INFORMATION TECHNOLOGIES FOR CONTEMPORARY LOGISTICS CENTERS

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Abstract

Emerging trends increased the role of sharing and management of information in logistics so the utilization of the appropriate information technology is important more than ever. Choosing of appropriate information technology infrastructure, and a process management technique to go with it, and the execution of a real-time integrated systems with high functionality and reliability always establish the efficient and effective supply chain management services. This paper includes descriptive and analytical understanding role of information systems in logistics and supply chain management. Logistics professionals are the main beneficiaries of this work. In this study we explain the capabilities of the contemporary Logistics Center information system and necessary parts of information technology infrastructure. We also provide some details as to the definition of information systems together with the roadmap to gain competitive advantage through the utilization of new information technologies; In addition to those, we present a guidance to be followed by the logistics centers to serve its stakeholders and for them to operate and manage its core logistics activities by applying information systems with process management approach. And, also covered are the multifaceted aspects of the power of information systems integration within a supply chain.

Keywords: Logistics Centers, Logistics Information System, Process Management, ERP, Supply Chain Management, Semantic Web.

1. Introduction

Currently none of the information systems packages (specifically ERPs) are satisfying to the requirements of the contemporary Logistics Centers from the perspective of the Information Systems. The main reason for this deficiency is that all these packages have not necessarily been designed to satisfy the requirements of the Logistics Centers. The problem is the scope of the requirements of the Logistics Centers which goes beyond the ERP boundaries. Therefore, in this paper we intended to define the capabilities and the required technologies of information systems that will fully satisfy the needs of Logistics Centers.

The paper is structured around six sections including the introduction. The second section defines the problem currently we are facing. The third section draws the framework and the business domain of the Logistics Centers in general terms that focus on definition of the Vision and Mission statements of a Logistics Center including Strategies the Policies and execution plans. The fourth section explains the ERP systems' competency of Logistics Center and the new trends. The final section contains the future of logistics information system.

2. Problem Definition

The competitive environment of the logistics business necessitates the heavily use of information technologies. These needs are creating the significant driving force for the local and global ERP vendors. Almost all vendors establish a base for a growth as a respond to this dynamics positively and promptly.

However, this being the case, records shows the significant failure rates in several ERP based projects[4]. Even well designed ERP packages so far have failed to satisfy the needs of a logistics centers due to the lack of definition of the requirements and improper process designs.

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[4] "Statistics show that more than 70 percent of ERP implementations, whether self-created or designed by established software vendors, fail to achieve their corporate goals. The primary reason, according to a Booz Allen & Hamilton study, is that companies have not made the appropriate strategic choices needed to configure the systems and processes." (Kulik G. August 1999. Supply-chain logistics. Global Logistics & Supply Chain Strategies. http://www.supplychainbrain.com)

From the users' standpoint, the lack of integrated perspective, insufficient analysis, and resistance to change in the organization and of the misperception of the environment can be counted as the deficiencies for the causes of failure.

The major problem can be identified as, "Currently available ERP packages are not compatible with the business domain of the contemporary logistics centers and they create an environment causing some integration gaps among supply chain participants".

The reason of this problem is related to the aim of design and implementations of these packages. ERP is the label that has been given to all back office activities of manufacturing based_organizations. Unfortunately ERP packages do not fully support the orchestration of the processes among the enterprises of a logistics center because the very package is not in compliance with the contemporary business dynamics. This problem has been determined by some of the authors who have focused on ERP's future. For example, Kalakota and Robinson (2001) have denoted that the ERP's future is related with customer and interenterprise integration and they named the new level of ERP as Extended Resource Planning (XRP). Similarly, Ross (2003) has cited that, the existing ERP systems should transcend their origins that would be more appropriate and the new systems must be called as the enterprise business systems (EBS). Possibly most forceful argument comes from Griffin and Scherrer (2004); they consider major ERP vendors such as SAP and Oracle no longer as ERP producers. Even it is difficult to find the term ERP anywhere in their web pages. Those vendors are positioned themselves as an IT company that provide the comprehensive range of enterprise software applications to help the organizations to consolidate, manage, use, share, and to protect the business information that comes in the format of customer relationship management (CRM), supply chain management (SCM). All of these examples and the conditions are directing us to focus on the business processes and the process management.

