Lappeenranta University of Technology
Innovation and Software, School of Business and Management
Degree Program in Computer Science

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INTEGRATION OF LOGISTICS SYSTEMS ACROSS COMPANIES' BORDERS

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ABSTRACT

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Integration of Logistics Systems across Companies' Borders

Master of Science Thesis in Technology

2016

85 pages, 11 figures, 9 tables

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Keywords: Logistics systems, information systems Integration, supply chain integration, inter-organizational information systems.

The growth of the companies working in the Logistics area has raised the need for using several Logistics systems that can meet the increased requirements in business processes. Different companies may use one or more Logistics systems internally and may use different Logistics systems that other collaborated companies use. Furthermore, these Logistics systems are required to communicate with each other in order to process and manage the flow of the information.

Integrating the Logistics systems is beneficial as it allows interaction between the whole systems and services instead of the need to replace them. In addition, it improves the efficiency, lowers the possible errors in the supply chain, reduces the costs and facilitates the

access of suppliers and customers to the information. This in turn leads to better relationships with both suppliers and customers.

Usually local integration of several Logistics systems is not very difficult, especially that mostly the companies buy their system from a single source. However, the case is different for integrating several logistics systems across the companies' borders. In this case, there are many factors play major roles in limiting the integration, such as using different systems and different output.

This thesis highlights these factors and challenges, demonstrates some solutions for the logistics inter-organizational integration from the perspective of information systems and presents some approaches for integrating these systems. There are many studies about the integration inside a company but fewer studies focused about the technical side and the information systems integration across company's borders or what is called inter-organizational integration. This study is a literature review that aims at illustrating the challenges, the requirements and some approaches in inter-organizational logistics information systems integration of logistics systems across the companies' borders.

ACKNOWLEDGEMENTS

Foremost, I would like to express my special appreciation and thanks to my supervisor, Professor Kari Smolander, for the continues advise and support. His guidance helped me all the time during writing of this thesis.

I would like also to thank my second supervisor Negin Banaeianjahromi for her assistance and for her valuable comments.

Finally, I would like to thank my family, mom, dad, Raneem and Rani for their love and support. You are forever beloved and memorable.

Lappeenranta, May, 2016

Rafeef Basna

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LIST OF SYMBOLS AND ABBREVIATIONS

3PL	Third-party Logistics
B2B	Business-To-Business
CLM	Council of Logistics Management
COBRA	Common Object Request Broker Architecture
DC	Distribution Center
E- Commerce	Electronic Commerce
EA	Enterprise Architecture
E-business	Electronic Business
EDI	Electronic Data Interchange
E-HUB	Electronic Hubs
EPOS	Electronic Point of Sale
ERP	Enterprise Resource Planning
FIPA	Foundation for Intelligent Physical Agents
IT	Informational Technology
KPI	Key Performance Indicators
LIS	Logistics Information System
MES	Manufacturing Execution System
OMS	Order Management System
SCM	Supply Chain Management
SOA	Service-Oriented Architecture
SOAP	Service Oriented Architecture Protocol

TMS	Transportation Management System
VAN	Value Added Networks
WMS	Warehouse Management System

1 INTRODUCTION

1.1 Background

Logistics analyzes and manages the way resources are obtained, in other words, it models the flow of goods, people and information across almost all economic systems and supports the systems' design and implementation(Nettsträter et al., 2015). It includes all the logistics areas from in-house logistics, transports, and store suppliers along the supply chain. To manage the flow, the systems are required to configure, control and regulate the flows, which can be defined as logistics software systems. In addition, information systems and technology has become a critical utility for managing business-to-business relationships (Pereira, 2009).

Integration of logistics systems means that these systems work together to adequately plan and forecast tools along the logistics supply chain, identify potential suppliers and distributors, and predict costs. Some logistics systems include Enterprise Resource Planning Systems (ERP), Warehouse Management Systems (WMS), Transportation Management Systems (TMS) and Supply Chain Management Systems (SCM).

According to Koliński and Fajfer (2011), supply chain integration is a complex idea and it is important to understand the business processes interaction along the supply chain in order to succeed in the competitive business area. In their opinion, the decisive condition in supply chain's integration for controlling analysis is, making decisions to choose the process and the workflow, the resources for executing activities, the resources for allocation in supply chain and other performance activity.

Integration between the logistics systems within a company may not be a big issue. In fact, most of the companies use ERP system that includes most of the information needed for the management. Therefore, there might be no need for additional software, but integrating these systems across the company's borders is challenging. In many cases, companies use different systems for Manufacturing Execution (MES) and data collection, Quality management and process control, WMS, TMS, or other systems. In addition, the data exchanged between collaborating companies might have different types (Shen et. al., 2010). There are many other challenges in integration across the company's borders that will be detailed in chapter six.

There are several approaches to overcome the inter-organizational logistics system integration challenges, one of this approaches which has been used often in the past is to buy the needed extra systems from the same supplier that provided the logistics system solution. However, this approach has limited both the supplier and the client companies. Another approach to overcome the integration challenges is to find a third party supplier who has already developed a solution (software or upgraded version) for the logistics systems which are running at both the collaborated companies. This approach often becomes expensive when the companies use multiple vendors and there is a need to build more and more adaptors and therefore, there would be extra costs on maintenance and extra complexity in the systems upgrades (Riives et. ai.,2012 and Shen et. al., 2010).

Another beneficial approach is using a middleware. Integration in this approach can be done by using middleware toolsets or using Service-Oriented Architecture (SOA) and web service design (Baskerville, et. al., 2005).

Other approaches, such as e-commerce uses Electronic Data Interchange (EDI) as a method for exchanging data between several information systems through standardized message formatting. In addition to EDI, researchers and practitioners have become interested in cloud technology to put all the information to a cloud server where it can be accessed by all the cooperated parties (Christiaanse et. al., 2004).

1.2 Objectives

The objective of this thesis is to demonstrate the concept of logistics systems and integration of logistics systems in inter-organizational environment. This study also highlights the integration challenges that logistics companies face when trying to link their logistics systems across their borders in order to facilitate coordination, reduce costs, and obtain better results.

In addition, the thesis presents the factors and requirements for integration and demonstrates some solutions to overcome the integration challenges.

1.3 Research Question

This study is a literature review and follow a qualitative research approach to spot the light on previous researches about the integration of the inter-organizational logistics systems.

The goal of this thesis is to answer the main research problem:

"what kind of approaches are feasible for overcoming the challenges that encounter the integration of the logistics systems across the companies' borders?"

To address the research problem, we will answer the following questions:

1. What are the logistics systems?
2. Why there is a need for integrating logistics systems?
3. What are the challenges that companies face when integrating their logistics systems across their borders?
4. What are the existing solutions of logistics systems integration?
5. What is the favorable approach in integration?

1.4 Structure of the Thesis

The thesis is structured as following:

First chapter is the introduction to the thesis, objectives and structure of the document. Second chapter presents the concept of logistics systems, definitions of most commonly used logistics systems nowadays. Chapter three demonstrates the connection between some logistics systems, the need for integrating them and the factor that affect choosing logistics systems. Chapter four illustrates the benefits of integration. Chapter five illustrates the requirements and planning for implementing the integration. Chapter six highlights the challenges that face companies when they need to integrate their local logistics systems with other companies. Chapter seven presents some options, methods and solutions for the integration's outside the companies' borders and Finally, Chapter eight demonstrates a comparison and discussion followed by the chapter nine, the conclusion.

2 LITERATURE REVIEW

2.1 Previous research

2.1.1 Supply chain integration approaches

Several studies have analyzed and measured the integration of supply chain using different approaches. Each approach focuses on a specific side of integration and studies it from a specific perspective. These main approaches are: internal/external integration, process integration, and information/data flow integration.

According to Flynn and Melnyk (2010), the internal/external integration is the key element of integration and focuses on the customer and the supplier integration only, without emphasizing the importance of central link of internal integration.

The second approach is studied from the process integration perspective. According to Lambert and cooper (2000), all parties of a supply chain need to overcome the functional challenges and use a process approach in order to have a successful integration implementation in supply chain. This approach focuses on the customer relationship management and service, demand management, order fulfilment, manufacture flow management, supplier relationship management, quality management, product development and commercial and return massage.

Third approach focuses on the integration of data and information flow or what is called the physical/material flows integration. This approach considers the relationship between the information flow integration the physical flow integration and the integration of two manufacturing improvement programs, lean production and Enterprise Resource Planning systems (Caliano et. al., 2006). Nurmilaakso and Kotinurmi (2004) analyzed the information flows integration in their study. There are not many articles about the data flows integration and this paper concentrates on this type of integration in order to find the technical challenges of integration and solutions for them.

2.2 Background

The Council of Logistics Management (CLM) defined the concept of Logistics in 1984, as the integration among many different activities that covers transportation, procurement, inventory control, distribution management, and customer service. Since the Council has put this

definition, the concept has developed and these activities has increased the emphasis in many firms (Prabir, 2002).

In addition, the CLM defined the Logistics management as the process of planning, implementing and controlling the efficiency and the cost of the flow. It controls the storage of raw materials, the in-process inventory, finished goods and all the information which is relevant from the origin point to the consumption point in order to provide the customer with conforming to his/her requirements (Prabir, 2002).

Building strong relationships along the supplier chain is a fundamental matter for business success. Managers and business analysts of supplier companies need to put a lot of efforts and time to keep ties strong. Maintaining the linkages in the supply chain can sometimes be hard, exhausting and even difficult to carry out, but the rewards are also worthwhile. In addition, supplier seek to establish long-term contract with their customers. To do that, they need to provide services and quality to satisfy their customers and they need to keep track on the development of tools and services their clients are using. Managers start to realize the important role Logistics plays in creating better value for their customers and better management of commercial transactions (Christopher, 1998).

According to Christopher (1998), many managers considered logistics as an important component when planning and creating the strategy formulation process for their companies. Furthermore, some managers have extended the role of logistics as a concept further to involve the upstream and downstream partners in order to encompass both suppliers and their suppliers and also customers and their customers and they renamed it to become what is called supply chain management.

Mentzer et. al., came by another definition for the supply chain. In his definition, he refers to the supply chain as a set of three or more entities whether they were organizations or individuals, which are directly encompass in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer (Mentzer, 2001).

In 1998, a group founded in University of North Florida and moved to Ohio State University formed “The Global Supply Chain Management Forum”. This group defined the Supply Chain

Management (SCM) as the integration of key business processes from the end user through the original suppliers. In this definition, the original suppliers provide products, services and information that create extra value for customers and other possible stakeholders. The definition demonstrates the components that include in supply chain, which can be described as a network of facilities and actors that acquire raw materials and component parts, then transforms them into intermediate goods and sub-assemblies in order to builds the final products and makes them available to the global labor market to be consumed by the final customer (Lambert et. at., 1998).

In the definition by The Global Supply Chain Management Forum, SCM consists of set of activities, processes, procedures, supporting institutions, and business practices that connect suppliers and customers in the labor market. According to Lambert, Cooper and Pagh (1998), a supply chain involves four different flows:

1. Required information from the buyer to the seller which triggers all later activities.
2. Goods' movement from the sellers to the buyers.
3. The rights to transfer the ownership from the seller to the buyer.
4. The payment from the buyer to the seller.

Here, the question rises on how the flows are enabled or in other words, how the flows from the seller to the buyer and in the opposite direction are done?

Nowadays, developers have built interfaces in both upstream and downstream directions in the supply chain frequently and that is enabled by a Logistics Information System (LIS), which in turn, provide access to each other's business and manufacturing systems (Lambert et. at., 1998).

Logistics information system facilitates the shipment, transportation and the warehouse activities aiming to provide cost and time efficiency and therefore, ensures the customer service by obtaining the adequate number of the desired product to its proper market. According to Bagchi (1992), LIS ensures the flow of information, product design and development, market intelligence, production scheduling, payments, and any other information flow for managing coordination among the various actors in the supply chain.

2.3. Logistics information system integration

To be effective, a supply chain has to connect the network's members and the functions to ensure that the flow will not be interrupted. This can be done by matching supply and demand flows in a network and securing accurate response at each buyer-seller transaction in the chain. Coordinating these flows in a network requires integration of supply chain partners to ensure unhindered flows at each of the many buyer-supplier interfaces in a supply chain network. Scientists consider that integration in the supply chain can encompass good management of information and closer organizational coordination among supply chain partners (Chopra and Meindl, 2001).

Lee (2000), outlines three dimensions for the integration of a supply chain which are: information, coordination, and organizational linkage. In his description, Information integration refers to sharing information and knowledge between all members of the supply chain. That involves sales forecasts, production plans, inventory status and promotion plans. On the other hands, coordination refers to the reorganizing the made decisions and responsibility in the supply chain. Finally, organizational linkages include the communication channels between the members in the supply chain, performance measurement, and sharing of common visions and objectives.

According to Lee, this kind of supply chain usually highlight the importance of speculative buying at each buyer-supplier interface downstream. At each interface, the extent of fluctuation due to speculative buying gets amplified leading to what is known as *"bullwhip"* effect (Lee, 1997). Bullwhip happens when there is an unevenness increases in moving up the supply chain from the consumer to the store to the distributor to the central warehouse end up at the factory.

Bullwhip results in making the whole supply chain to run more inventories than actual requirement and still there is more to run but not enough place to keep. Therefore, there will be inefficient use of production and warehouse resources, high transportation costs, and high inventory costs (Chen and Samroengraja, 2000). As a result, the customers' satisfaction will be reduced and would be more demand on finding solutions.

Experts frequently need to rework and reorganize the supply chain process and therefore, the transshipment will increase the costs. Many experts have concluded that sharing of capacity and inventory information between a manufacturer and its customers, collaboration, close communication, partnership and process integration along the supply chain can help to reduce the risk of the bullwhip effects (Lee, 1997). For that reason, companies should strive to share data, plans, forecasts and other information that can significantly reduce the bullwhip effect.

According to Katunzi (2011), integration means visibility or information sharing, which reduces the inventory costs, the bullwhip effects and ensures timely delivery (Katunzi, 2011).

Integration can take several methods; customer integration, internal integration, intro-organizational integration or material and service supplier integration, technology and planning integration, measurement integration and relationship integration. This thesis focuses on the integration across the company boarders along the whole supply chain.

2.4 Definitions of common logistics systems

Logistics information systems are a subset of the company's total information systems which deal with the issues related to logistics decision making. According to Ballou(1999), there are three distinct elements that make up the logistics information system which are: input, database and its associated manipulations and output.

