data mining and ETL processes (see Figure).

Neural networks are used for processing very large amounts of data using rules and logical inference, and for making new rules, based on preliminary results and decisions. They are used for learning from these data, make predictions, and find possible correlations or patterns among data. An artificial neural network is composed of interconnecting artificial neurons - programming constructs that simulate the properties of biological neurons. Artificial neural networks are usually used to gain an understanding of biological neural networks. It is complex computer software that provides very good facilities for approximating data, learning knowledge from data, approximate reasoning, and parallel processing. It is used for function approximation, regression analysis, pattern recognition, predictions, discovering potential problems, data mining, system identification and control (vehicle control, process control), customer requirements and habits etc.

Fuzzy logic systems are also rule-based systems, but they are based on fuzzy rules (rules that represent knowledge that is ambiguous, vague, or even contradictory) and fuzzy inference ("fuzzy inference is a method that interprets the values in the input vector and assigns values to the output by means of some set of fuzzy" (Olugu & Wong, 2009)). Fuzzy logic variables, in contrast with conventional Boolean logic, may have values that range between 0 and 1 (variables can be also linguistic; in this case they are managed with special functions). Fuzzy logic is successfully used in predictions, analysis and measurement of performance of a supply chain.

Genetic algorithms perform evolutionary computation; they solve complex combinatorial and organizational problems by employing analogy with nature's evolution (Kasabov, 1998). These algorithms can be part of an expert system or of other information-processing systems.

Expert systems are knowledge-based systems that contain expert knowledge, gathered in the knowledge base, and act in the way the (human) experts do. The knowledge is represented by production rules (if-then). Experts systems are decision-support systems - they provide expertise for solving problems using machine-learning methods and artificial neural networks. They can be used for problem diagnosing, interpretations, monitoring, predictions, etc.

Computer simulation tools: are very powerful computer based systems that represent the real world and offer the opportunity to practice various situations and scenarios which are part of this real world, or are planned to be part of the real world. Simulation tools are used also for training and optimization of various processes, analytical and design processes, forecasting and modeling. Good examples of simulation tools in supply chain management optimization are cargo simulating software and route planning software.

Cargo simulation software is a cargo loading optimization software that allows creation of compact graphical load plans, selection of the optimal truck/container for transportation of the specified cargo, and maximizes truck/container utilization.

Route planning software: is a route optimization software programme, which allows the routing of multiple vehicles simultaneously, honoring various business rules (vehicle capacities and costs, work day rules, specialty pre-assignment of orders to vehicles, customer-committed time windows, etc.). It is designed to plan an optimal route between two geographical locations and to provide a list of places a vehicle will pass by, with crossroads and directions that must be followed, road numbers, distances, etc. (Vatovec Krmac, 2010) It usually provides also an interactive map with a suggested route(s) marked on it. It could be a separate application or integrated part of TMS (track and tracing software).

3. Barriers to the full implementation of ICT in supply chains

During the past two decades, supply chain management has received increased attention among industries because it helps achieve a competitive advantage. Information sharing between supply chain partners is one of the most important enablers for effective supply chain management, and greater supply chain collaboration and visibility. Recent advances in ICT and deployment of ICT tools in supply chains have significantly facilitate the information sharing. Despite the important advantages of ICT usage in the supply chain there are (still) some significant barriers in the process of establishing ICT. The fact is that a large number of manufacturers is still performing a lot of manual retrieving and management data processes using spreadsheets, self-made databases, etc., or maybe neither these tools. The barriers always influence one another and together have a negative impact on ICT capability or enablement of a supply chain, because they slow down this process. I in order to find or develop modes or strategies to tackle these barriers it is important to determine their nature.

The level of ICT implementation depends mostly on the size of the logistics company and types of logistics services this company performs. Regardless of the type of company, we

can easily conclude that barriers to ICT implementation are common to all. They are differing only slightly in relation to company size.