3. Characterization of the Logistics Centers

A Logistics Center (LC) should organize all the logistics activities regarding layout, business processes, and information systems for several enterprises under one roof. In this paper customer is assumed to be a manufacturing company who wants to outsource all of her logistics operations to an LC. As shown in Figure 1, the LC plays a central role for orchestration of the activities among all the participants of the supply chain such as manufacturers, sellers, transporters, suppliers and, retailers. Moreover, all of the already mentioned components here gather to fulfill the specific requests of the customer.

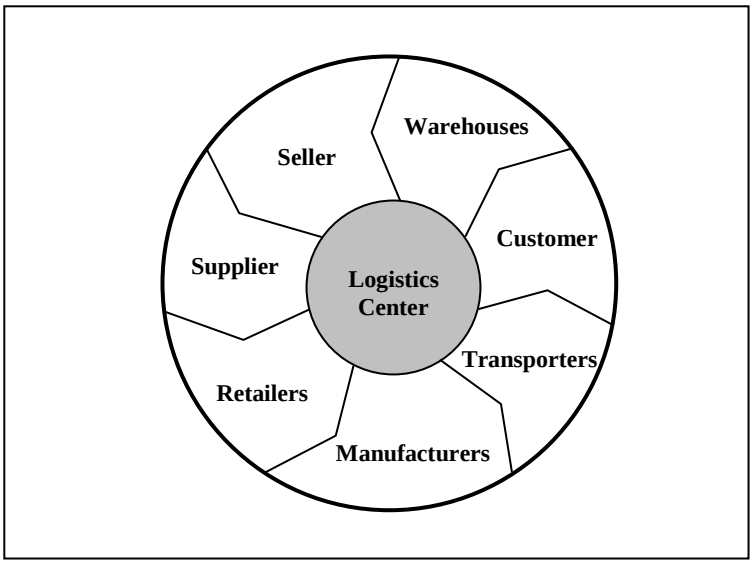

Figure 1. The central role of an LC.

The overall goal of an LC is defined as to add a value to the participants of the LC operations by introducing logistics systems which in turn incorporate the newest technological solutions. Several industrial practices help us to understand the concept of an LC. For instance, some of the LC objectives are "quick and integrated distribution processes, paperless control of all goods movements and, map all logistics processes in an integrated system"[5]. The objectives listed above show how an LC has a unique role in supply chain and consequently, we represent the benefits of an LC to its customers' logistics operations such as:

- The significant reduction in order lead times,
- A notable increase in capacity and flexibility,

[5] http://www.sap.com/industries/machinery/pdf/CS_Stauff.pdf

- An increased customer satisfaction with delivery quality and punctuality,
- Some monetary advantages and fiscal benefits,
- The sizeable, measurable and controlled logistics operations,
- To provide an environment in order to concentrate somewhat deeper in main business functions.

Basically an LC plays an intermediary role, but this role does not explain the full positions of an LC under contemporary business conditions. The logistics dynamics causes an increased collaboration between LC and its customers. Same dynamics defined as a much-closed partnership rather than a relationship between the sides under the win-win philosophy. An LC does not only realize some core logistics functions such as transportation, warehousing, shipment consolidation and but also provide service to the customers' own resources, capabilities, and technologies. Most of the LC has to share and fulfill its customers' strategy. Therefore, an LC is responsible to analyze, redesign and rebuilt of all logistics processes of its customers if necessary. The LC should have the necessary information technology, human, management and support resources to satisfy all of these innovative requirements. Thus an LC should clearly state the common target and the reason as to why this company has been established for all her stakeholders after all. And this is what we call as the statements of both vision and mission.

A Typical Vision Statement for an LC might be: "An LC of X by guaranteeing the balanced satisfaction of her stakeholders will be the MARKET LEADER in Turkey for the Integrated Logistics Services for sector Y latest by the year 2010 as an interim target and will be the Market Leader within the European Union for the same sector by year 2020 and finally by enlarging its service spectrum to include the sectors V, W, Z will be either number 2 or number 1 in the World Market and sustain its position for a long time."

Parallel to this Vision, a typical Mission Statement might follows such as: "By fully satisfying her stakeholders and gaining competitive advantage for sectors Y, V, W, Z for the Logistics services, LC of X has a clear goal to add value to the enterprises in its target sectors by combining the newest and long lasting solutions in conjunction with the innovative systems designs and implementations."