According to Ballou, the inputs are data items required for planning and operating logistics system, which are obtained from customers, company records, published data or company personnel.

The database and its associated manipulations are needed for managing the databases that include the data selection that are required to be stored and retrieved, options for the used methods in analysis and the selection of the basic data-processing procedures.

Meanwhile, the outputs of a logistics information system can be in documents forms and include the following reports:

1. Costs or performance statistics summary reports.
2. Inventories or order progress status reports.

3. Some exceptional reports that compare the desired performance with the actual performance.
4. Reports that initiate the action.

Many logistics firms nowadays run several logistics systems due to increasing in the need for the integration along the supply chain. Suppliers have their own logistics systems which mostly manage the whole work for them internally. When the business extends and the suppliers are working with new customers that run different local systems, the integration is required and maybe new systems are needed. However, Chapter three illustrates in detail the need for integration in the supply chain. But first some logistics information systems are described in order to understand their work.

Enterprise Resource Systems (ERP) are software packages that enable the integration of transaction oriented data and business process throughout an organization. These packages include several modules, such as human resources, sales, finance and production, providing cross-organization integration of transaction based data throughout embedded business processes. These software packages can be customized to the specific needs of each organization up to certain limits (Esteves and Pastor, 1999).

Warehouse Management System (WMS) is another logistics system, which is defined as a software application that supports the day-to-day operations in a warehouse (Techtarget, 2009). WMS programs provide tasks centralized management like tracking the inventory levels and the stock locations, free stock locations, purchased and delivered products of a warehouse. WMS systems can be installed in a firm as a single program to manage its warehouse or can be part of an ERP system. WMS systems include components, which are the warehouse facility, the material handling equipment layout, warehouse internal operations or activities (with management staff and employees), vendor and customer-order flows for small items, master cartons, or pallets, company informational technology (IT), host, WMS, and warehouse computer systems, (for communications between company departments as well as between the company and vendors and customers) and inventory control (Mulcahy and Sydow, 2008).

Transportation Management System (TMS) is a part of SCM which is focused on managing the transportation Logistics. A TMS facilitates the interactions between the order management system (OMS) and the distribution center (DC) or a warehouse (Techopedia).

Manufacturing Execution System (MES) is a system that offers real time applications (Kletti, 2007). It enables producing current and historical maps for production equipment and therefore, can be used as a basis for optimization processes. MES manages and monitors the work-in-process in a factory by keeping track of all the manufacturing information in a real time, recovering real time data from monitors and employees. Some ERP systems encompass MES as a part of its modules. The main objective of MES is to reduce cycle time, improve productivity and the total time for making an order.

2.5 Logistics activities of value Chain – Porter model

Many organizations nowadays are involved of thousands of logistics activities from the perspective of converting the inputs into outputs. These activities are carried out in order to determine the costs and the profitable effects of the companies.

Two main activities categories can be found; primary activities and support activities in which all businesses should be undertaken in some form. Primary activities involve the physical creation, sale, maintenance and support of a product or service. Porter (1985) described the primary activities as following:

1. Inbound Logistics:

These activities involve the relationships and linkages with the suppliers. They cover all the activities, which are required in order to receive, store and expand inputs.

2. Operations:

These activities are needed in order to convert the inputs into outputs. This includes converting products and services.

3. Outbound Logistics:

These activities cover the relationships and the linkages with customers and include all the activities which are necessary for collecting, storing and distributing the output.

4. Marketing and Sales:

These types of activities inform buyers about the outputs (products and services). These activities encourage buyers to purchase them and facilitate their purchase.

5. Services:

These activities include all what is required to guarantee the customer's satisfaction by keeping the product or the service working properly by the buyer after they have been sold and delivered.

On the other hand, the support activities support the functions of the primary activities. Porter defined the support activities as following:

- Infrastructure:

These activities represent the company's support systems and the functions that are required for applying maintenance. Some examples of infrastructure activities which can assist businesses to obtain advantages include administrative operations, accounting, legal and general management.

- Human Resource Management:

These activities cover all the aspects and functions of human resource management like recruiting, hiring, training, motivating, rewarding and keeping the employees. Good human resource management reflects good advantages to the businesses as people are the source of the value.

- Technology Development:

These includes all the activities that are required for managing and processing technologies and information and protecting the databases in a company. Additionally, it involves reducing the costs of technologies used at the company, stay up to date with latest technologies and maintain information technologies.

- Procurement:

This activity also called purchasing and it represents the actual act that the company does in order to get the required resources for operating. This include looking for vendors and obtaining the best costs.

Figure 1. Illustrates Porter's value chain. The dotted lines describe that each support activity may play a role in the primary activity. For example, procurement activities play a support role in marketing and sales with other activates and at the same time, they operate with certain activities.

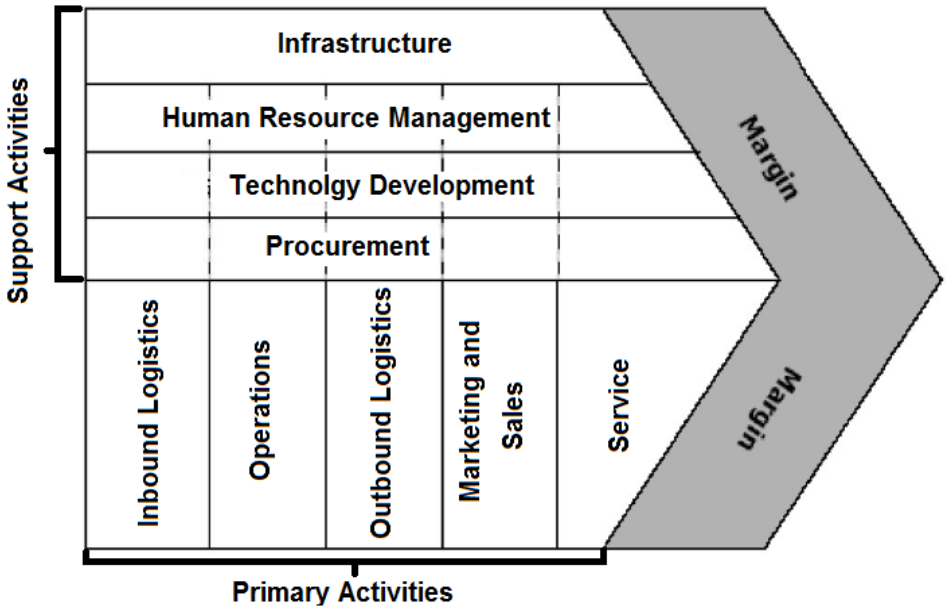

Figure 1 Porter's value chain (Porter, 1985)

3 INFORMATION TECHNOLOGIES NECESSITY FOR LOGISTICS INTEGRATION

3.1 Internal and external logistics information technologies

Internal logistics information technologies include all the technologies that are working among the departments and sections of an organization and facilitates exchanging information, communication and the functional processes. In additional, it includes the company's databases, software and applications, which are characterized by the integration level, data accuracy, timelines and quality (Closs and Savitskie, 2003).

An example of internal logistics information technologies is enterprise resource planning (ERP) system which is mainly developed to increase the accuracy and reliability of an enterprise's data. Other examples are warehouse management systems (WMS) and Transportation management systems (TMS).

External logistics information technologies are the ones that facilitate communication, information exchange and procedures among the partners of supply chain. These technologies include external interfaces, applications or mediators that work together to provide better information exchange among the members of the supply chain and to enable effective analysis and reporting about the supply chain activities and processes.

Some examples of external logistics information technologies are Electronic Data Interchange (EDI) web technologies and clouds computing (Liu et. al, 2012). In addition, implementing strategic and tactical information exchange and coordination with customers and supplier is considered as a good indicator for external logistics information technologies.

3.2 The connection between some logistics systems

The selection between logistics systems can be difficult for third-party logistics (3PL) providers because they need to find the capabilities that do not exist in all the warehouse management solutions. In addition, add-ons systems proved that they can be viable options for the companies which seek extending their existing functions. Figure 2 demonstrates the connection and information flow between ERP, WMS, TMS and SCM. Each of the supplier, the producer and the customer may have its own ERP, WMS and TMS systems but shares same SCM. The Materials always flow from the supplier to customer via the producer but the information flows among all of them.

According to Nettsträter et. al., (2015), when the supplier produces resources and semi-finished products, it may need separate WMS system in order to keep track over its warehouse and also use a separate TMS for shipping the resources to the producer. In this case, the ERP system obtains only the inventory results of WMS and the shipment details to store it in its modules. On other words, ERP systems are dealing with the financial parts of WMS and TMS. At the end, all the data are shared with the SCM for all the parties. On the other hand, when the producer produces the end or the finished product, it may also use separate WMS, TMS and ERP and share its product information on the shared SCM.

At the customer side, when it stores the product at the distribution centers, SCM involves all the necessary information. In this case, all the supply chain process can be visible for all the parties with local access to each party WMS, TMS or ERP.

As a conclusion, SCM systems are not limited to a single company. They can be used among company supply networks meanwhile WMS, TMS, and ERP are used locally. However, the differences between ERP and SCM are becoming foggy as many of ERP systems nowadays support multi-site capabilities and cross-site planning, processing and execution functionalities which are able to manage the supply chain.

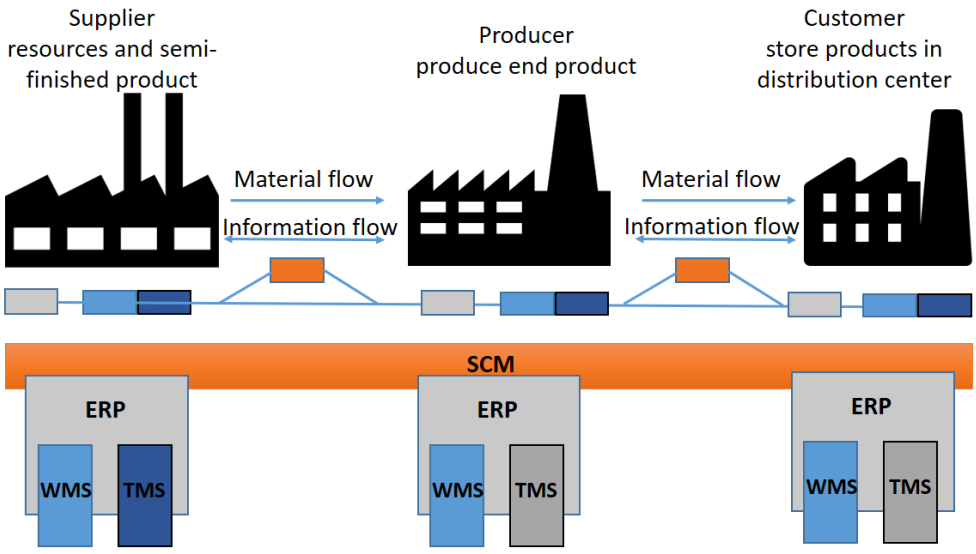

Figure 2 Connection and information flow between ERP, WMS, TMS and SCM (Nettsträter et. al., 2015)

3.3 Factors affect choosing the required logistics systems

Choosing whether to use SCM, WMS, ERP or any other system depends on many factors, like the size of the organization, the need for specific functions, the purposes of the use and future extension.

Organization size

In many cases, the system size is connected to the organization size since it defines what is required to use and which functions are needed. Size of an organization may define how big the business the organization is running and therefore, the need for more systems to do the tasks. For example, in a company like CMA_CGM shipping line, which owns vessels, containers, warehouses and terminals all over the world, there is a need to use different logistics systems. In such a case, it is more efficient to use ERP system as an overall and use specific systems to do other specific functions like WMS, TMS for warehouse and transportation purposes (CMA_CGM, 2015).

Specific functions

When the company becomes international and operates under different legalizations and conditions, based on the country it operates in, then it might be necessary to use specific logistics systems. Some of these systems required special treatment and developed for the specific environment. For example, billing methods may differ from one country to another based on the logistics running in that country and therefore, it needs to have different software in each country. In this example, the billing module in an ERP system cannot be used as there are specific non-standard requirements to be taken in consideration and therefore, it is important to use separate billing system to do the billing tasks which in turn can be linked to the ERP system used in the organization.

Purpose of the use

Whether to use ERP, WMS, or SCM, may depend on the purpose of the ongoing business. WMS might be the best option when the company goal is to increase the warehouse operations efficiency like inventory or streamlining operations and to reduce the costs throughout the supply chain. However, WMS software does not cover other supply chain operations and

typically needs to connect to other systems to be integrated throughout the supply chain. Meanwhile, SCM has a package or suit of software that support supply chain planning and execution applications, such as warehouse management and transportation management. Therefore, SCM integration include fully management of entire supply chain. On the other hand, ERP systems cover process across enterprises like human resources, customer relationships management, SCM and accounting. However, ERP does not include all the functionalities that are needed in an organization. For example, ERP does not offer WMS rather than inventory control (Harris, 2006).

Future extension

According to McCrea (2013), whether to choose between ERPs package and dedicated systems, companies should take in consideration whether they want to be tied to one or more vendor. In most cases, cloud-based option is more flexible for companies dealing with shipping to beef up their supply chain software without the need to give up their ERPs. In addition, such challenges come out when the company business increases and therefore, additional functions are required and development of new software or add-on is needed. In some situations, developing additional software from same vendor might be not possible either, because the vendor does not develop these kinds of systems or the original system is developed with some limitations.

3.4 Inter-organizational compatibility

According to Kanter (1994), inter-organizational capability is defined as sharing experiences, values, principles and business strategies between the cooperated companies. Compatibility can be obtained from the existing work practices and the values that partnering companies have and can simplify sharing the business information along the whole cooperated partners (Ngai et. al., 2011).

Although inter-organizational compatibility builds collaboration across the cooperated partnering companies, the shared resources do not lead all the time to positive organizational performance advantages of the partners (Sarkar et. al., 2001). According to Schraeder and Self, (2003), inter-organizational compatibility can be achieved by using similar technological

infrastructure (technical compatibility), cultural compatibility and common goals and objectives (strategic compatibility) among all the partnering companies. Technical compatibility comes from information systems similarities that are running in the partnering companies and other technologies like network compatibility, software, Electronic Point Of Sale (EPOS), business oriented technology, operational and technical business process (Sarkar et. al., 2001). Meanwhile cultural compatibility comes from cultural background, norms, traditions and values and it is important aspect as the variety of values and norms among the partnering companies may result in instability and loss of control in the marketing environment, which in turn affect the inter-organizational information management, transferring information and the process of data-based decision making (Jones and Griffiths, 2005). On the other hand, the strategic compatibility emerges from the strategies, plans, goals, and objectives the partnering companies have to facilitate communication, interaction and coordination of the partners' activities (Farrelly and Quester, 2005). Therefore, the interactions and information exchanging should be considered on the tactical and strategic level as well as on the operational level among all the partners in the supply chain (Barratt, 2004).