Various studies (Harland et. al, 2007) indicate that lack of awareness, support and commitment of top management about use or implementation of ICT could be the most formidable barrier to its implementation. If implementation and continuous development and improvement of ICT (internally and externally) are not strategic goals of the logistics company, it is unrealistic to expect any drastic improvements in efficiency and performance. But there are also many other barriers:

- disparities of supply chain companies,
- resistance of personnel to change to ICT supply chain management (changes in work culture and nature of work),
- integration problems in supply chain (IT infrastructure disagreement regarding the adoption and specification of the technical systems to be used, etc.),
- doubt about security and access privileges to information sources (important barrier in implementing internet and extranet technologies in the supply chain),
- costly, time consuming and "risky implementation of cross-organizational information systems" (Dvorak et. al., 2009),
- luck of trust in mutual connections between supply chain companies,
- fear of information systems breakdown,
- fear of supply chain breakdown,
- lack of funds,
- insufficient or poor ICT infrastructure and resources,
- lack of qualified personnel,
- unfamiliarity of personnel with ICT software systems and tools,
- incompatibility of company with customers and suppliers,
- organizational barriers (changed roles),
- rapid obsolescence of technology, etc.

Barriers can be also grouped by different criteria. One of them could be the source of barrier. In this case we differentiate internal and external barriers. *External barriers* interfere with the capability of establishing information flows among customers and/or trading partners and logistics companies. Clear information flows are necessary for undisturbed cooperation between supply chain partners and a primary precondition for effective supply chain management. Some frequent problems are disparities of supply chain companies, integration problems along the supply chain, fear of supply chain breakdown, etc. Internal barriers are consequences or results of internal problems, economic or organizational, and exacerbate exploitation of internal resources; they also have a negative impact on external functioning. Typical *internal barriers* are unfamiliarity of personnel with ICT systems and tools, lack of qualified personnel, lack of funds, fear of information system breakdown, doubt about security and access privileges to information sources, resistance of personnel to change to ICT supply chain management and others.

Another possible division of barriers is into groups of human-related and technology-related barriers. *Human-related* are all those barriers related to personnel, its capability to use ICT technology, fears, luck of trust, resistances, etc. On the other hand, *technology-related barriers* are all technical problems regarding integration of new ICT equipment and tools with legacy systems, incompatibility of systems and/or tools, rapid obsolescence of technology, disparities of supply chain companies, etc.

The barriers can also be categorized as economic, organizational or technological, depending on their consequences.
One of the big problems or threats to the most innovative logistics service providers is the speed with which ICT innovations spread and consequent rapid obsolescence of these technologies. Logistics service providers have to develop and adopt different software applications and processes to adequately support their business activities and to gain benefits from technologies. The high speed of diffusion and multiplication of applications by computer suppliers, the need for permanent renewal of existing information systems, demand a lot of their time, money and continuous organizational changes, and lead to the emergence of new activities and the elimination of obsolete activities. So, companies may prefer subcontracting solutions or outsourcing logistics activities rather than internalizing operations that necessitate technological investments that may substantially change their ways of doing business.

4. Conclusion

The primary purposes of adopting and implementing new technologies in any specific functional area have always been and always will be the reduction of overall operational costs, the improvement of operational performance, the improvement of customer satisfaction the reduction of inventory levels, and the reduction of lead-time. With proper information technology use also administrative and purchase order costs can be minimize. The importance of integrative and collaborative technologies, that make feasible improvements in information sharing, coordinating of supply chain activities, improvement of trust between partners, and commitment to supply chain relationships, is on the top of the priorities regarding the ICT technology for next decade.
In the field of information communication technologies every prediction as to how the development of technologies will proceed is tenuous. The main reasons are the velocity of changes in doing business, in information technology development itself, and the impact of globalization and other economic factors that drive or have a direct impact on the development of ICT.
But there are some points we can emphasize with confidence. There is the daily phenomenon of the internet developing a greater and more powerful role in doing business. According to the Gartner's' predictions (Gartner, 2010; Plammer, 2010) for next year's internet marketing will be still very important, but the companies should not focusing primarily only on the Internet for marketing purposes because they could find themselves unable to market effectively to customers. This could be a competitive disadvantage for them. Therefore, new approaches and new applications will probably emerge.
New internet-based software architectural and development approaches are already now making a significant shift of internal, in-house applications to the cloud, and probably this shift will be even more "massive" in next year's. SaaS implementations will be even less complex and even more affordable (Gonzales, 2009), and their number will increase significantly.
Considering that knowledge about customers, suppliers, and market demands still represents the real competitive advantage, the importance and improvements of business intelligence, prediction, optimization techniques and tools, will increase.