Following these definitions for the common objectives of an LC, the company values, policies and of the strategies are to be defined to reach to the Vision. Consequently, the careful and detailed analysis of the operational, support and managerial processes will be the key milestones to go further on the requirements and systems definitions which will define the means of realizing the vision plus will constitute the domain upon which the implementations and realizations of the strategies will take place. Therefore the system requirements will be identified and created as if it is a replica of the physical system or corresponding activities system in a virtual world. This aim will be reached if and only if the operational processes are precisely defined at each and every step. And thus, the corresponding software transactions environment gets to be acquired naturally.

The vision and mission statements together with associated strategies and policies are realized through the precisely designed processes and that way they will provide a way to create a competitive advantage to the LC,, to her customers and, to the satisfaction for all logistics supply chain participants, what we called as the stakeholders.

4. The Capabilities of an ERP Systems and the New Trends

The business activities and the information technology (IT) of an LC are comprised of numerous dependent and independent components. The IT is the largest context that includes information systems (IS) and infrastructural parts such as the communication networks, hardware and software technologies. The IT model is depicted in Figure 2. In this study, we are especially focused to LC's ERP requirements since as a whole the ERP has a vital role for the execution of the business plans of a competitive LC.

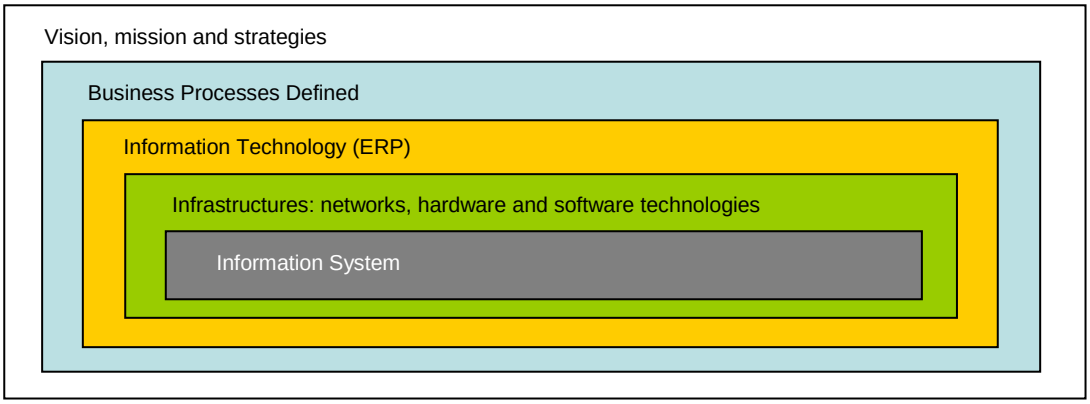

Figure 2. Information technology model.

The ERP system of an LC (LC-ERP) has two major characteristics as already mentioned in section 2 and explained below:

#1 The LC-ERP must be exercising all necessary controls, flexibility and dynamism functions over the LC operations. The major gap here is; the design goals of ERP systems might be over specific for the manufacturer company, since the ERP systems originally have been developed under MRP philosophy. However; since an LC operates in service sector, the ERP has to include many patches to satisfy in-house LC requirements accordingly. On the other hand the patches might present some real threats for LC's major business activities since they may present some real technical problems in the format of the potential implementations and upgrades. For example; the core logistics domain concepts such as navigation, landing, airport, seaport and, warehouse operations are some kind of a patch for ERP.

An LC-ERP must be responding to the contemporary LC requirements and it must be providing highly integrated, manageable, and well-matched infrastructures between the LC's strategic business units and ERP itself as shown in Figure 3. An LC-ERP can be communicating with each of these sub-systems in order to create a value plus to provide a progress in the roadmap to reach the vision by performing the mission.

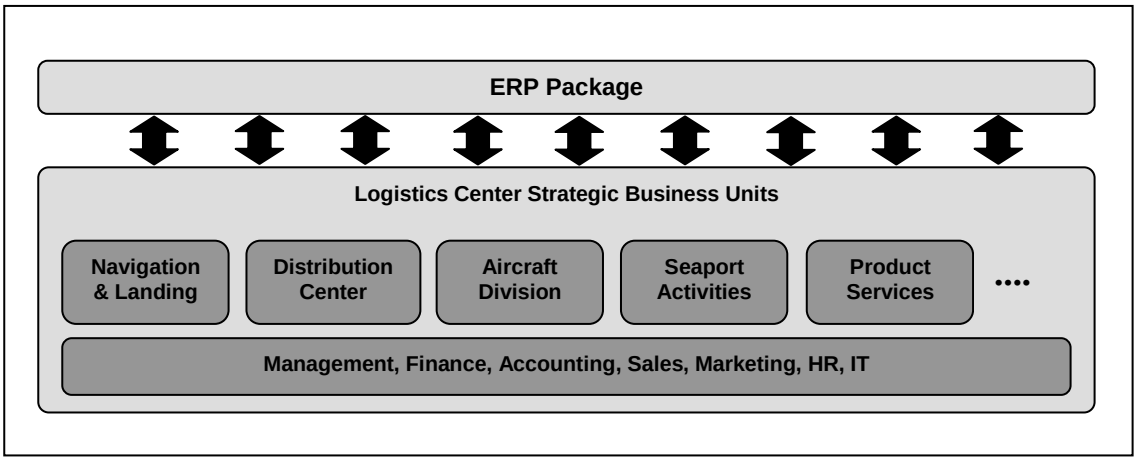

Figure 3. A simple relationship between LC's business units and ERP.

#2 LC requirements are more complex in the multiple heterogeneous business worlds as aforementioned. Each and every customer has unique logistics and business processes. Thus a competitive LC needs integrated solutions among all participants together with a process based customized solution for its customers and members of supply chain. At this point, an LC-ERP should have capabilities to design, implement, support, manage and handle different logistics operations for LC's value chain which require different ERP products and infrastructures. One unique ERP package cannot manage and satisfy separately each of the customer's logistic processes as shown in Figure 4 and there is no any shortest way to a successful solution of the problem.

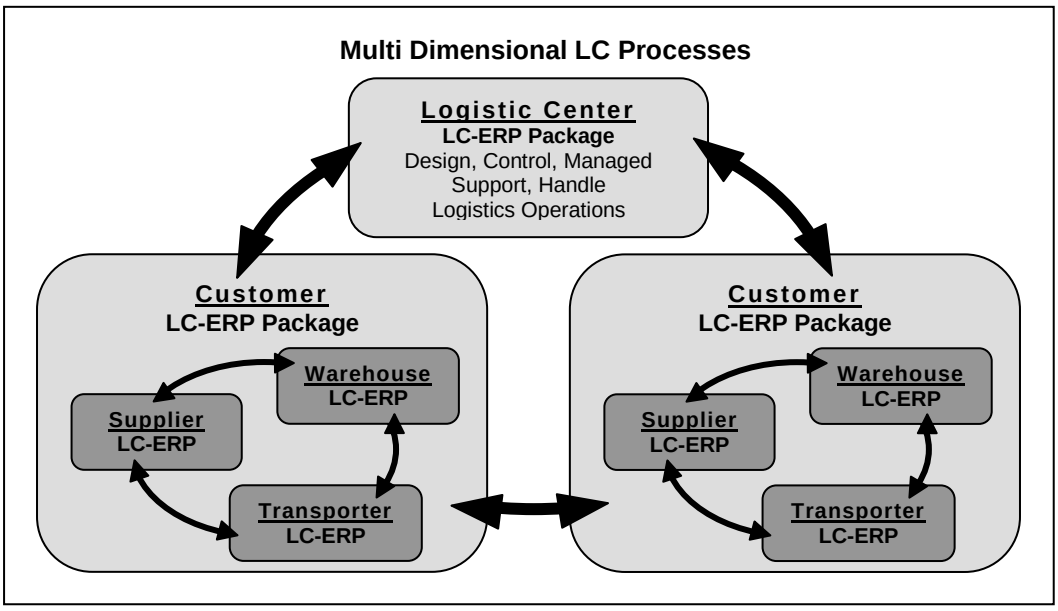

Figure 4. Multi dimensional LC Processes.

Creating a major logistics operation means the adding of intelligence to the LC-ERP services, delivering interactive and timely information to the right people, synchronizing customized business operations, and executing and managing all activities which one can attain only through the integration of information and the services. Even though there are a lot of advantageous of an information possession, it is not always enough when the managing the business processes and functions are in question The Company must share related information among members of supply chain, and also LC must develop knowledge based IT infrastructure for intelligence gathering and analysis.

Integration is the dominant theme for a success of the entire supply chain, thus, this objective is obtained by powerful, safe, reliable, timely, and process based integration that takes place among the LC channel partners and customer itself. The integration attributes discussed below are remarked from Singletary (2002):

- Working together,
- Data sharing,
- Common database utilization,
- Real-time processing,
- Seamless operation,
- Record once and use many times, in everywhere.

Supply chain integration has important attributes, such as; design concepts, functionality, security, and scalability. It should also be process based as well. The security is one of the most important concepts and SCM must include sophisticated security capabilities in the e-commerce and in the e-business environment and also should be able to support current as well as legacy technologies without a fuss.

Fulfilling of the vision and mission statements that were defined in section two, the job of an LC-ERP is to establish the best orchestration and managerial harmony between the members of supply chain. An LC-ERP should control and identify the risks in order to manage them and coordinate the related processes for each of the alliance in the multi dimensional logistics operation as shown in Figure 4. Also, an LC-ERP package should use the new technologies to do real time integration among all supply chain virtual participants. This real time integration is the main philosophy of SCM whose success depends upon the fulfillment of well-known logistics keywords “the right product, the right place, the right price, the right time, and the right condition”. Under this assumption, an LC-ERP implementation is a collaborative effort and the integration of supply chain activities or partners each of which is one of the key concepts for ERP package. For example, planning is one of the important process integration subject that refers to joint design of supply chain members’ resources such as manpower, container, warehousing with the customers requests such as time, destination and so on. On the other hand, planning activities should contain some other logistics activities such as forecasting, manufacturing scheduling and product design for logistic customers. Therefore; the planning synchronization needs task sharing, determining the interactions, development of cooperative actions, coordinating the activities and sharing the results among business partners of SCM.

This type of integration is called the Business Process Integration (BPI) and it allows the exchange of information between applications as part of a business process among different supply chain participants. The key point here is that the business requirements can be a process-based model. In process-based model; activities, flows, transactions, and roles are defined and organized by an LC as well as other LCs, customers and other suppliers. Also BPI gives a chance to optimize company resources and to provide business-reengineering facilities for all supply chain members.

The architecture of BPI should be based on eXtensible Markup Language (XML). The XML is a programming language, which provides the means of describing and exchanging data in a common, open and universal format for structural documents, database integration and a data transfer. The standard XML format coordinates information flow, application connectivity, and process management among key partners and business units. XML services can maintain IT based service providers in both internal and external processes.

Despite of the many positive items of XML it is not enough for a solution of integration problems. An example from Dacontas helps to understand this problem: If labeling something in XML price should define in one label <price>$12</price> and another label in the invoice <cost>$12</cost>, there is no way that a machine will know that those two mean the same thing. The problem stems from the heterogeneous database structures and organizations. That means that an LC may have many commercial relationships and in turn every relation may have its own specific data structures. In this example every company has got her own metadata model thus, there are significant difficulties to consolidate. Eventually, these types of conflicts and/or contradictions will pose a threat to the integration processes.

This complex and highly heterogeneous environment needs carefully analyzed business functions and requirements, and also highly technical background. The very nature of this problem forces the solution to move to the information level integration. It means that the integration tools of an LC should answer all integration problems concerning the processes at information level first. Here, the data has a central importance and

information integration involves structured data. So, the LC should establish a shared metadata model; that provides a common view of the data across the chain, of which provides solutions for the integration and migration of all business application data. This is also useful for business intelligence, data warehousing, data mining, CRM, and data analysis.

Currently the existing ERP packages utilize the traditional solutions for integration. And that requires the utilization of master data which is unified data storage across partners in a heterogeneous landscape. So, the LC and her customer have to share the semantically familiar master data which is a common practice and a common problem of an ERP domain.

The traditional tools, which were developed as a countermeasure to the problems of ERP are B2B and B2C and these applications are embedded in BPI. However, traditional B2B and B2C applications are so specific to integration problems faced at application level. One of the proposed solutions is the electronic data interchange (EDI) format but it needs so much effort to build and it is by no means flexible and open to improvements. The metadata model with EDI facilities might propose a solution but not without a high costs of software development, hardware and support. As a result some solutions do exist but they are neither flexible nor easy to implement. Also a multi-organizational information sharing needs some other systematic approach to find a solution to the existing integration problem.

Defining a common set of terms is important stage for adaptable and reusable logistics framework. Essentially logistics is a larger information ecosystem that is quite similar to the business domain model; which emphasizes four major areas successively listed as the products, customer, infrastructure, and financial aspects (Osterwalder (2004).

Modeling of logistics domain means that the extending of semantics of logistics data to cover the whole value system. As an example to the concept of extending the partial transport domain model (Nichols, 2003) is depicted as Figure 5 below.

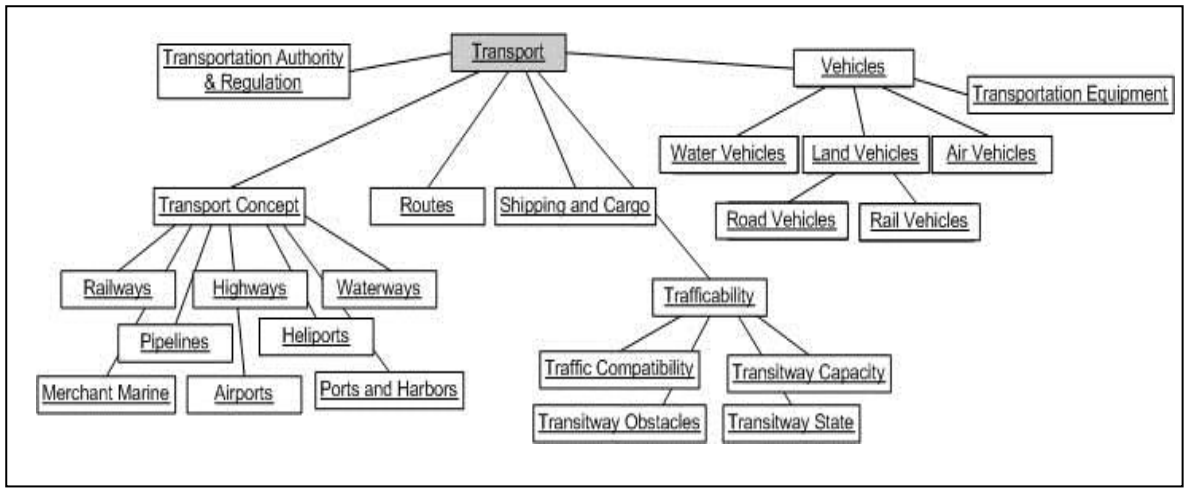

Figure 5. A partial transport domain model.

In this stage we can mention a hierarchical classification system, that's called taxonomy. A Taxonomy provides classification of a specific domain and the domain appears to be a collaborative environment to every parts of logistics business. In other words, taxonomy is a good way of describing the domain models. Therefore, sharing the information automatically from a general repository via Web should be possible. This situation creates some advantages for business integration and provides intelligence to logistics data. This is called knowledge-based operations and it has named as Semantic Web by Berners-Lee (2001) since all these activations occur on the current Web environment. The World Wide Web is an enormous success in business life. All trends show that the web is changing life and creating growth in the business outputs; especially logistics dynamics are affected from that.

Despite of many positive advantages, the web does not have enough intelligence. Actually, logistics business and value chain relationships require more sophisticated solutions. The Semantic Web provides a transformation from HTML pages that are well understood by humans to machine-readable format, so that the web gains meaningful, understandable, more sophisticated and machine-process able information specializations by a series of new standards such as XML, Web Ontology Language (OWL), Resource Description Framework (RDF), and other W3C standards.

The ontology is a shared and machine-executable conceptual model in a specific domain of interest such as Logistics. The machine-processing ability is the central difference between taxonomy and ontology (Daconda et

al., 2003). By definition, ontology is rigid and inflexible, and assumes one absolute definition that exists for each knowledge element. The idea is to establish a set structure of definitions and relationships between different models that are canonical[6] and eternal (Brock, 2005). OWL is an ontology language currently defined for the Semantic Web by W3C in early 2003. OWL allows for class hierarchies, constrained properties, and relations between classes. RDF is an XML-based language for representing information in the Web and a general method of knowledge modeling.

The Semantic Web might propose a way of changing the LC operations due to reasons stated below:

- Data, system and content integration.
- Enterprise application interoperability.
- Being able to manage the cross-organizational business processes.
- Customizable service-oriented architectures.

5. Conclusion

In this paper we have defined a problem and explained the possible integration approaches and the opportunities as a solution. By implementing the process management approach an LC can effectively solve this problem and may gain a competitive edge from this after all. And, from this perspective the major attributes that a successful LC-ERP should have are

- LC-ERP systems satisfy all of the requirements of all stakeholders under the defined vision and mission.
- LC-ERP systems are process based.
- LC-ERP systems are adaptable to the changing business dynamics.
- LC-ERP systems focus to the knowledge-based integration for all the stakeholders.

A good knowledge of logistics domain and good software engineering abilities & practices coupled by experiences, planning, management, plus having a direct relationship with companies' vision and mission statements yield an enterprise level success for an LC. The concept of semantic web will possibly provide a new solution to the existing integration problems.

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[6] Canonical refers to a common set of rules used to classify the relationship between things.