Achieving inter-organizational capability can be considered one of the bases for planning inter-organizational integration among the logistics companies especially that many logistics companies expand their business further than the country's borders. This situation is widely common and taking the technical, cultural and strategic compatibilities into account will assist better integration. Additionally, in supply chain, there are efficiency and efficacy-related compatibilities according to Chen, Daugherty and Roath, (2009). While efficiency capabilities assist companies to gain logistics performance at lower expenses, efficiency-related capabilities enhance the relationships among the partners in the supply chain and respond to customers' needs. That is why Morash and Lynch (2002) looked at the supply chain compatibilities as logistics-oriented capabilities and customer service-oriented capabilities.

3.5 The impact of inter-organizational compatibility on inter-organizational information systems integration

When a network of members forms a supply chain or logistics inter-organizational cooperation, they require sharing the flow of information, materials, services and money and that needs systematic, strategic coordination for the traditional business functions, operations and procedures which can manged by supply chain management as to Vlosky, Smith and Wilson 1994. According to them this management should be done both individually within each partnering company as well as across the businesses within supply chain. The main goal of this management is to support the long-term relationship and to monitor the overall performance of the supply chain.

As Chen, Daugherty and Roath, (2009) explained the compatibilities categories that exists in the supply chain; efficiency and efficacy-related capabilities, then supply chain requires effective and efficient product transactions for information that are shared among the partnering companies. In addition, companies usually share sensitive data about their businesses, which are required by the partnering companies to improve the forecasting, enhance the quality of the services, strength the relationships and the interactions, improve the profits and develop future common goals and this requires extra efforts. Therefore, integrating logistics information systems along the supply chain or between business-to-business partnering companies is beneficial for the performance.

When companies that are willing to integrate their businesses have compatibilities in their cultural background like norms and traditions and have similarities in their aims, goals, objectives and future cooperation, they can manage to fully integrate the businesses. According to Grandon and Pearson (2003), “compatible practices, values and culture are the required platforms for information systems adoption and integration”. Therefore, inter-organizational compatibility comprises the determination of both e-commerce and information systems for the partnering companies. In addition, the technical compatibilities ensure that companies are able to share all the necessary information easily and planning the technical compatibilities well can be considered as a valuable key for successful business-to business integration between the information systems running within the partnering companies.

As companies face several barriers and obstacles both on the technical side and the cultural side during information systems adoption and integration process, therefore, technical, strategic and cultural compatibility can be considered very valuable keys for inter-organizational compatibility and well connected to inter-organizational information systems integration (Premkumar, 2000).

Li and Williams (1999), found that when companies enrolling themselves into relationships and integration with other partnering companies that run different technologies and technical systems, will finds it difficult to maintain the relationships and attain strong integration and mostly is not wise to go for integration. Klein and Rai (2009), suggested some solutions for integration in case of lack of technical compatibilities which include establishing inter-organizational relationship with only one partner, however, it is not efficient solution for growing business, but still a step towards increasing profits in order to be able to change the used technologies at that company. Another solution is to reduce the number of functions of the application to some limited number of transactions like shipping orders and invoices. With such solution companies actually not benefiting from the whole integration advantages or even limiting them to the minimum however they are reaching the goals of integrating the business with other partnering companies.

Klein and Rai (2009), explained that integrating several partners involve several transactions, hardware, software and applications, networking techniques, networking protocols and other technical requirements and integrating the information systems in inter-organizational environment is a complex process. That is due to technical barriers and challenges (which are explained in chapter six) that prevent or obstacle the development of integrating information systems along the partnering companies as to Li and Williams (1999). On the other hand, the incompatible software and applications, hardware, and network systems make disharmony and delay the inter-organizational integration of information systems.

Rajaguru and Matanda, (2013) studied the effects of inter-organizational compatibilities on supply chain capabilities based on the inter-organizational information systems integration. They suggested that there is direct impact on the technical, strategic and cultural compatibility on inter-organizational information systems integration and indirect impact on the technical

and the strategic compatibility on supply chain capabilities via inter-organizational information systems integration.

3.6 The need for inter-organizational integration of information systems

There is ample anecdotic evidence that many companies experience significant extra costs due to supply chain problems. Konicki (2002) reports on a major retailer's inability to master supply chain logistical problems. Companies faced sharp spikes and drops in demand for products

and sales merchandise were often out of stock when customers go to the store. In such a case, if: (1) information is being shared, data inconsistencies across enterprises can be eliminated so that all companies accurately perceive the current state and therefore (2) new information is being shared, new business practices become possible.

Another important point for illustrating the importance of implementing integration is the economic consequences which happens due to inadequacy in addressing suitable integration. According to Frohlich and Westbrook (2001), there is a strong connection between performance and integration. Their studies showed that when the level of integration is higher, there is higher level of performance.

In addition, integration in the domain of software engineering based on component of software development paradigm is becoming very important. For example, software design utilizes the reusable components to build applications like Enterprise Java Beans, .Net and DCOM. These approaches are based on the construction of distributed applications through components' coding and assembly (Linthicum, 2000).

3.7 Options in inter-organizational information systems integration (Holistic approach vs Collaborative approach)

To operate efficiently and to have competitive advantages, organizations need to consider integrating their business with other organizations that can provide complementary services that increase the mutual advantages for all the cooperated parties. However, organizations find themselves in front of several challenges to answer the following questions (Elmir et. al., 2014):

- What is the benefits of integration?
- Is there a need for integration?
- When to integrate?
- What to integrate?
- What are the parties to integrate with?
- What is the possible future extension of the possibilities to change the partner?
- What is the best approach for implementing the integration?

According to Elmir et. al., (2014), there are two approaches to study the inter-organizational system: Holistic view and collaborative view, which are illustrated in figure 3.

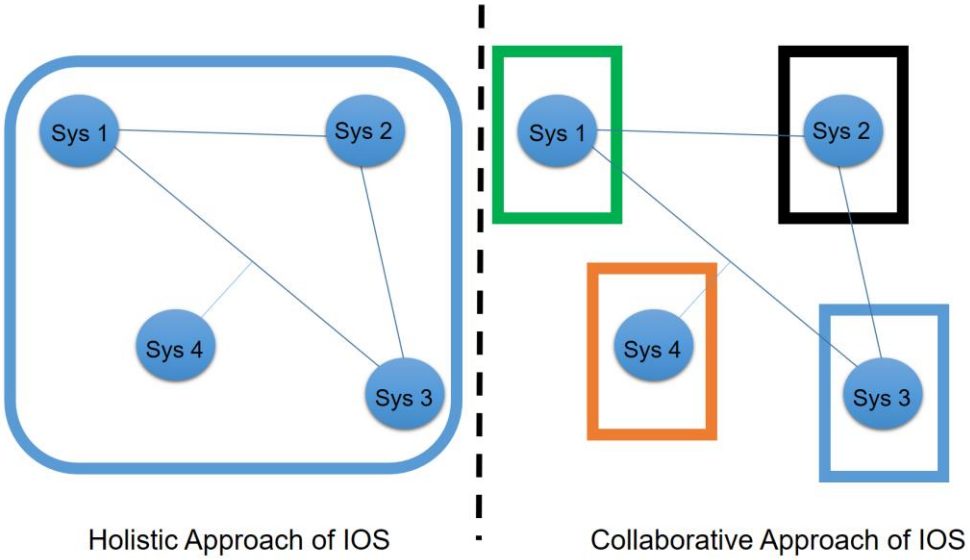

Figure 3 Holistic Approach Vs Collaborative Approach (Elmir et. al., 2014)

The holistic approach means that the entire organizations do not focus on one specific component or system, oppositely, it realizes the network in holistic and systemic manner and a single inter-organizational system support the network by aggregating the members' systems (Keating, et. al., C 2003).

According to Jamshidi (2011), the patterns of type of integration and aggregation mechanisms manage the relationships between the information systems that are distributed on the network

and the inter-organizational system is usually managed more. In addition, the cooperated members share tools and mechanisms that manage and control the inter-organizational systems in which it masters the both individual and the overall partners' systems (Morris et. al., 2004).

The other approach is the collaborative approach which means the focus is on the internal partner systems and then finding the alternative system interactions. In this approach, the management and control are done internally at each cooperated member in the network and the interoperation patterns are used to manage the relationships between the members, (Elmir et. al., 2014).

3.8 Outsourcing and third-party logistics provider as an option for integration implementation

According to Richey et. al., (2010) to attain an efficient supply chain development, partnering companies need more than paying attention to information systems technologies and proper communication channels. The development requires reorganizing and restructuring both intra-organizational and inter-organizational processes.

This development might be difficult or insufficient to be done without support from other companies. In such cases, companies may decide to outsource all or part of the segments of logistics/supply chain systems. Recently, there is a growing demand for outsourcing the logistics activities to third-party logistics (3PL) provider and this development is expected to increase according to Hertz (2003). Many organizations became more interested in outsourcing their logistics activities to attain several benefits like costs reduction, product/service quality improvement, flexibility increment, and business focusing (Alkhatib et. al., 2015).

According to Lieb (2008), third-party Logistics have been growing rapidly in the past few years and many advantages motivate companies to outsource their logistics system by using third-party capabilities and competencies.

There are several advantages of logistics outsourcing. Table 1 illustrates some of them.

Table 1 Advantages of logistics outsourcing

Advantages	Reference	Description
Save costs and time	Jiang, Frazier and Prater (2006)	- Resources can be reinvested in more efficient processes. - Vendors are specialists who can build logistics systems with lower costs.
Improve product quality	Bardhan, Whitaker and Mithas (2006)	- Allows companies to focus on the business parts and put efforts on improving that parts.
Increase flexibility and agility	Lau, and Zhang (2006)	- Reduces the constraints of the organization's own production capacity. - Convert the fixed costs into variable costs. - Increase the agility of responding to the market changes. - Releases the partners from several organizational issues like trust and visibility of information.
Allows focus on core competences	Jiang, Frazier, and Prater (2006) Alkhatib, Darlington, Yang, and Nguyen, (2015)	- Vendors can achieve better investments in new technologies and techniques. - Reduces the focus on technologies problems. - Reduces the focus on find

		the best tools, techniques, technologies, software and implementation time.
Increase global inventory visibility	Alkhatib, Darlington, Yang, and Nguyen, (2015)	- Allows better monitoring on the inventory technologies.
Share responsibilities and reduce risks	Alkhatib, Darlington, Yang, and Nguyen, (2015)	- Reduces the organizational and technical risks. - Divides the responsibilities among the partnering companies and keeps the technical responsibilities for Vendors.

4 INTER-ORGANIZATIONAL INFORMATION SYSTEMS INTEGRATION ADVANTAGES

4.1 Benefits and advantages of information systems integration

Several benefits can be gained by integration information systems between several logistics companies as described below:

- Managing the overall supply chain execution

The main point of integrating several logistics information systems along a supply chain is to enable a process to be done efficiently in shortest period and keep data up to date along the whole parties of the supply chain (Frohlich and Westbrook, 2001). Each company usually runs several information systems to achieve all the required tasks and operations, then it sends the updated information to other cooperated companies in which they use to their own or to send back some acknowledgment. As many logistics information systems are running locally and simultaneously to do their tasks, then integrating these systems will control the overall execution in a way that makes the global logistics process standardized and this improved integration is the very essence of supply chain management (Gattorna, 1998).

- Providing unified Key Performance Indicators and reporting format

Key Performance Indicators (KPI) is an indicator provides information about the manufacturing current state, it allows companies to get information about where to take action to improve its performance. It indicates operating cost, lost time injuries, number of environmental incidents, asset utilization and asset availability (Weber and Thomas, 2005). By integrating the logistics information systems, a standard KPI can be established in order to measure the individual and the overall operation costs and performance of the supply chain. In addition, the integration ensures that the output and the reports of the logistics systems of each company can be read by any other cooperated company (Weber and Thomas, 2005; Kletti, 2007). This unification of both Key Performance Indicator and reporting grants all the companies flexible working environment and facilitates communication as well as it reduces the time spent on converting some reports into another format in order to be read by the other information systems (Weber and Thomas, 2005).

- Improve customer service

Customer satisfaction is one of the most important goals of any company and therefore, improving the services provided to the customers has taken big part of the researches (Alfalla-Luque et. al., 2013). Many researchers have studied the relationships with customers as a key point of company's success and believed that one advantage of integrating companies businesses is attaining the customer satisfaction (Helo and Szekely, 2005). From one hand, one can consider that each company in the supply chain can be considered as a customer to the other members, which in turns, implies that all the cooperated parties seek to each other satisfaction. Integrating the information systems between the cooperated companies will facilitates the completion of the tasks and operations in a way that makes all the members satisfied. This involves decreasing the possible conflicts that may happen due to bad quality of service, late paid bills, late delivery and other possible services.

From the second hand, the perspective of the final customer or the final consumer of the service or product, integrating information systems of cooperated companies will bring many advantages. First, integration accelerates serving the customer as to collaborative systems, which work in a way to predict the preferred services and products for customers based on the sales statistics. Second, many systems provide feedback which can be used in better way when they are integrated to generate better action (Bagchi, 1992; Helo and Szekely, 2005).

- Improve the supplier productivities

Sharing information about the customer product capacity, inventory level state, required quantity of a product, product sells state and other necessary information could help the suppliers to increase or decrease the production of specific product (Prabir, 2002). Some systems include feedback function that can send information about customers' satisfaction about a product or service, this feedback helps supplier to predict customers' preference and maybe make decisions on producing similar products or services.

- Sharing Information about orders, products and stock status

Visibility of the orders among the cooperated companies is important for many reasons, it speeds up the ordering process, decreases the possible lack of clarity in an order, decreases the operation time and gives fast and automatic response to an order in some cases (Prabir, 2002).

In addition, if the supplier is about being out of a specific product, the system notifies the supplier to order that product or even in some systems, it may order the product automatically from its origin companies. Such a feature, reduces time and efforts to make orders especially when there are tens or hundreds of products that are required to purchased (Gosain et. al., 2003). A good example about this unique feature, which can be done only when systems are integrated, is the case of supermarket. Usually supermarkets do not make daily orders for many products like chocolates, instead they make a list of all the chocolates types they need from a specific company and then send the order. In many cases, the order might have tens of different types of chocolates and thou, adding each item to the order list may take several ours, as the purchasing department needs to take in account the current stocked quantity of each product, the sales amount per month, expiration date, the seasoning product and necessary amount to purchase. Integrating the information systems between the supermarket and the chocolate provider will enable the automatically requests sending.

- Increase the reliability levels of the provided services

A service is reliable if it is consistent by time, available when needed and meet the customers' expectation (Dai, 2003). The integrated systems will have automated approach of sharing information, which is needed to provide a specific response, based on this response, many decisions can be made like purchasing decisions, price offers, eliminating or adding some services. In addition, as long as the systems are communicating with updated information, a customer can any time find the desired information and use it in which it assists achieving the all the parties in the supply chain. The reliable service levels can be increased as the shared information is up to date and the companies trust each other and work for the overall benefits (Bowersox, et. al., 2002).

- Saving time and costs

Taking in consideration the size of a logistics company, one can think of the number of systems that are running within that company and the number of operations that are carried on, furthermore, the number of the processes to achieve one task. For example, in a port terminal for shipping cargo, several systems are running to deliver the product from the arrival time of the vessel until the product is delivered to the customer. The shipping line company needs to communicate with several parties like customs, customers, IT companies, the terminal services companies (road construction, electricity, water, cleaning, etc.) also with partners from other countries or cities. If to consider the communication is with the customer, integrating some information systems with the customers will decrease the transportation costs, warehouse costs and distribution costs. This is due to the reduction or elimination of several of bureaucratic procedures that could have done by using the traditional procedures. (Nooteboom, 1992).

- Using the transportation facility efficiently

Transportation is one of the most important logistics services that have been studied and researched by researchers and organizations. Many researchers pay attention to the impact of Transportation Management Systems (TMS) in adding great value to the logistics companies, (Esper and Williams, 2003). Integrating TMS systems from different logistics companies will improve the quality of service that is provided to customers, optimize the way of shipment, optimize transportation activities, control the overall transportation plans of the supply chain and provide better forecasting (Helo and Szekely, 2005).

- Provide optimal goods flow

Planning goods flow in advance brings many benefits to all the parties that are trading in many fields of logistics business; manufacturing and production management, warehouse management, inventory level, shipments and handling, transportation and delivery, finance and cost management and the customer satisfaction and relationship management (Lewis and Talalayevsky, 2004 and Gross ,2013) For example, in shipping line terminal, planning in advance the quantity of containers that the terminal can deliver to customer daily will decrease the time the customer needs to wait to obtain declaration for picking up the container, organize checking the container by custom, reduce the tracks traffics at the terminal, accelerate the

delivery to customer and thou, improve the customer experience. However, planning goods flow takes both time and efforts for organizing the flow and communicating with all the parties to provide optimal plan and schedule, especially with large-size companies. One can imagen the number of e-mails that are sent between shipping terminal and posts delivery company just for handling one process. Both companies run several systems locally which deal with all the operations within their borders but still they communicate with e-mails for handling operations like delivery of products, complain about late delivery or nor arrival products, paying bills, etc.

Inter-organizational integration of the systems along the cooperated companies take advantage of the actual use of the information systems to its maximum as it links these systems and accelerates achieving the tasks, this in turn, will improve the quality of service, minimize the inventory level for the goods, optimize the productive time for logistics operations, reduce the expenses of storing, purchasing or transportation, reduce the time to delivery and decrease the errors and lack of clarity (Gross ,2013).

- Shortening the lead times

Lead time is the time between the initiation and completion or execution of a process or in other words, it is the time from the product/service purchasing point to the delivery point to customer and controlling the lead times can be considered as a competitive advantage for the whole supply chain members. According to (Tersine, et. Al. 1995), management of the lead times requires good analysis of the status and identification of the flow of materials and information. Richard et. al., demonstrated that the reduction of the lead times in largest link of a value-added chain is important but might not be sufficient to reduce it for the whole value-added chain and that the reduction of lead times should eliminate the bottlenecks from the system.

(Perry, J. H., 1996), found several factors that can be considered reasons for increasing the lead times in manufacturing environments across multiple industries, one of these reasons could be the lack of knowledge of transportation management. Reducing the lead time decreases the process costs and times which in turn deliver the service/product to the customer

faster. Integrating the systems in different companies can reduce the time needed to deliver the service/product to the customer.

- Increase useful information volume

The key success behind integration is sharing information among the partnering companies which leads to better control and management of each company individually as well as to the overall benefits (Prajogo and Olhager, 2012). However, companies need to choose what to share and what not to share as to their privacy and local development, but at the same time each company should not prevent other companies from gaining access to beneficial information at any time.

A question on how to determine what is beneficial information can be discussed and agreed when planning the integration. However, the amount of shared information is usually big and grows by time and require some kind of control. This growth in the volume of information is essential for decision making, future investments, business development and market extension which could lead to add more partners to the chain (Prajogo and Olhager, 2012).

- Provide real-time information

Information technologies nowadays are necessary for managing business-to-business operations and activities especially within the fast development of business. In addition, many competitive advantages can be attained by using information technologies and as most of logistics companies if not all information technologies and systems are used in daily basis to achieve the companies' businesses (Mason, et. al., 2003).

Integration between several information systems allow companies to provide real-time information which include inventory level, delivery status, production planning, scheduling, transactions monitoring, process status and reports exchanging which allow companies to monitor and control their business activities or supply chain performance (Prajogo and Olhager, 2012). In other words, integrating the systems and technologies facilitate gaining competitive advantages as accessing to the shared information is possible anytime from any physical location which in turn facilitates work and creates comfortable working environment.

- Facilitates alignment of forecasting

Information technologies makes it easier for companies to align their business forecasting and to schedule the operations between customers and suppliers which enable better internally interaction, communication and coordination (Prajogo and Olhager, 2012). When cooperated companies are up to date with all the current information, predicting future challenges, obstacles and possible troubles can be obtained as an overall. In addition, forecasting can be aligned in a way that future cooperated work can be achieved better. Most of the obstacles that mainly face the supply chain can be due to both time and spatial distance, which can be overcame by forecasting alignment (Prajogo and Olhager, 2012).

5 REQUIREMENTS OF INTER-ORGANIZATIONAL INTEGRATION

Inter-organizational information systems can be considered as an automated systems shared by several companies and aims to facilitate creation, storage, transformation and transmission of information that extend the enterprise borders (Kumar and Van Dissel, 1996).

Organizations start understanding the competitive advantages of entering in close interactions and relationships with other organizations that complement their works. However, merging business between several organizations require managers and executive teamwork to set good strategy and plan in order to manage efficiently the inter-organizational systems. For that reason, several qualities, organizational and functional requirements are needed to achieve a solid integration among the organizations.

According to Sprague and Mc Nulin (1993), there are six requirements or characteristics can be identified:

- Partners that are willing, able and ready to cooperate.
- Agreement of standards to be used like communication protocols and company policies.
- Third parties which are usually involved in the development and they may include software/service providers or inter-organizational partners in the business processes.
- Synchronization the work among the partners.
- The new electronic relationships like electronic business models are more important than the technical aspects.
- Efforts should be complementary and openness.

When integration take place, the access to stored application and information should be shared with privileges access based on the members' specific context.

5.1 Quality requirements for inter-organizational integration

There are several challenges that an organization needs to overcome in order to achieve successful collaboration with its partners. An organization needs to develop its agility to respond to the changes in context without changing in its quality of service as the quality affects the relationship with the partners as it affects the organization's reputation (Elmir and Bounabat, 2012). In addition, organization should increase the quality interactions with

partners and organize the improvement of the performance to reflect on the overall performance.

5.2 Functional requirements for inter-organizational integration

Functional requirements are those which describe the functionality of the system or the behavior of the system and all the activities that the system will perform. According to Elmir, A functional requirements involve information systems and their components and the functionality abilities are mainly identified in the requirement collection stage which is important to be set up to govern the new system activities (Elmir, et. al., 2014).

Elmir stressed that functional requirements should guarantee that the integration will not affect the independency and the privacy of the partners' systems in a way that each partner will maintain its autonomy on its own systems. In addition, functional requirements ensure the organizational compliance like the functional audit trail for the database or limiting access for the authorized users which is directly connected to ensure the privacy of information of each partner and to organize the access to information and resources. Further, there are several security risks when implementing the inter-organizational integration like information security, resource accessing control and hacking attacks which should be managed by the functional requirements.

Other possible functional requirements include the operations performed among the parties, the process of work flow, preparation of reports and outputs, business rules, administration and authentication functions and legal requirements.

5.3 Organizational requirements for inter-organizational integration

This type of requirements refers to organizing the future cooperation with all the partners in term of adaptation to the new integration environment and the evolution and development of relationship. These requirements are related to the quality requirements that are connected to the system change management. The change requests can be categorized into two main categories according to Elmir, et. al., (2014), adaptability category and evolution category.

- **Adaptation requirements**

These requirements are context dependent change requests which include reusing some solutions that are already exists in a new context, available resources that are located in different locations and can be accessed Simultaneously, services that are complementary between the cooperated parties, management changing flexibility and adding other services that are not available to do some task based on the use of the service.

- **Evolutionary requirements**

These requirements are time dependent change requests which deals with some organizational changes by time like implementing the frequent or continuous organizational changes, preserve the inter-organizational information systems, assisting establishing a stable environment, increase the level of verification and validation and expanding the solutions for integrated delivery networks and its development.

5.4 Flexibility requirements

Flexibility of a system means that the system design is able to adapt the external changes when they occur. Flexibility is one of the important points that has been studied when organizations decide to integrate their systems as it involves the future extension of the used systems which in turn can impact the costs of the organization. Flexibility requirements usually are studied carefully when companies are willing to integrate their systems as inter-organizational integration often reduces the level of flexibility of the individual organization (Stelzer, et. al., 2006).

Stelzer studied the integration requirements for inter-organizational information systems integration from two dimensions or scopes:

- Scope of integration: which refers to the integration intensity degree: this refers to which level the integrated systems are intensely correlated and to which level they have space of local development. The type of integration can however define the scope of integration, whether to integrate the whole features or services within a system or to allow access some specific services in this system. Or whether to apply holistic integration of partly integration.

- Scope of standard usage: which refers to the flexibility of integration: this refers to the type of standards that is used when implementing the integration. Some organizations tend to use standard systems, concepts or techniques among the other cooperated parties while others prefer to use standards only for the collaborated systems without changing the whole systems features.

5.5 Scalability requirements

Scalability means the ability of a system or network to be extendable over time when there is need to add new features or services or when it is important to integrate it with other systems. From the IT point of view, scalability could be the ability of plugging in and unplugging software or business component (Luke, 1993).

many authors suggested that integrating systems from several companies should take in consideration the scalability of the new systems, techniques or services that are going to be used especially that companies may extend it business by cooperating with new partners or extending the systems when growing their business (Barratt, 2004).

6 INTER-ORGANIZATIONAL INFORMATION SYSTEMS INTEGRATION CHALLENGES AND BARRIERS

Integrating several logistic systems along the supply chain will definitely bring many rewards and benefits for all the parties. However, implementing inter-organizational integration is not an easy task, even in the ideal situation when all the organizations have been well provided by flexible and extendable information systems and databases. Some other perspectives must be taken in account when preparing for inter-organizational integration such as managing the organizational relationships, making decisions about what information to share, who is authorized to access to shared resources and other logistical legalization.

Historically, information systems were designed, built and optimized to solve the local needs. There might be some of organizations who take in consideration building extendable information systems, however, it is not the reality in most cases. In addition, companies might not find it profitable to combine their business with other companies due to many considerations like poor understanding of the benefits of supply chain, fear of failing or just not willing to extend their businesses. The challenges have been divided into two main categories, organizational challenges and technical challenges. These barriers and challenges are described below based on Barratt (Barratt, 2004 and Moberg et. al., 2003).

6.1 Organizational challenges

- Coordination of workflow

Coordinating the workflow can be difficult when the various organizational units need to act as a harmonious whole. This needs to be planned well in advanced (Giachetti, 2004). Coordinating the workflow includes organizing the logistics operations, business procedures, purchasing and sells process. Controlling the workflow needs also special attention to shared information, common policies and common working relationships. Further, companies must establish agreements on the purpose of integration, objectives and future expectation and collaboration in order to avoid the conflicting goals (Legner and Wende, 2007).

Companies should have a vision of establishing long-term collaboration. Failing to attain good collaboration will affect directly on the performance of the collaborated companies, add

additional expenses and may lead to integration failure or even troubles between the collaborated companies.

- Lack of trust

Mutual trust is an important key of integrating companies with each other. Trust means that all the collaborated companies will respect the confidentiality of information, security of information and working in a way that brings benefits to all companies instead of each individual. In addition, trust occurs over time and involves putting common plans and working on achieving these plans on time (Katunzi, 2011).

Usually, companies are worried about the competitive situations and may think that integration would affect their position in the market, that may happen due to lack of understanding the integration concept. Managers need to understand that integration means achieving better excellence and that it is for their own benefits to trust each other and share information (Fawcett, et. al.,2008).

- Cost of inter-organizational integration

As several information systems, technologies, platforms, software, process and producers might be developed for the integration, one can consider the bill of integration might be very expensive. Some authors studied whether logistics integration may increase the total costs (Larson, 1994 and Byrne and Shahriar, 1992). Additional costs include planning the integration, preparing the stages of the implementation, setting up the communication channels and organizing the policies, relationships and other legalistic logistics. In some cases, integration can be very expensive when new infrastructure, systems, technologies or software are required for each company individually.

- Silo Mentality

According to Wisner et. al., (2015), Silo mentality refers to a “I win, you lose” mentality, which means that companies pay less attention to the needs of customers, by using cheaper suppliers for obtaining their products/services and assigning few resources to the new products and service design. In other words, Silo mentality occurs when companies do not put in their accounts the effects of their decisions and actions on the supply chain as a whole and to the

long-term relationships which can payback competitive advantages and profits to the whole members of the supply chain.

Cachon (2005) found out that Silo mentality may take place internally between the departments of an organization as well as externally. Internally, silo mentality occurs when the transportation manager for example tries to reduce the total annual transportation costs while without intention, the manager increases the safety stock and brakes down the customer service level. This is no wonder one of the most significant challenges that happen in supply chain management (Cachon, 1999).

Companies are required to pay extra attention to Silo mentality to overcome this phenomenon individually before integration take place.

6.2 Technical challenges

- Lack of supply chain visibility

The technical challenges that face the partnering logistics companies and put extra barriers to integrating their systems could be due to the lack of information visibility along the supply chain or the partnering companies. In a 2002 survey documented by Tumaini Katunzi (2011), two to third of manufacturers failed to synchronize completely their supply chain operations with their logistics partnering companies and two to third of these companies said it was due to the usage of different supply chain management software and applications than their partnering companies. This in turn, delayed or prevented in many situations, accessing to valuable information that are required to be shared among partners, which result in lack of supply chain visibility.

Lack of supply chain visibility results in several problems (Giachetti, 2004), First, partnering companies need to extract their data from their ERP systems or legacy systems and other local logistics systems, then in some cases, convert the output to fit the partners' systems and then send it to the partnering company. On the side of the receiving company, data are uploaded to the information systems before they become shared and ready to evaluation process. The time for the whole process may result in losing customers, having higher costs, decreasing the

competition with other companies and inefficient utilizing the real benefits of the supply chain.

- Information systems have different formats

It is difficult to deal with divers or heterogeneous applications that use different formats (syntax) and may have different meanings (semantics) of data. The output of a specific system may not be suitable as an input for another. Some common cases may include distorted formats for tables, lines, symbols that appear when transferring them from one organization's system to another one (Giachetti, 2004). In addition, the characters, symbols and some special numbers of a system may be interpreted in differently to what it meant in its original system. For example, a system may define "$" as a measuring unit meanwhile another system interprets it as a sign to start running a command.

- Lack of information technology knowledge

Information technology plays a key role in supply chain integration. It assists companies to increase the volume and complexity of information that are needed in communication among the partners. In addition, it allows the company to obtain real-time information about the process in the supply chain which include inventory level, delivery status and production planning. In other words, it facilitates the company's management and control over the supply chain activities (Prajogo and Olhager, 2012).

In spite of that nowadays all the logistics companies have information systems, however, these systems might use several technologies which are not made to be integrated.

When companies are planning for the integration, choosing the information technologies to be used in future or the communication technologies to facilitate interaction might not be an easy task, especially that some companies may decide to extend their systems while others may need to pay extra money to build totally new systems due to lack of their information technologies.

- System incompatibility

Several technologies are used while implementing the inter-organizational integration and they have the capacity to share common data via several databases and software, therefore,

information system compatibility can be considered as a significant obstacle because it can lead to supply chain interruptions (Zsidisin, 2003). Additionally, most of these technologies are new while in some cases, the technologies used by the companies might be old and not compatible with the offered technologies.

- Lack of knowledge

Several points must be taken in consideration before applying integration like information systems which are currently used in the companies, the current existent technologies, information accessibility, security and privacy of shared information, future technologies and development and many other points. Changes and information sharing may confuse people and give unsecure feelings or a fear for their job security, particularly if outsourcing accompanies integration (Katunzi, 2011). If the leaders or the executor team do not have sufficient knowledge about attaining suitable integration for all the participants or if they lack knowledge of the threats that can appear while implementing integration or in the future, an unprofitable integration may take place. Wisner et. al., (2015) suggested that successful supply chain management requires well education and training and avoiding innovation.

6.3 Sharing information problems

It is for the logistics managers job to design order management systems that effectively match pipelines to the marketplace.

There is a number of problems associated to sharing information when setting up an inter-organizational system to share data.

6.3.1 The bullwhip effect

The bullwhip effect is a significant problem that occurs in the supply chain. Disney and Lambrecht (2008), refer to the bullwhip effect as the tendency of new orders to increase the variability when passes throughout the supply chain towards producers and raw material suppliers. When the final customer demanded orders are transformed into highly unorganized or erratic orders for suppliers, the information in supply chain gets distorted. This phenomenon usually is characterized by fluctuation or swinging of the orders at each level of

the supply chain which expand and increase when moving up the supply chain away from the customer (Croson and Donohue, 2003).

For better understanding of the bullwhip effect, figure 4 below illustrates a simple example.

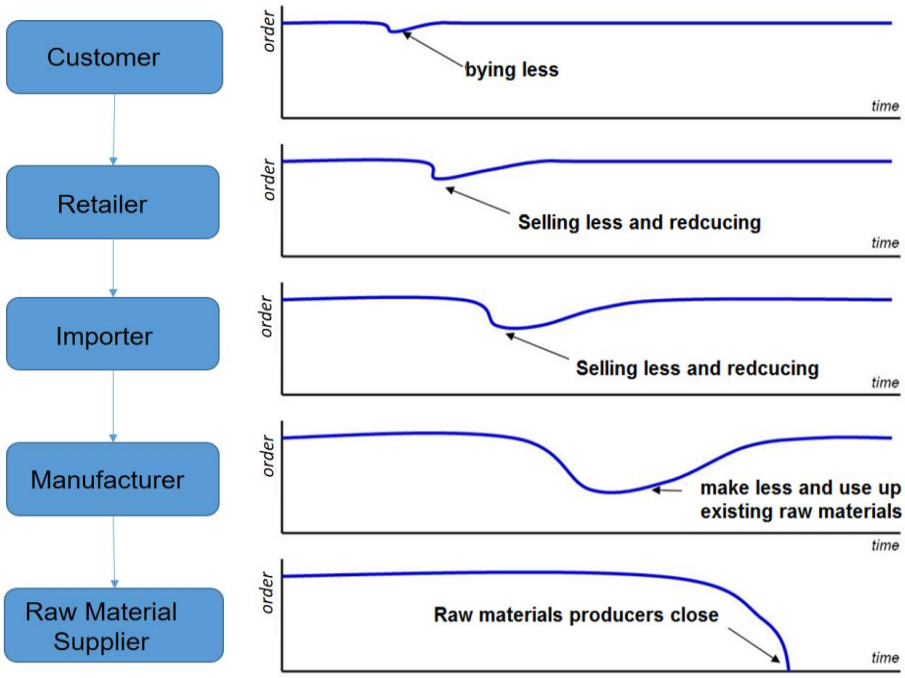

Figure 4 Bullwhip effect example on submitting orders (Tasko, 2014)

The customer may have some economic troubles and wish to reduce buying one product. In this case, the customer reduces the ordered amount of that product. Repeating this act may give the retailer feeling that this product is not going well and therefore, retailer may make a decision to buy less from the importer. The importer recognizes that this specific product is not going well and may make an exaggerated decision to import only the required amount instead of storing spare amounts at its warehouses. Therefore, the manufacture may change the whole production plan of that product and decide not to produce it. The customer could have made a wrong decision that affects the whole supply chain.

We can conclude that it is difficult to measure the bullwhip effect as the demand is aggregated. If the customer makes more orders, then if to start from the point of sales data for individual products for a specific retail outlet, then retailer distribution center is increasing its

orders and the demand is aggregated on the manufacturer and in turn the demand is aggregated on the raw material supplier (Lambrecht, 2008).

According to Disney and Lambrecht (2008) causes of the bullwhip phenomenon are the following factors:

First factor is wrong estimation of the orders, decision makers may over-react to the changes in the demands and therefore, make wrong forecasts.

Second, the demand signal processing which involves adjusting the parameters of the inventory replenishment rules like target stock levels, safety stocks and demand forecasts. Sometimes, the rational adjustments may give random responses and therefore, confuse the supply chain parties.

Third factor is delaying in both the information and arrival of products or what called lead-time. The lead time may increase when the variability increases.

Fourth factor is the practice of order batching which is represented by the set-up production, transportation and economies of scale ordering, when these increase, the orders variability increase and the bullwhip occurs.

Fifth, the price swinging may play good reason in the bullwhip effect. Retailers offer discounts, in-store promotions and other quantity discounts, this mean they need to buy in advanced bigger amounts than usual to insure that their stores are full, this in turn changes the demand chart and the forecast accuracy.

Stephan and Marc considered rationing and short age gaming another important reason to cause bullwhip. This means that there are many orders in the supply chain within a short period. This happens when customers exaggerate in making orders at a certain period and thou, manufactures find it hard to make an accurate forecast.

6.3.2 Different point of view on an objective

Arguing which process or strategy can be applied among the members of supply chain may vary due to several factors like cultural background, long-term agreement or contract with external partner or individual plans and strategies.

Cultural background may play major role in disagreement when setting up plans for integration, what is considered acceptable and good in one culture might not be suitable for the potential partner from other cultural background. In addition, companies with different cultural background may look at the same concepts, ideas, objects and definitions from different perspective (Jones and Griffiths, 2005). For instance, one company may consider the best approach for providing quality of service to customers is to shorten the time for waiting in queue in its offices as it is an important matter and could lose the customers if they have to wait long time. To do so, that company may decide to increase the number of employees or the number of offices. Meanwhile, another company may consider quality of service could be achieved by providing online solutions like chatting systems and emails or providing phone services with low costs in order to satisfy its customers instead of increasing the number of offices. However, online approach may not be efficient service in some countries.

In addition, companies may have their own objectives, plans and strategies, which they are on progress, some plans might be for a specific period of time like five-year plan and integration process may interrupt the ongoing plan. From one hand, each company seeks its own profits at first and then it looks for what other companies can benefits its business. The decision on whether to integrate or not can be discussed in light of the benefits, profits and earnings the integration will add to the company compared to the costs that the company may have without integration. From the other hand, tight integration may limit the companies' flexibility and agility, change plans to adapt the new unified objectives which in turn, may delay or reconsider joining the collaboration (Stelzer, et. al., 2006).

Mangers may look at plans, strategies and objectives from several perspectives as discussed which lead to several challenges when to decide to integrate. In order to achieve successful integration, managers need to have common understanding for concepts, ideas and objectives related to integration which might be difficult task as to several cultural backgrounds or other legalization issues.

According to Edwards et. al. (2001), the number of European companies who have integrated themselves by supply chain model are less than what was suggested by many authors and the integration seems to be not the main strategic objective. In addition, Edwards et. al., believes

that not many logistics companies are putting efforts for reaching true integration in the supply chain by linking their operations with the operations of suppliers and customers.

Holweg et. al., (2005) demonstrated some reasons which hinder or curb many companies from willingness to apply close integration with the supply chain partners. In his opinion, lack of understanding the collaboration practices. Another reason is the variety of limitation of information and communication technologies. Further, some researchers like Edwards et. al., (2001) studied whether the information and communication technologies are effectively assisting the flow of information and integration between companies in the supply chain.

In addition, according to Edwards et. al., many companies which implemented Enterprise Resource Planning (ERP) systems have not integrated their enterprise process using the applications. According to Akkermans et. al., (2003), the role of ERP systems is modest when comes to supply chain integration and may limit the inter-organizational coordination. However, there are many ongoing developments to enhance the integration of information and communication technologies across companies' borders. While some third party logistics providers concentrated on service based on standard solutions and economies of scale, others focused on customer solutions development, meanwhile some other studies developed conceptual models to support the integration in the supply chain (Naim et. al., 2006).

7 INTER-ORGANIZATIONAL INFORMATION SYSTEMS INTEGRATION TECHNOLOGIES

Planning the integration across companies' borders requires understanding of several issues related to techniques, technologies, software, and strategies to ensure successful implementation. This can be based on the following options: Infrastructure pooling, data exchange interfacing, service oriented interaction, process composition and standards adoption (Elmir, et. al., 2014).

- Infrastructure pooling

The idea behind this approach is to provide a pool of services and information that can facilitate the support of applications and information gathering and at the same time, use the pooled services to enhance the infrastructure. In addition, this approach replicates the data and services between the partnering companies from a remote site or by sharing the infrastructure between these partners.

- Electronic data exchange interfacing

This approach provides unified data exchange method among partnering companies by using the logic of point-to-point custom interface between the information subsystems. It uses the EDI logic which refers to exchanging data and business transactions like purchase orders and invoices, in a standard format and content (Pijpers et, al., 2009 ; oracle, 2016).

Although there are some disadvantages about using data exchange interfacing such as permanent exchange of data in the involved subsystems and interface maintenance costs when it is implemented in large-scaled integration, it is still a unique way of exchange data and achieve the required goals.

- Service oriented interaction

In many situations, integration is more than exchanging of information, there are several reasons make integrating the services one of the most important aspects of implementing integration between cooperated companies such as using services that are not locally

developed to reduce costs and time required for such local development. This approach depends on reusing the applications and services or in other words reusing the services functionalities and therefore, it is possible to create complex services from the combination of several existing ones (Elmir, et. al., 2014). This mean inter-organizational integration between several information systems will be based on reusing existent services and systems functionalities in order to provide successful integration.

Service oriented interaction is used to deal with process-oriented services among the whole partnering companies and therefore, adding extra value to the business services.

- Process composition

This approach is about providing collaboration between the inter-organizational processes by connecting the underlying subsystems which are responsible for execution of the processes within the partnering companies. In other words, it is more processes approach which is automated to build business processes among the cooperated companies (Elmir, et. al., 2014). This approach works by establishing process-oriented services across the partnering companies and operating the integrated business process of the workflow.

- Standards adoption

This approach ensures that the inter-organizational information systems use set of accepted standards for data representation, information exchange techniques and communication technologies and therefore, it develops these standards based on the partnering companies. In this way, numbers of common standards are implemented to be used among the partnering companies (AU, 2007).

In spite of the fact that using standards is important when implementing integration between several companies with different cultural backgrounds and domains, this approach have several weaknesses like standards are changeable by time and therefore, it will be not sufficient to the continues of the interoperability. In addition, changes over time need to be followed by developing new standards. Furthermore, some companies may not accept the standards to be applied at their information processes.

7.1 Middleware for logistics inter-organizational integration

Middleware approach is the traditional way of integrating information systems across the companies' borders. It is a standard programming interfaces and protocols, which are used to facilitate connecting the heterogeneous and distributed systems and to enable the implementation of an information utility. The middleware is located in the middle layer, between the company applications and the operating systems and networking software layer (Bernstein, 1996).

7.1.1 Middleware service

By using middleware services, an organization can move from using its legacy systems to new ones by encapsulating them as a set of functions, then it can use communications middleware services to access those functions remotely for example by using Common Object Request Broker Architecture (COBRA). In addition, an organization can replace some parts of its legacy system with middleware services like for example, replacing the application's database to middleware database services. Middleware services has several features or characteristics which can be listed in table 2.

Table 2 Some features of middleware services (Bernstein. 1996)

Feature	**Description**
Multi functioning	Middleware service should meet the needs of several of systems across many companies
Runs on multiple platforms	Middleware service must have implementations which can run on several platforms or it would be considered as a platform service.
Distributed	Middleware service should be able to access remotely all the connected distributed systems and services or to be accessed by the services running remotely

Supports standard protocols	Middleware service must support standard protocols like TCP/IP and IOS OSI protocol suite or at least a published protocol like IBM's SNA LU6.2
Supports standard API	Middleware service should support standard API in order to facilitate the interactions and the use of its protocols and tools
Transparent	Middleware service should be transparent with respect to the API in case of possible access to it without any need to change in the API

The middleware approach brings many benefits to the organizations as it reduces the maintenance of the systems by depending on the middleware providers. On the other hand, the developers also benefit from programming middleware, it allows them to focus on application (specific issues) and on a high-level interface. This in turns, reduces the complexity of protocols and networking levels (Bernstein, 1996). According to Linthicum (2000), there are several types of middleware which suit specific type of integration by utilizing different technologies. Figure 5 illustrates middleware sits between platforms and applications.

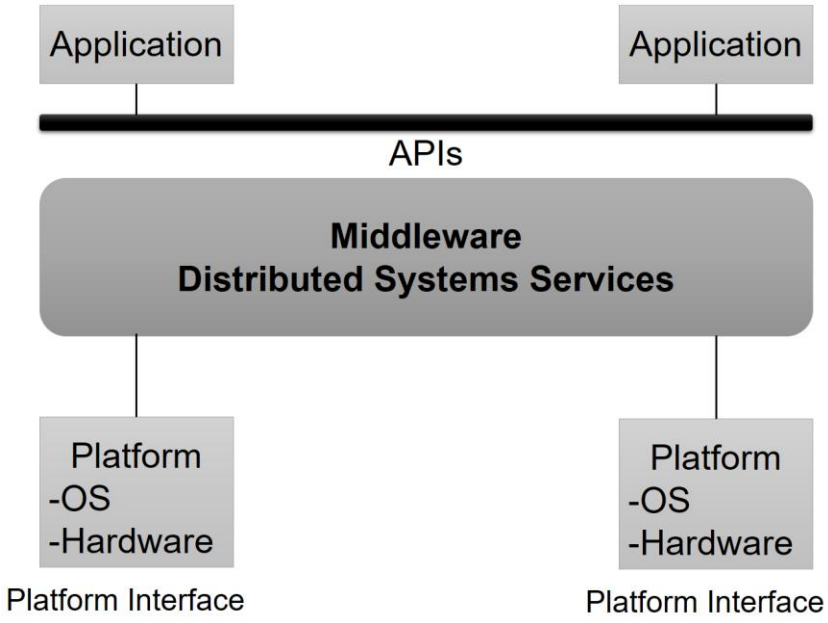

Figure 5 A middleware between platforms and applications (Linthicum 2000)

7.1.2 Multi-agent integration middleware

The development of wireless technologies and internet made it easier to manage the logistics companies' tasks and increased the agility and flexibility of the companies' works. It provided logistics works and supply chains with mobility feature and therefore, companies can extend their works to be in a mobile environment.

According to Zhao et. al. (2009), there are some limitations in the mobile working environment. As the work is based on wireless technologies, then failure to connect to the wireless network can lead to delaying the work if not stopping it. In addition, the bandwidth limitation can be also another obstacle to mobile works which limits the speed of transferring information between partners.

Santofimia et. al. (2008), studied the multi-agent integration middleware as an alternative solution to overcome the limitation in the mobile environment. Multi-agent is a single layer in the mobile supply chain management systems which provide dynamic interactions for the members of the supply chain. In this approach, each agent middleware is responsible for its own functions, provides other agents by its services and offers several personalized services to

external applications with unified interfaces. Figure 6 illustrates framework of the multi-agent middleware.

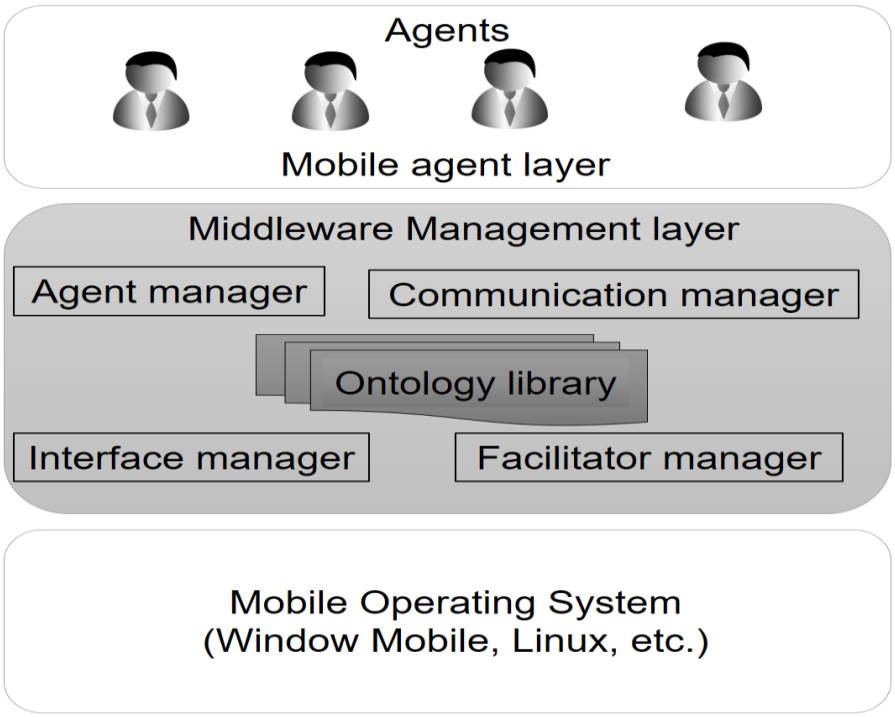

Figure 6 Framework of the multi-agent middleware (Tarnbe, 2008)

Based on figure 6, the mobile agent layer contains several independent agents, which are responsible for specific businesses and can finish their functions independently. For example, the order agent can receive order from external partner via mobile terminal device at any time and send the order to another agent to process the order and send back the results. The management layer contains the agent manger, communication manger, ontology library, interface manager and the facilitator manager, which are the basic components for integration middleware. In addition, there are several uniform interfaces to improve the flexibility and expansibility of the multi-agent integration middleware which allow the agents to integrate with external systems and applications. Finally, the mobile operating system layer is the one responsible to reduce the heterogeneity issue among different mobile terminal systems or communication networks (Tarnbe, 2008).

Figure 7 illustrates one possible framework for mobile supply chain management based on multi-agent integration middleware.

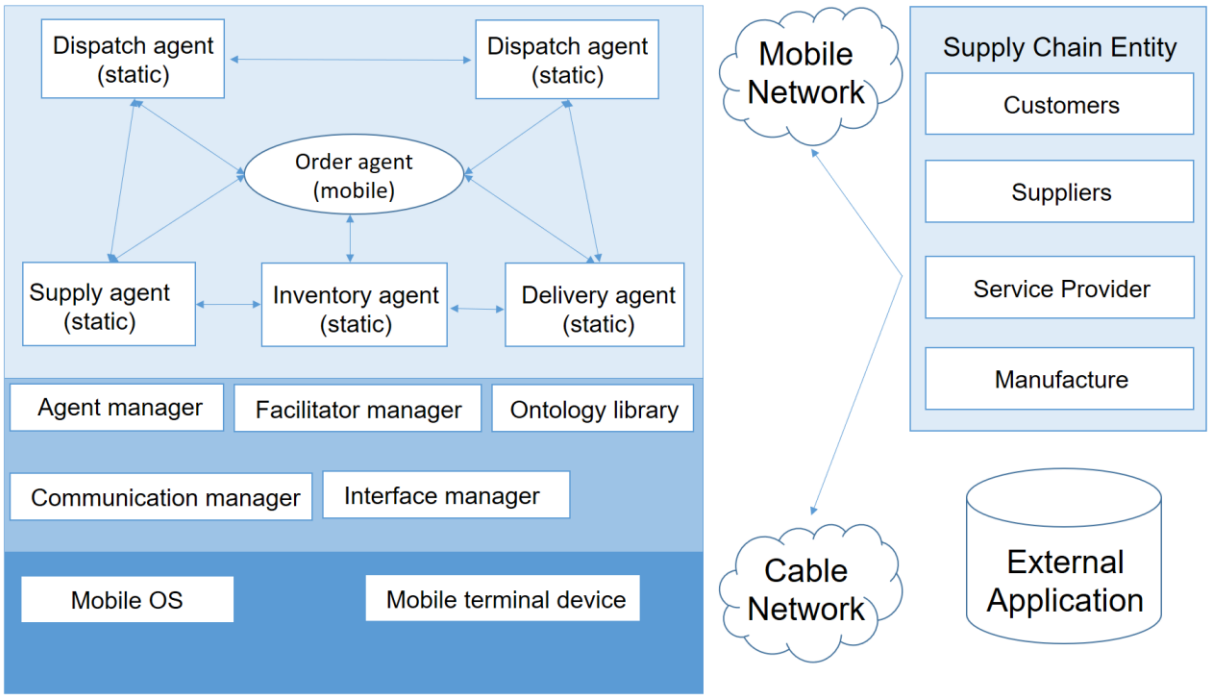

Figure 7 mobile supply chain management framework based on multi-agent integration middleware (Tarnbe, 2008)

As it is shown in figure 7, there are needs for several agents like: dispatch agent, supply agent, resource agent, deliver agent and inventory agent are designed as static services agents and each provide several independent functions. For example, dispatch agent searches the suppliers for possible information about the customer's order; supply agent describes the services provided by suppliers meanwhile, resource agent manages the mobile network resources, deliver agent is responsible for delivering statements of delivery and inventory agent checks the inventory status for each partner. In addition, the order agent, which is a mobile agent moves among the network nodes to transfer order request and collect the responses and resources.

According to Foundation for Intelligent Physical Agents (FIPA) (Santofimia et. al., 2008), agents can be carried through communications by the use of the asynchronous message

transmitting and the practices found that asynchronous message transmitting can be useful when disconnection take place in wireless networks as the information can be sent later. For instance, when a partner makes order via mobile equipment, the order agent collect the information of the order and search different agents for an optimal response. At this time the partner can be totally disconnected until the interactions between the agents return the results to the partner. In addition, using real-time information along the multi-agent module can illuminate the bullwhip effect and improve the mobile supply chain management (Mundle et. al., 2009).

A good example where to use multi-agent integration middleware could be in shipment terminal where all the transactions take place in a mobile environment and several mobile equipment are used from the moment of vessel arrival passing by the point of track departure out of the terminal and till the point of delivering the product to the final customers. Another example could be when a post delivering companies need to deliver a package to the final destination. A driver may have a mobile equipment to get information about the package delivery and needs to send back the status of delivery to the main office.

Although multi-agent integration middleware can improve the flexibility and reaction speed for the logistics partnering companies and solve some integration obstacles among the mobile devices and distributed information systems, it involves some limitations (Cosmin, et. al., 2003). First, many different agents will be developed to do specific functions and this involves extra costs. Second, every vender may have its own way in developing middleware service and support standard functions and therefore, changing the vendor might not be preferable all the time as it may add some complexity or developed some non-standard solutions. In addition, this approach involves problems of deploying the agents on the mobile equipment.

7.2 Electronic commerce and electronic business in logistics inter-organizational integration

Electronic collaboration has been increased in the recent decade due to the wide use of internet as a global communication platform for electronic business (e-business) and electronic commerce (e-commerce). E-commerce and e-business can be defined as the business activities that are carried out via electronic channels with/without the use of internet and the difference between them are mainly that e-commerce includes activities such as online buying-and-selling transactions while e-business involve running business over electronic communication channels like e-procurement which include more general activities of logistics integration. (Papazoglou and Ribbers, 2006, and Nurmilaakso, 2008). In logistics companies, shared information platform and online intermediaries enable the and e-business which in turn, enable sharing electronic information and transactions between partners (Baida et. al., 2008).

Electronic data interchange (EDI) is one methods of e-commerce for exchanging information in electronic form between several companies and industries and by the combination of EDI and internet, several advantages have been emerged such as more flexible and cheaper platform for inter-organizational integration, (Christiaanse et. al., 2004). EDIFACT (Electronic Data Interchange for Administration, Commerce and Transport), XML documents, and recently web Services are several international standards for EDI which logistics partnering companies use in order to exchange the necessary information between their systems.

The selection of B2B technologies goes beyond the type of the standards the partnering companies plan to use, it depends also on the type of platform like EDI, Web-based or value-added networks and on the type of the software (vendor or developer) which will be implemented. Table 3 illustrates some standards in electronic B2B integration technologies and the protocols, data exchange format, integration style, B2B architecture and the frameworks.

Table 3 electronic B2B standards (Schubert and Legner 2011)

Standards	**EDI/EDIFACT**	**Internet, XML**	**Web services**
Communication/ transport protocols	Proprietary protocols (X.400, OFTP, FTAM, . . .)	Internet (TCP/IP protocols	Internet (TCP/IP protocols)
Data exchange format	Text-based (ASCII, Unicode)	XML-based	Web services (SOAP) XML-based
Integration style	Document oriented (store and forward): EDIFACT messages (asynchronous)	Message oriented: XML messages (asynchronous/ synchronous)	Service oriented: Web services (synchronous)
B2B architecture	Value added networks (VAN) as intermediaries	Web architectures, convergence of internal and external integration	Service-oriented architectures (SOA), convergence of internal and external integration
Frameworks	EDI Reference framework	OpenTRANS, RosettaNET, ebXML	Dynamic e-business Model by Joseph Bih

In addition, several platforms exist for inter-organizational communication systems which include: Direct company-to-company linkages (hardwired), WEB-EDI, General commercial VAN, Specialty value added networks (VANs), XML-EDI and Internet Email.

7.2.1 Factors affect the selection of the B2B standard type for e-business

Choosing specific platform to be deployed in inter-organizational integration is affected by several factors and based on these factors, each of these platforms may have advantages and disadvantages. Table 4 describes some of these factors.

Table 4 Factors affect the selection of the B2B standard type for e-business (Schubert and Legner 2011)

Factors	Description
Communication speeds	Related to the speed of communication channels for information transmission (bandwidth allowed on the systems)
Type of standards	Related to the compliant between the standards with the systems that are in use in the logistics partnering companies
Security	Related to the security issues over the internet and may include the security of shared data, recovery related issue in case of data loss and system break-in security related
Reliability	Refers to maintaining of operations and processes, avoid break down, data backup and recovery services
Transaction filtering (profiling)	Refers to the ability to filter the transactions and eliminate other information that are not desired
Additional value-added services	Related to the extra services which add value to supply chain activities such as consulting and translation service to provide better EDI-integration business systems like (EDI-to-FAX)

Information access	Related to monitoring accessing information, transmission status report, usage accounting data and performance of the communication systems
costs	Related to both the fixed and variable costs of the built systems, technologies and communication and the possible upcoming costs

Schubert and Legner (2011), documented the main three perspectives on inter-organizational integration which are: technical, organizational, and institutional integration and based on this integration perspectives, they built sequential research outcomes as can be shown in the figure 8.

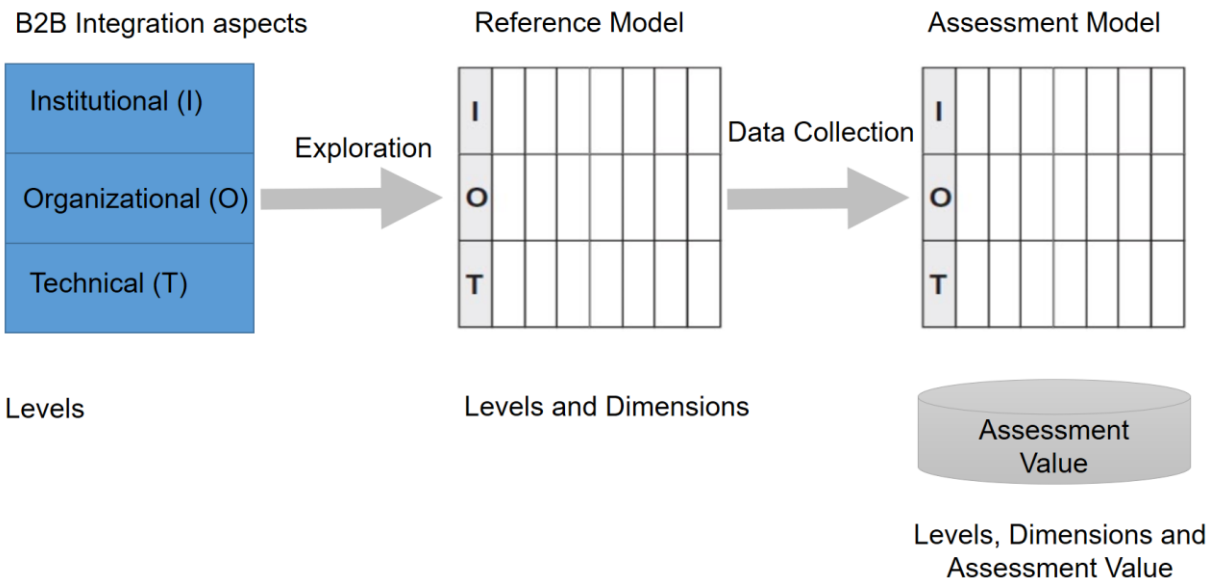

Figure 8 sequential research outcomes diagram (Schubert and Legner, 2011)

The Assessment model enables companies to assess their abilities and value chain integration levels and table 5 lists the sequential research outcomes and their descriptions.

Table 5 The sequential research outcomes (Schubert and Legner, 2011)

Outcomes	**Resources**	**Researches**
B2B integration Reference model	Obtained from literature of supply cahin integration	Model is built based on database of real-world case (data exploration)
Derived B2B integration Asseessment model	Is based on analysis of current state	Model is built based on real-world transactional data
B2B integration development guide	Obtained from research literature and analysis of best practice	Developed based on bridging the gap between current state and ideal state

As the focus in this thesis is on the technical side of integration, only the technical integration will be discussed. Technical integration defines the process of sharing information internally in an organization or across the company's borders through communication and interaction between several systems.

Based on the previous researches of (Al-Naeem et. al., 2004 and Bussler, 2003), a three types of integration can be described as following:

1. Client Integration: in this case, the access to the systems, applications and information is usually from the direct users via internet (Websites and portals).
2. Applications Integration: refers to the functional integration and machine to machine applications linking. Several options for this integration include exchanging electronic messages by the use of remote methods invocation or service calls and asynchronous communication.
3. Data Integration: involves integration on the database level and can be achieved by the several ways like file copy, data synchronization or replication.

Figure 9 illustrates a generic model of technical integration and the links between the several integration forms which has been discussed.

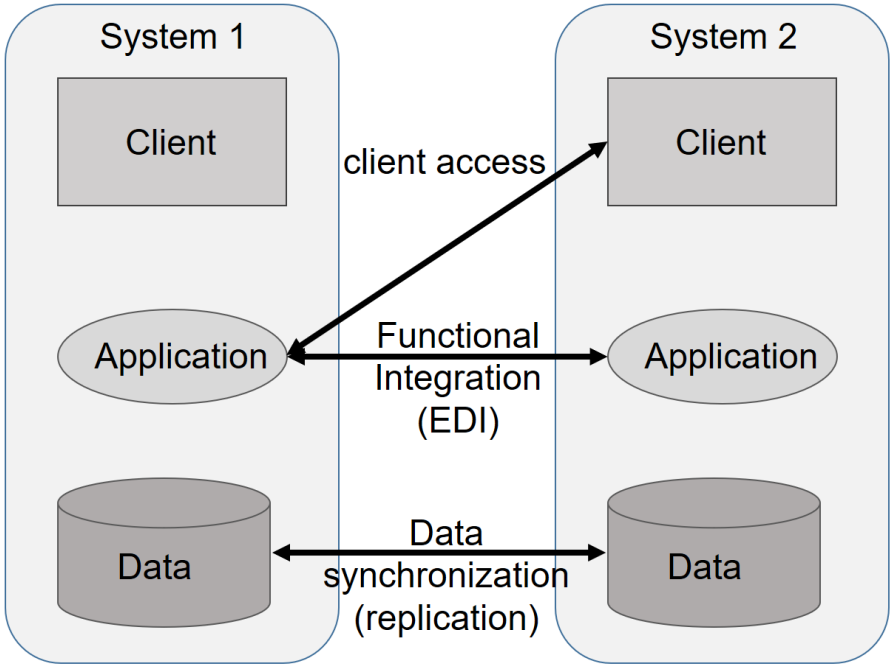

Figure 9 Generic model of technical integration (Schubert and Legner, 2011)

7.2.2 Analysis of advantages and limitations of e-commerce

Several researches investigated the factors that may have great impact on the B2B e-commerce integration and performance in supply chain. (Ding, 2014) listed some of these factors which include the company size, organization structure, Strategic alignment, Business process redesign, Staff size, Process change, IT investment, IT intensity, Unique knowledge and Interdependent information needs with supplier. The decision whether to use e-commerce depends on these factors.

According to Schneider (2010), using e-commerce brings several advantages to cooperating companies such increase the speed of doing the works, reduce the costs and time needed for extracting information, increase the accuracy of information, increase purchasing and other logistics transactions and increase the sales which in turn increase the earnings of the companies. Goel, (2008) found that using e-commerce in logistics companies provide faster delivery to partnering companies and facilitates the shipment tracking using web portals and online shipment tracking.

Studying the factors that affect the selection of specific e-commerce's standard for implementing inter-organizational integration along logistics partnering companies highlights several points (Schneider, 2010). First, choosing specific standard is an important factor for integration and this means that the companies need to consider restructuring their existing databases to suit the standard. There is also difficulty in transactions related to processing software. Second, the fast growth of other technologies beside the limitations of bandwidth demand, scalability and reliability might have an impact on the customers' relationships and makes it difficult to trust that information would be available at any time needed. Third, in logistics world, security and privacy are important aspects to be taken in consideration and transactions like payments and shared data must be secured. Finally, it is important to compare the costs of establishing integration using e-commerce and the future costs reduction benefits.

7.3 Service-oriented Architecture (SOA)

Interoperability has become the main concern of companies when considering changing partners or integrating business with other partnering companies and for that reason several integration approaches have been studied to facilitate the interoperability (Legner and Wende, 2006). Recently, service-oriented architecture (SOA) approach has been developed as an attempt to utilities the existent software components and services and reuse them for in future (Leymann, et. Al., 2002).

As a definition, (Mahmood, 2007) SOA is an enterprise architecture which characterized by loosely coupled and systems or services reusable. The technical processes in SOA are implemented as services and each service represents a specific function. The definition indicates that the service is a software component and can be used by other software components or accessed via web interface or over network (Mahmood, 2007). The main aim of SOA is the integration of business activities within the companies and across the companies' borders (Hurwitz, 2009). The major reason that makes SOA suitable for integration purposes is the loosely coupled feature and easiness of connecting and exchanging services in addition to its unique aspect, which combines several existent services to integrate complex business tasks and only develops a new service if it does not exist. Therefore, there is a noticeable reduction in the integration costs and the integration's maintenance costs, (Beimborn, et. al., 2011). In addition, SOA is based on services which can easily integrated, have standards and provide self-contained services (Baskerville, et. al., 2005).

In order to achieve its work, SOA is combined of three major components: service directory, service provider and service requester and it has several standards, table 6 below describes some of these standards.

Table 6 SOA Standards (Leymann, Roller and Schmidt, 2002)

Standard	Name	Description
SOAP	Simple Object Access Protocol	-Protocol for communication with web services via internet -It specifies the message format which are exchanged between service requestor, the service provider, and the service directory
WSDL	Web Services Description Language	-It is an XML format describes the structure and the contents of the service directory - There are two relevant points: actual business information and service types
UDDI	Universal Description, Discovery, and Integration	-provide the ability to describe a web service that is not standardized - A WSDL Web service description can give all the information to be invoked

In logistics inter-organizational integration, SOA provides easy way of existing IT infrastructure and systems alignment to like the partnering companies efficiently by removing the redundancies, creating unified collaboration tools and control IT processes (Baskerville, et. al., 2005).

7.3.1 Factors influence implementing SOA in logistics inter-organizational integration

According to the requirements of inter-organizational integration which mentioned earlier, it seems that SOA fit these requirements. SOA provides flexibility, scalability and interoperability and therefore, can achieve integration purposes. However, the question is

whether SOA would be suitable for all kinds of logistics integration. In a study on whether to adopt or not to adopt SOA, there are four situations where deploying SOA could be useful based on Bobby Woolf (Wang and Liao, 2009):

1. High level of data distribution.
2. Availability of services and needed functions.
3. The development, maintenance and updates of individual parts of application are required to be independent.
4. Applications require reusable functions and data.

According to Wang and Liao, (2009), SOA approach is useful when solution is integrated on business activities of several different systems and programming models and when the companies are increasing the types of businesses or developing new applications and services continuously.

Based on these studies, SOA can achieve high competitive advantages in logistics organizations especially for big-size organizations like shipping line, post delivering companies or supply chain. Usually big-size organizations run many services simultaneously and there is always need for developing more services and applications, or updating the current applications. In addition, one can imagine the load of works that are required to develop each service individually and link them to each other in order to run one system like billing system.

On the other hand, according to Wang and Liao (2009, SOA needs to be as a standard component via intermediate software which involves additional process for computations which in turn, may slow down the services and the whole run-time and as a result it may reduce the performance. The most technical obstacle of SOA is the abstract creation and maintenance of services as SOA increases the IT business complexity. In addition, Wang and Liao stated that SOA integration needs good control and quality management to obtain successful integration rewards.

7.3.2 Transferring inter-organizational business process into service oriented architecture

To discuss whether implementing SOA can be useful in the field of logistics integration and can improve the B2B commerce, an example of manufacturing company with two plants is described (Pulier, E. and Taylor, H., 2005). If one plant needs specific item, its ERP system sends a request message to the computer or information system at the headquarters (HQ), which in turn sends automatically request to the other plant's ERP system to check whether the plant has this item in its stock. If the other plant does not have the item, then the HQ system sends an electronic order to the supplier's ERP system. In order to facilitate the company's inventory request and the supply ordering process, an enterprise architecture can be used to connect the systems in all the sides using proprietary interfaces. This approach provides a tight coupled integration which may return inflexibility to the partnering companies. Figure 10 illustrates the business process and enterprise architecture solution.

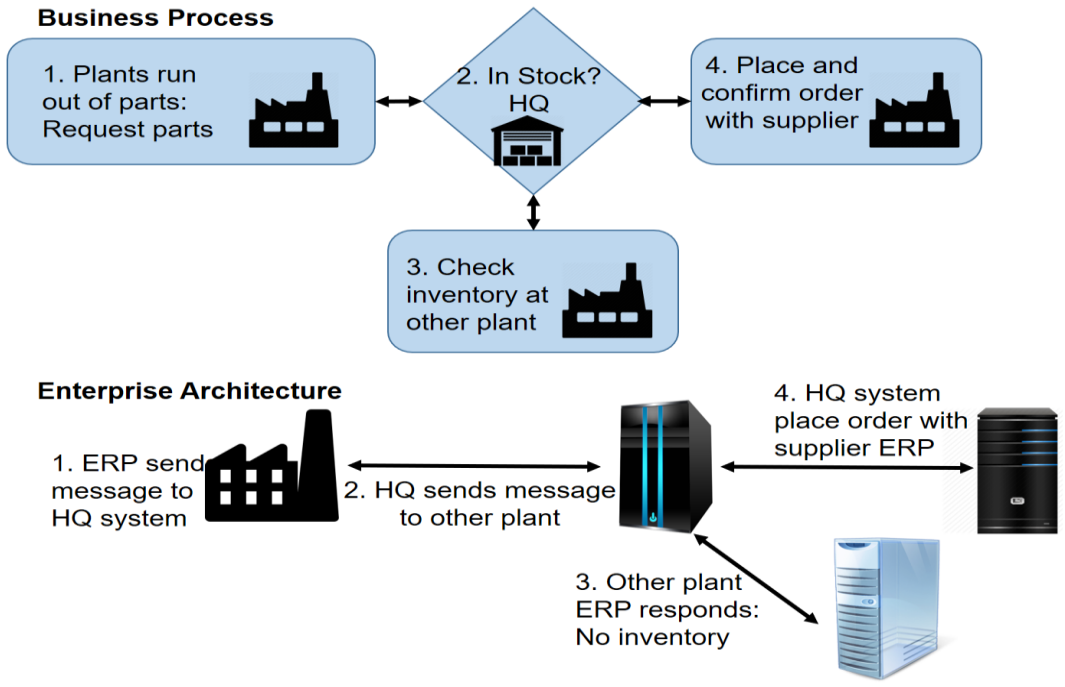

Figure 10 Business Process Vs Enterprise Architecture solution (Pulier and Taylor, 2005)

By deploying SOA approach, it is possible to implement new opportunities for establishing B2B commerce without significant restructuring the underlying systems and without the need to create proprietary interfaces. SOA enables the first plant to check directly from the second plant if it has the needed item and make orders without passing through the HQ system. This means reducing the complexity which is used in the previous approach, more flexibility and saving time for reworking the infrastructure of the systems in all the sides. With SOA, the HQ system can use its web service to monitor the transaction flow by passing SOAP (Service Oriented Architecture Protocol) messages between the second plant and the supplier. Figure 11 illustrates SOA approach.

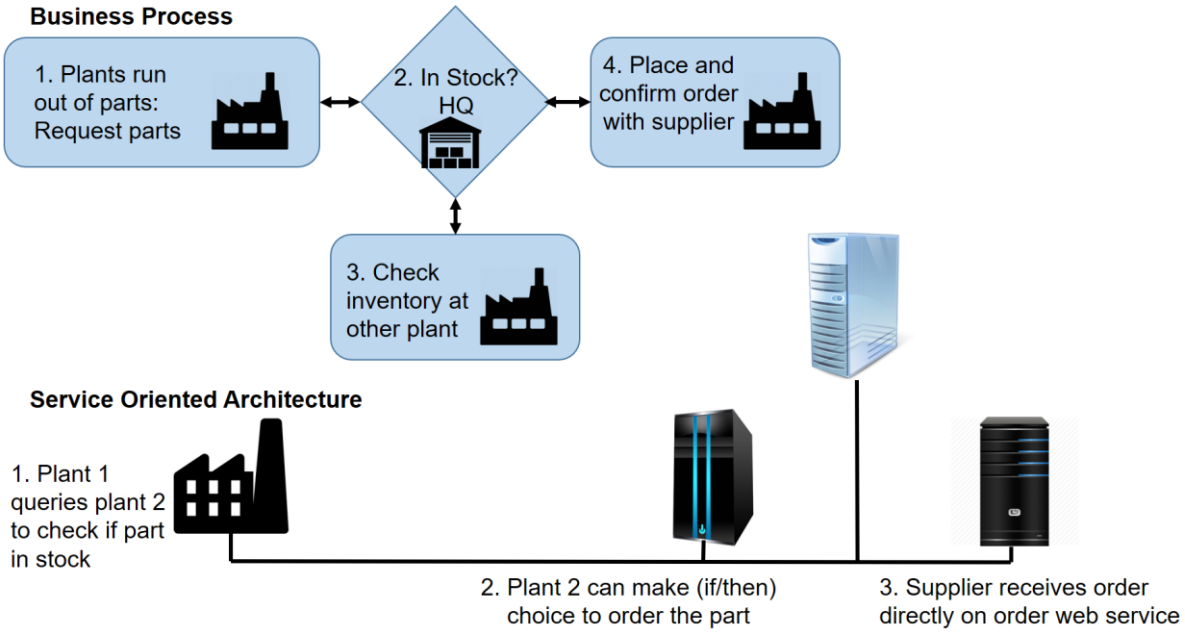

Figure 11 Business Process Vs SOA approach (Pulier and Taylor, 2005)

8 DISCUSSION AND ANALYSIS OF THE FEASIBLE INTEGRATION

The main key of inter-organizational integration is sharing information between partnering companies and therefore, the integration should start with focusing on exchanging information (Lee, 2000; Mentzer, 2001). The level of integration may vary depends on information sharing characteristics like availability of information, real-time information, dependency level of information, privacy and secrecy of information. Thus, not all partners will have same level of integration as this depends on the mutual interests of the partnering companies (Lamberet et. al., 1999).

All the integration approaches that are mentioned in this thesis have focused on finding solutions to facilitate sharing the information and the integration of logistics systems across the companies' borders. However, to answer the main question on what could be the feasible approaches to overcome the challenges that encounter the integration of the logistics systems across the companies' borders, a brief description about the advantages and limitations of each approach will first take place, followed by discussion on which approach could be suitable at certain cases.

The following tables describe briefly advantages and limitations of each integration approach based on the integration concept based on the literature review.

Table 7 advantages and Limitations of middleware – multi-agent integration middleware

Advantages	Limitations
Speeds up the overall work by dividing the work between several agents (Tarnbe, 2008)	Expensive, needs developing several agents to do specific functionality (Cosmin, et. al., 2003)
Stores information and sends it later when disconnection take place in wireless networks using asynchronous message (Santofimia, et. al., 2008)	Depends on one vendor as each one has its own way of developing middleware (Cosmin, et. al., 2003)
Reduces the heterogeneity issue among	Changing vender may develop some non-

different operating systems (Tarnbe, 2008)	standard solutions and therefore, add complexity (Cosmin, et. al., 2003)
Removes the bullwhip effect and improves the mobile supply chain management (Mundle, et. al., 2009)	Difficulties in deploying agent on mobile equipment (Cosmin, et. al., 2003)

Table 8 advantages and Limitations of E-commerce

Advantages	**Limitations**
Reduces the costs and time needed for extracting information (Schneider, 2010)	Changing e-commerce standards require restructuring the existing databases and therefore, the business process (Schneider, 2010)
Increases purchasing, sales and other logistics transactions (Schneider, 2010)	Several EDI standards are required in most cases (Schneider, 2010)
Provides fast delivery to partnering companies (Goel, 2008)	EDI system involves a significant initial investment (Schneider, 2010)
Makes shipment tracking easy via web portals and online shipment tracking (Goel, 2008)	Scalability and reliability problems (Schneider, 2010)
	Needs electronic protection as security and privacy are not guaranteed (Schneider, 2010)
	Poor performance in mobile environment Zhao et. Al., 2009)

Table 9 advantages and Limitations of Service Oriented Architecture (SOA)

Advantages	Limitations
Increases scalability and interoperability (Legner and Wende, 2006)	Requires to be as a standard component via intermediate software which involves extra computations (Wang and Liao, 2009)
Reduces maintenance costs (Beimborn, et. al., 2011)	A slow-down service may take place as to the extra computations (Wang and Liao, 2009)
loosely coupled feature which facilitates integration process (Beimborn, et. al., 2011)	Increases the IT business complexity as to its abstract creation and maintenance of the services (Wang and Liao, 2009)
Eliminates the need for replicating the functionality from one system onto another (Kumar, et. Al., 2007)	Might be costly in case of unused technologies suits SOA infrastructure (Wang and Liao, 2009)
Web services allows accessing applications from several platforms (Stal, 2002)	

Based on the literature review and the tables, choosing a feasible approach for integration may depend on the several points. The middleware approach is not sufficient when logistics companies run their businesses in a mobile environment as to network disconnection issue and bandwidth limitation (Zhao et. al., 2009). To overcome this issue, a multi-agent integration middleware has been developed. In this respect, several researchers concluded that using the EDI or electronic hubs (E-Hubs) as integration technologies might not be efficient to the mobile-working environment (Santofimia et. al., 2008). Even with Service oriented architecture (SOA) approach, network disconnection is one major issue as this approach is based on network services.

One possible solution to improve integration might be by combing the multi-agent middleware with SOA. According to Srinivasan et. al. (2011) this combination improve the information sharing, SCM performance and managing the inventory and as a result, reducing the supply

chain costs. According to Stal (2002), middleware integration methods like COBRA is heavy to use and not easily accessible via web applications and services, meanwhile SOA (based on web services) allows applications to be accessed from a platform neutral environment using any communication protocol.

On the other hand, the studies show that there is a connection between the size of the partnering companies and the chosen approach of integrating their businesses. Using e-commerce in some cases, might be a problem for integrating small businesses (Power, 2002). According to Power, the initial cost to setup EDI is time consuming as EDI's start up takes long period, which in turn, make the cost of implementation high. In this respect, some researchers highlighted the importance of comparing the initial costs of integration using e-commerce to the future costs reduction benefits. According to a study in Australian companies, it was found that small and medium size companies have got some extra costs and difficulty of implementation EDI and that large-size companies are more likely to obtain benefits of using EDI than the smaller one (Power, 2002).

In addition, it was noticed in some cases that when implementing the integration, larger logistics partnering companies may force smaller partners to use EDI. However, e-commerce increases the purchasing, sales and other logistics transactions (Schneider, 2010) and therefore, it might be useful for integrating logistics companies which deals with simple business tasks. Meanwhile, multi-agent middleware could be a feasible option for integrating the systems of small-sized partnering companies if they depend on one vendor and do not consider changing it in the coming future (Cosmin, et. al., 2003). Middleware agents could perform all the simple tasks like purchasing, ordering and inventory, ensure availability of information and eliminate the heterogeneity among several terminals (Tarnbe, 2008). In addition, the literature review shows that SOA is not suitable for simple business tasks like pure purchasing or selling procedures. Also in situations that the integration requires linking very simple services between the cooperated companies SOA is not suitable as it increases the IT business complexity. Furthermore, if the partnering companies are running technologies that do not suit SOA infrastructure, there is a possibility that applying SOA in integration might be costly (Wang and Liao, 2009).

Another point in the selection of integration approaches, is the importance of scalability and interoperability. In this respect, SOA supports and increases both the scalability and interoperability of the systems as it depends on loosely coupled feature and exited service which in turn facilitates the integration process (Beimborn et. al., 2011), (Legner and Wende, 2006). In addition, SOA removes the needs for replicating same service as it can merge them in one function and use this function from several places on the network. Meanwhile e-commerce has some problems with the scalability as it involves deploying several EDI standards and changing one of these standards requires restructuring the exiting databases to suit the new standard. This means replicating the integration work and restructuring the business process (Schneider, 2010). Furthermore, an interoperability problem may occur if two partnering companies run different EDI standards that do not communicate with each other (Schneider, 2010).

Multi-agent middleware approach reduces the heterogeneity among different terminals and runs several middleware agents, each provides independent service to perform specific functionality, therefore, when a new service is needed, a new agent could be developed, this in turn, increases the scalability of the systems (Tarnbe, 2008).

Finally, when comparing the costs of implementing each approach, one can think about several types of costs: initiation costs, maintenance costs and future development or extension costs. As SOA depends on existing services and software solutions, the initiation costs are acceptable. Although SOA reduces the maintenance costs in many cases (Beimborn, et. al., 2011), it was observed that when the used technologies in integration do not suit SOA infrastructure, SOA solution might be costly one and therefore, the extension costs might be higher (Wang and Liao, 2009). EDI involves high initiation costs due to the need for developing several EDI standards and giving a special attention to the security part (Schneider, 2010). In addition, maintenance costs could be high as well if the EDI standards were not developed to suit the future extension as restructuring the existing databases might be needed (Schneider, 2010). Meanwhile multi-agent integration middleware is an expensive solution; it requires developing several agents in order to perform specific functionality, however, the maintenance costs and extension costs could be reduced if it depends on the same vendor (Cosmin, et. al., 2003).

9 CONCLUSION AND FUTURE WORKS

We conducted a literature review study to investigate feasible approaches for overcoming the challenges encountered during integrating logistics systems across the companies' borders. To achieve this objective, the challenges and the requirements of logistics system integration have been studied and several integration technologies and approaches were discussed. The challenges were divided into three main categories: organizational, technical, and information sharing challenges. In this thesis, the integration approaches were studied based on information sharing perspective as it was considered the main key of inter-organizational logistics systems integration (Lee, 2000; Mentzer, 2001). Meanwhile the main requirements of inter-organizational logistics system integration were studied based on quality, functionality, organizational requirements, flexibility, and scalability.

The thesis emphasizes the benefits gained by integrating the logistics systems of several companies on both technological and economical sides. From the literature review, it was found that by integrating the companies' logistics systems, the partnering companies will gain an overall execution management, improve both the customer services and suppliers' productivity, improve the products/services quality and reliability. Integration will also provide up-to-date manufacturing information, provide optimal delivery and goods flow, decrease the lead times, increase the useful information for future plans and save costs and time.

All the mentioned approaches have many advantages and limitations that are discussed and the selection of feasible approach depends on the requirements of the integration and the working environment. Multi-agent integration middleware is considered an expensive solution but suitable for mobile working environment as it solves the main issue of wireless disconnection and availability of real-time information besides connecting several heterogeneous mobile terminals. E-commerce integration was found to be suitable approach for the integration of companies that execute simple business tasks but involves some complexity when initiating and developing EDI standards. Meanwhile, Service Oriented Architecture (SOA) integration approach could be useful when there are high level of data distribution and available reusable services. In addition, it was observed that SOA is not suitable for simple business tasks.

This thesis is an asset for IT managers and decision makers of logistics companies, which are interested in combining their logistics systems with other partners to gain the maximum benefits from the cooperation. It provides some integration approaches for integrating logistics systems across companies' borders in order to understand the challenges and the requirements and to facilitate the selection of the approach that suits the integration requirements. In addition, based on literature review this thesis demonstrates a comparison between some available integration approaches and provides details about information sharing integration based on previous studies which in turn, may assist the researchers and the students who are interested in this topic.

Several studies focused on providing information about a specific integration approach. They discussed its advantages or disadvantages, and its application in specific areas but there is still lack of comparison between these approaches. This thesis fills this gap by providing detailed comparison and discussion for which could be feasible integration approaches. However, the thesis does not include all the available approaches for implementing the integration and it does not provide solutions for all the challenges that face the integration except the logistics systems integration problems.

Further improvements of this thesis can be done by providing all the available integration approaches and technologies and compare them to find out what could be suitable approach under specific conditions. In addition, to improve this thesis, one can think of studying combining some approaches like SOA and multi-agent middleware to enhance the overall performance.

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