5. References

1keydata. (2011). Business Intelligence. Available from http://www.1keydata.com/datawarehousing/business-intelligence.php

Brocke, J.V.; Rosemann, M. (2010). *Handbook on Business Process Management 2: Strategic Alignment, Governance, People and Culture*. International Handbooks on Information Systems. Springer. ISBN ISBN: 978-3-642-01981-4.

Business Software. (2011). Top 10 Warehouse Management Software Vendors Revealed. 2011 Edition. Profiles of the leading Warehouse Management Software Vendors. Business-software.com.

Shelly, G.B.; Frydenberg, M. (2010). *Web 2.0. Concepts and applications*. Course Technology. Cengage Learning. Boston. ISBN-13:978-1-4390-4802-3.

Chatterjee, L. & Tsai C. (2006). Transportation logistics in global value and supply chains. Center for transportation studies, Boston University. White paper. Available from http://www.bu.edu/transportation/CTS2002G.pdf

Bell, M. (2010). *SOA Modeling Patterns for Service-Oriented Discovery and Analysis*. Wiley & Sons. pp. 390. ISBN 978-0470481974

Bidgoli, H. (2004). *The Internet Encyclopedia.* Volume 1. Wiley & Sons. pp. 707. ISBN 0471222011.

Daniel, E.M.; White, A. & Ward, J.M. (2004). Exploring the role of third parties in inter-organizational Web service adoption. *The Journal of Enterprise Information Management*, Vol. 15, No. 5, pp. 351-360, ISSN 1741-0398.

Dvorak, Z.; Čekerevac, Z. & Zemiar, Z. (2009). Proper communication means as a tool of decreasing company management risks, Krizovy manažment, No.1, Year 8, pp.19-23, ISSN 1336-0019, Žilina, Slovaky.

Dittmann, J.P. (2010). Managing the basics supply chain functions. *Supply Chain Management.* http://www.scmr.com.

EPICOR. Key Strategies: For IT success in today's distribution environment. EPICOR white paper. September 2009. Brown Smith Wallace Consulting Group. Available from http://erp.ittoolbox.com/research/key-strategies-for-it-success-in-todays-distribution-environment-21717

Fliedner, G. (2003). CPFR: an emerging supply chain tool. *Industrial Management & Data Systems,* Vol. 103, No. 1, pp. 14-21, ISSN 0263-5577.

Gartner Inc. (2009). Predicts 2009. http://www.gartner.com/it/products/research/predicts09/predicts09_tab1.jsp

Gartner Inc. (2010). Gartner Top End User Predictions for 2010: Coping with the New Balance of Power. Summary Report. Available from http://www.bopartner.com/pdf/gartner_predicts2010_NewBalancePower.pdf

Gates, B. (1999). Everyone, Anytime, Anywhere. The next step for technology is universal access. Forbes ASAP. Available from http://www.microsoft.com/presspass/ofnote/10-04forbes.mspx

Gonzales, A. (2009). The True Value and Meaning of Software-as-a-Service TMS. ARC Brief. ARC Advisory Group. ARCweb.com. Available from http://www.leanlogistics.com/leanlogistics_documents/ARC---The-True-Meaning-and-Value-of-Software-as-a-Service-TMS.pdf

Harland, C.M.; Caldwell, N.D.; Powell, P. & Zheng, J. (2007). Barriers to supply chain information integration: SMEs adrift of eLands. *Journal of Operations Management,* Vol. 25, No. 6, ISSN 1234–1254.

Horvath, L. (2001). Collaboration: the key to value creation in supply chain management. *Supply Chain Management: An International Journal*, Vol. 6, No. 5, pp. 205-207, ISSN 1359-8546.

Karisruhe Institute of Technology. (n.d.). http://www.commputation.kit.edu/92.php

Kasabov, N.K. (1998). *Foundations of Neural Network, Fuzzy Systems, and Knowledge Engineering*. A Bradford Book. MIT. ISBN 0-262-11212-4.

Lambert, D.M.; Cooper, M.C. & Pagh, J.D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management*, Vol. 9, No. 2, pp. 1-19, ISSN 0957-4093.

Lancioni, R.; Schau, H.J. & Smith, M.F. (2003). Internet impacts on supply chain management. *Industrial Marketing Management,* Vol. 32, No. 3, (April 2003), pp. 173-175, ISSN 0019-8501.

LGI Systems Incorporated. (n.d.). The data warehousing information center. Available from http://www.dwinfocenter.org

Light, B.; Holland, C.P. & Wills, K. (2001). ERP and best of breed: a comparative analysis. *Business Process management Journal*, Vol. 7, No. 3, pp. 216-224, ISSN 1463-7154..

McIvor, R. & Humphreys, P. (2004). The implications of electronic B2B intermediaries for the buyer-supplier interface. *International Journal of Operations & Production Management*, Vol. 24, No. 3, pp. 241-269, ISSN 0144-3577.

Obank, A., Leaney, P., and Roberts, S. (1995). Data Management within a manufacturing organization. *Integrated Manufacturing Systems*, Vol. 6, No. 3, pp. 37-43, ISSN 0957-6061.

Olugu, E.U. & Wong, K.Y. (2009). Supply Chain Performance Evaluation: Trends and Challenges. *American Journal of Engineering and Applied Sciences*, Vol. 2, No. 1, pp. 202-211, ISSN 1941-7020.

Oracle. (2008). Business Process Management, Service-Oriented Architecture, and Web 2.0: Business Transformation or Train Wreck? An Oracle White Paper. Updated August 2008. Available from http://searchmanufacturingerp.bitpipe.com/detail/RES/1288191501_440.html

Patterson, K.A.; Grimm, C.M. & Corsi, T.M.. (2004). Diffusion of supply chain technologies. Vol. 43, Issue 3, ISSN 0041-1612, Available from http://www.freepatentsonline.com/article/Transportation-Journal/121673632.html

Pincher, M. (2009). How to beat the recession using underutilized technology. Communications of ACM, ACM TechNews, (February 2009), Available from http://cacm.acm.org/news/20593-how-to-beat-the-recession-using-underutilized-technology/fulltext

Plammer, D. (2010). Gartner Top End User Predictions for 2010: Coping with the New Balance of Power. Summary Report. Available from http://www.gartner.com/it/content/1260200/1260215/january_14_top_predictions_2010dplummer.pdf

Razi, M.A. & Tarn, J.M. (2003). An applied model for improving inventory management in ERP systems. *Logistics Information management*, Vol. 16, No. 2, pp. 114-124, ISSN 0957-6053.

Schiff, M.A. (2010). Business intelligence: Improving your company efficiency and effectiveness, no matter its size. SAP White paper, (July 2010), Available from http://www.silicon.com/white-papers/view/business-functions/business-intelligencea-guide-for-midsize-companies-improving-your-companys-efficiency-and-effectiveness-no-matter-its-size-61306040/

SDG Computing Inc. (n.d.). The business intelligence and data warehousing glossary. (16.4.2011) Available from http://www.sdgcomputing.com/glossary.htm

Sheriff, M. (2006). Application of business intelligence in transportation for a transportation service provider. Available from http://www.techrepublic.com/whitepapers/application-of-business-intelligence-in-transportation-for-a-transportation-service-provider/386490

Shobrys, D. (2003). Business Intelligence and Supply Chain Management. Supply Chain Consultants. Wilmington, DE.

Stackpole, B. (2011). *Improving supply chain visibility via technology: options, trends and ROI-driven projects*. A SearhManufactoringERP.com Ebook.

Searchmanufacturingerp.com. Available from http://www.bitpipe.com/detail/RES/1276874691_104.html

Strategic Direction. (2004). Meeting the manufacturing challenge. Vol. 20 No. 11, pp. 28-30. Available from http://www.deepdyve.com/lp/emerald-publishing/meeting-the-manufacturing-challenge-performance-advantage-of-mes-a7VIyqOug1

Tseng, Y.; Yue W.L. & Taylor M.A.P. (2005). The role of transportation in logistics chain. *Proceeding of the Eastern Asia Society for Transportation Studies*, Vol. 5., pp. 1657 - 1672, ISSN: 1881-1132, Bangkok.

UC4. (2010). Intelligent Service Automation and Service Oriented Architectures. White paper. UC4 Software GmbH. Available from http://www.bitpipe.com/detail/RES/1301686243_940.html

Vatovec Krmac, E. (2005). Modern information communication technologies and tools for supply chain management. *Promet, Traffic & Transportation*. Vol. 17, No. 6, pp. 303-309. ISSN 0353-5320.

Vatovec Krmac, E. (2007). Interdependence between logistics activities and information communication (ICT) technologies. *Promet, Traffic & Transportation*, Vol. 19, No. 2, pp. 115-119. ISSN 0353-5320.

Vatovec Krmac, E. (2009). Business Intelligence in Transportation Logistics. *Transport 2009, Meh., Transp., Komun*., pp. 1-6(II), No. 3, ISSN 1312-3823, Sofia, Bulgaria, (6. -7. November 2009).

Vatovec Krmac, E. (2011). Computer based tools and simulation systems in the process of education of maritime and traffic engineers. *Collection of scientific articles. Economic sciences*. Vol. XXII, (in publication), ISSN 2219-5378.

Verwijmeren, M. (2004). Software component architecture in supply chain management. *Computers in Industry*, Vol. 53, Issue 2, (February 2004), pp. 165-178, ISSN 0166-3615.

Wikipedia. (2011a). Artificial intelligence. (16.4.2011) Available from http://en.wikipedia.org/wiki/Artificial_intelligence

Wikipedia. (2011b). Cloud computing. (16.4.2011) Available from http://en.wikipedia.org/wiki/Cloud_computing

Wikipedia. (2011c). Web 2.0. (16.4.2011) Available from http://en.wikipedia.org/wiki/Web_2.0

Winter, R. & Strauch, . (2004). Information Requirements Engineering for Data Warehouse System. *ACM Symposium on Applied Computing*, pp. 1-2, Nicosia, Cyprus, 14. - 17.3.2004, ISBN:1-58113-812-1.

Supply Chain Management - New Perspectives

Edited by Prof. Sanda Renko

ISBN 978-953-307-633-1
Hard cover, 770 pages
Publisher InTech
Published online 29, August, 2011
Published in print edition August, 2011

Over the past few decades the rapid spread of information and knowledge, the increasing expectations of customers and stakeholders, intensified competition, and searching for superior performance and low costs at the same time have made supply chain a critical management area. Since supply chain is the network of organizations that are involved in moving materials, documents and information through on their journey from initial suppliers to final customers, it encompasses a number of key flows: physical flow of materials, flows of information, and tangible and intangible resources which enable supply chain members to operate effectively. This book gives an up-to-date view of supply chain, emphasizing current trends and developments in the area of supply chain management.

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen