Lappeenranta University of Technology
School of Industrial Engineering and Management
Software Engineering and Information Management

Negin Banaeianjahromi

INTEGRATION OF ELECTRONIC COMMERCE AND ENTERPRISE SYSTEMS

Supervisors: Professor Kari Smolander

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ABSTRACT

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Integration of electronic commerce and enterprise systems

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The necessity of EC (Electronic Commerce) and enterprise systems integration is perceived from the integrated nature of enterprise systems. The proven benefits of EC to provide competitive advantages to the organizations force enterprises to adopt and integrate EC with their enterprise systems. Integration is a complex task to facilitate seamless flow of information and data between different systems within and across enterprises.

Different systems have different platforms, thus to integrate systems with different platforms and infrastructures, integration technologies, such as middleware, SOA (Service-Oriented Architecture), ESB (Enterprise Service Bus), JCA (J2EE Connector Architecture), and B2B (Business-to-Business) integration standards are required. Huge software vendors, such as Oracle, IBM, Microsoft, and SAP suggest various solutions to address EC and enterprise systems integration problems.

There are limited numbers of literature about the integration of EC and enterprise systems in detail. Most of the studies in this area have focused on the factors which

influence the adoption of EC by enterprise or other studies provide limited information about a specific platform or integration methodology in general. Therefore, this thesis is conducted to cover the technical details of EC and enterprise systems integration and covers both the adoption factors and integration solutions. In this study, many literature was reviewed and different solutions were investigated. Different enterprise integration approaches as well as most popular integration technologies were investigated. Moreover, various methodologies of integrating EC and enterprise systems were studied in detail and different solutions were examined.

In this study, the influential factors to adopt EC in enterprises were studied based on previous literature and categorized to technical, social, managerial, financial, and human resource factors. Moreover, integration technologies were categorized based on three levels of integration, which are data, application, and process. In addition, different integration approaches were identified and categorized based on their communication and platform. Also, different EC integration solutions were investigated and categorized based on the identified integration approaches.

By considering different aspects of integration, this study is a great asset to the architectures, developers, and system integrators in order to integrate and adopt EC with enterprise systems.

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Lappeenranta, September 25th, 2013

Negin Banaeianjahromi

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ABBREVIATION

ABAP	Advanced Business Application Programming
AIA	Application Integration Architecture
AJAX	Asynchronous JavaScript and XML
ANSI	American National Standards Institute
API	Application Programming Interface
AS	Application Server
AS2	Applicability Statement 2
B2B	Business-to-Business
B2B2C	Business-to-Business-to-Customer
B2C	Business-to-Customer
BAPI	Business Application Programming Interface
BI	Business Intelligence
BPEL	Business Process Execution Language
BPM	Business Process Management
BPO	Business Process Outsourcing
BPSS	Business Process Specification Schema
BW	Business Warehouse
C2B	Customer-to-Business
C2C	Consumer-to-Consumer
CAF	Composite Application Framework

C-commerce	Collaborative commerce
CICS	Customer Information Control System
CIDX	Chemical Industry Data eXchange
CO	Controlling
COBOL	Common Business-Oriented Language
COM	Common Object Model
CORBA	Common Object Request Broker Architecture
CPA	Collaboration Profile Agreement
CPP	Collaboration Protocol Profile
CPPA	Collaboration Protocol Profile and Agreement
CRM	Customer Relationship Management
CXF	Celtix and XFire
CWM	Common Warehouse Metadata
DCE	Data Communications Equipment
DCOM	Distributed Common Object Model
DNS	Domain Name System
DSS	Decision Support Systems
DTD	Document Type Definition
E2E	Exchange-to-Exchange
EAI	Enterprise Application Integration
E-business	Electronic Business

EBO	Enterprise Business Object
ebMS	Electronic Business Messaging Service
ebRIM	Electronic Business Registry Information Model
ebRS	Electronic Business Registry Service
ebXML	Electronic Business using eXtensible Markup Language
EBS	Enterprise Business Service
EC	Electronic Commerce
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange For Administration, Commerce & Transport
EFT	Electronic Fund Transfer
EIS	Enterprise Information System
EJB	Enterprise JavaBeans
ERP	Enterprise Resource Planning
ESB	Enterpriser Service Bus
E-Service	Electronic Service
E-store	Electronic Store
E-tailing	Electronic Tailing
ETL	Extract, Transform and Load
FAST ESP	Fast Search & Transfer Enterprise Search Platform
FI	Finance

FTP	File Transfer Protocol
G2C	Government-to-Citizens
HCM	Human Capital Management
HTML	Hyper Text Markup Language
HTTP	HyperText Transfer Protocol
IBM	International Business Machines
ICE	Information and Content Exchange
IDL	Interface Definition Language
IEP	Enterprise Integration Pattern
IIS	Internet Information Services
IS	Information System
ISO	International Standards Organization
IT	Information Technology
IMS	Infrastructure Managed Services
J2CA	J2EE Connector Architecture
J2EE	Java 2 Platform, Enterprise Edition
JAAS	Java Authentication and Authorization Service
JAX-RPC	Java API for XML-based Remote Procedure Call
JBI	Java Business Integration
JCA	J2EE Connector Architecture
JDBC	Java DataBase Connectivity

JMI	Java Metadata Interface
JMS	Java Message Service
JNDI	Java Naming and Directory Interface
KM	Knowledge Management
LES	Logistics Execution System
LO	Logistics
MDM	Master Data Management
MM	Material Management
MOM	Message Oriented Middleware
MQI	Message Queue Interface
MQM	MQSeries Queue Manager
MQSeries	Message Queue Series
MSMQ	Microsoft Message Queuing
MSN	Microsoft Network
OASIS	Organization for the Advancement of Structured Information Standards
ODBC	Open Database Connectivity
ODBO	OLE DB for OLAP
OMG	Object Management Group
ORB	Object Request Broker
OSI	Open Systems Interconnection
PI	Process Integration

PIP	Process Integration Pack
PIP	Partner Interface Processes
PLM	Product Lifecycle Management
PP	Product Planning
PRM	Partner Relationship Management
REST	Representational State Transfer
RMI	Remote Method Invocation
ROI	Return On Investment
RPC	Remote Procedure Call
SAP	System, Application, and Product in Data Processing
SCM	Supply Chain Management
SD	Sales and Distribution
SME	Small and Medium-Sized Enterprise
SMTP	Simple Mail Transfer Protocol
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
SRM	Supplier Relationship Management
SSIS	SQL Server Integration Services
STEP	Standard Template for Electronic Publishing
TCP	Transmission Control Protocol

TPM	Transaction Processing Monitors
UCCnet	Uniform Code Council Network
UDDI	Universal Description, Discovery, and Integration
UDP	User Datagram Protocol
UML	Unified Modeling Language
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
URI	Uniform Resource Identifier
W3C	World Wide Web Consortium
WCF	Windows Communication Foundation
WebAS	Web Application Server
WebDAV	Web-based Distributed Authoring and Versioning
WF	Windows Workflow Foundation
WPF	World Population Foundation
WSDL	Web Service Description Language
WSIF	Web Service Invocation Framework
WSIL	Web Service Inspection Language
WSRP	Web Services for Remote Portlets
XMI	XML Metadata Interchange
XML	Extensible Markup Language
XSD	XML Schema Definition
XSLT	EXtensible Stylesheet Language Transformations

Y2K	Year 2000

1 INTRODUCTION

1.1 Background

According to Ruh, et al. (2001), over the past three decades, the concept of integration in information systems content has changed dramatically. Generally, what is meant by integration is the concept of bringing together a different set of hardware and software components and applications in order to form a system which embraced a seamless flow of information. Integration in its own nature seems to be complex and critical operations since different people have very different opinions of integration.

EC (Electronic Commerce) is known as buying and selling products and services via Internet. Goel (2008), defined EC as "a modern business methodology that addresses the needs of organizations, merchants, and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery, by using Internet."

Enterprise systems are complex and integrated systems consist of processes, organizations, information, and supporting technologies (Nightingale & Rhodes, 2004). Enterprise systems are a common place within an organization or between organizations to communicate and share resources (Bernard, 2012).

Enterprise systems have brought significant improvements to the organizations, by automating processes (Davenport, 1998). Enterprise systems can be customized to serve any industry perfectly. By implementing enterprise systems, companies can gain strategic value and EC as a competitive advantage can bring more value to the companies by integrating it with enterprise systems (Davenport, 2000).

The earlier research around the integration of EC and enterprise systems can be realized from the early general discussions about the influence of integrating Internet on companies (Wigard, 1997). After that the topic of EC was more around customers and the issues, such as security, trust, convenience, and price (Lohse & Spiller, 1998; Elliot & Fowell, 2000; Khalifa & Limayem, 2003).

EC brings value to the companies by automating the trading processes of the organization and provides financial improvements to the company. Organizations

realized the great benefits that they can gain by implementing EC and try to integrate their existing platforms with EC solutions.

EC not only harmonize the internal business processes, but also facilitates business connectivity with trading partners. EC is not limited to the enterprises and companies; it can be seen in governmental routines, social services, and education. The realized benefits of EC and enterprise systems integration are uncountable for stakeholders. Also EC can work as an internal part of the enterprises to bring more accuracy and reduce human workloads.

Limited research has been conducted about the integration of EC and enterprise systems specifically. Although there are varieties of studies about the importance of adopting EC and the influenced factors, but there are still lack of research about the technical issues of the integration.

EAI (Enterprise Application Integration) as a major technique in inter and intra-enterprise application integration can be seen in most of the integration projects. Large software vendors, such as SAP, Oracle, Microsoft, and IBM tried to overcome the integration problem of enterprise systems and EC by offering different solutions and products. These solutions can be customized and applied to different industries.

1.2 Objectives of this thesis

The main objective of this thesis is to provide detailed and explicit information about EC and enterprise systems integration, including the techniques, standards, levels, and solutions. Moreover, the thesis will indicate the importance and challenges of EC and enterprise systems integration.

The main research question is, “How to integrate EC and enterprise systems?” To understand the objectives, more detailed questions are asked.

This thesis aims to answer the following questions:

- Why EC and enterprise systems should be integrated?
- What are the existing solutions of enterprise integration?
- What are the existing solutions of EC and enterprise systems integration?

1.3 Structure of the thesis

This thesis is a literature review, designed to explain the enterprise integration especially with EC system. Thesis includes 7 chapters.

First chapter is the introduction to the thesis, objectives and structure of the document. In second chapter the concept of EC in introduced and the benefits and challenges are discussed. Third chapter gives comprehensive information about enterprise systems, such as definitions and a brief description of ERP systems. In the Fourth chapter the enterprise integration is explained in detail, first enterprise integration is defined then EAI is introduced, and benefits and barriers of EAI are examined. In the fifth chapter integration technologies, such as middleware, service-oriented architecture, and enterprise service bus are investigated, also the integration of EC and enterprise systems is studied precisely. Chapter six is the provided solutions for EC integration by different software vendors. And finally, chapter seven is the conclusion of the thesis. Figure 1 illustrates comprehensive structure of thesis.

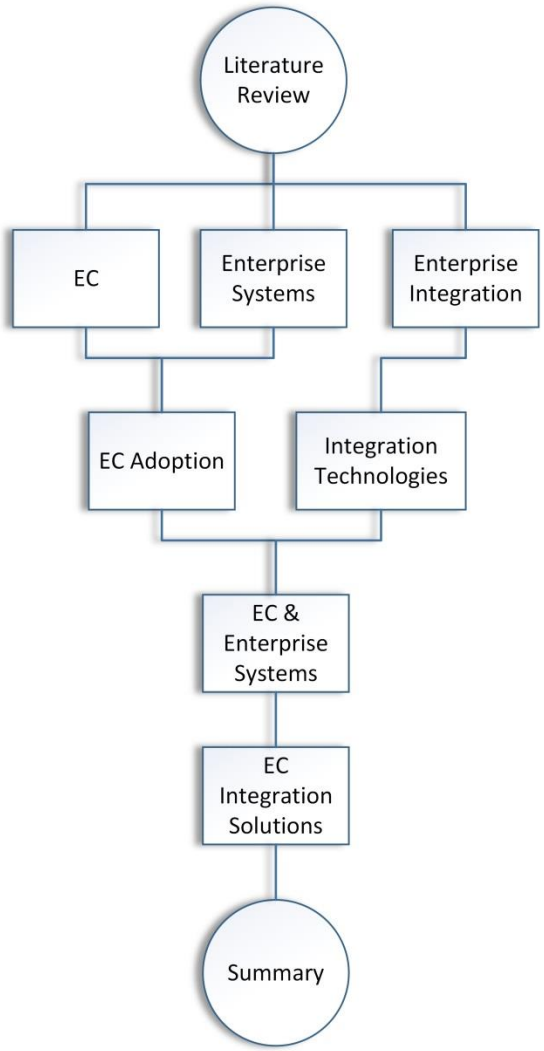

Figure 1 Structure of thesis

2 ELECTRONIC COMMERCE

EC is a critical area as a way of gaining competitive advantage for enterprises which can determine the success or failure of an organization. On the one hand, lack of strategic decisions, lack of management, lack of trust, and lack of proper infrastructure are the reasons that cause the failure EC in an organization and consequently waste money, time, and resources of an organization. On the other hand, implementing an EC system with right management and strategic manners can benefit an organization through automating and enhancing business processes within and across an enterprise.

The purpose of this section is to provide a brief introduction to EC and the advantages and disadvantages of its conduction. For this purpose, previous literature is studied and the relevant issues are extracted.

2.1 Electronic commerce definition

The history of EC begins at the late 1970's where the main point of using it was for electronic transactions via EDI (Electronic Data Interchange) and EFT (Electronic Fund Transfer). The first online shop was introduced by Michael Aldrich in 1979 and the first B2B solution was employed by Thomson Holidays in 1981 (Tkacz & Kapczynski, 2009). After that EC were adopted by many companies who recognized the advantages of conducting business anywhere and anytime (Jennex, et al., 2004).

The common meaning of EC is shopping through Web. However, the meaning of EC is not limited to online shopping, it also embraces the business activities between trading partners and the internal business process activities use to support their buying, selling, hiring, planning, and other activities (Napier, et al., 2006; Turban, et al., 2008; Schneider, 2010). EC has changed the appearance of business operations in competitive enterprises (Raghavan, 2005).

Kalakota & Whinston (1997), divided EC definition into four perspective of communication, business process, service, and online. From a communication perspective, EC is the delivery of goods, services, information, or payment over computer networks or buy any other electronic means. From a business process perspective, EC is the application of technology toward the automation of business

transactions as work flow. From a service perspective, EC is a tool that addresses the desire of firms, consumers, and management to cut service costs while improving the quality of customer service and increasing the speed of service delivery. From an online perspective, EC provides the capacity of buying and selling products and information over the Internet and other online services.

Turban & King (2003) added two more perspectives of collaboration and community to this list. According to them from a collaboration perspective, EC is the facilitator for inter- and intra- organizational collaboration, and from a community perspective, EC provides a gathering place for community members, to learn, transact, and collaborate.

Wigand (1997), has defined EC more broadly to denote "the seamless application of information and communication technology from its point of origin to its endpoint along the entire value chain of business processes conducted electronically and designed to enables the accomplishment of a business goal; these processes may be partial or complete and may encompass business-to-business as well as business-to-consumer and consumer-to-business transactions". (Wigard, 1997)

In many studies, the word EC has been replaced by e-business (Electronic Business). However, there is a slight difference between EC and e-business. E-business encompasses any transactions which includes EC. E-business comprises all the performing activities by a firm selling and buying services and products using computers and communications technologies. EC sites are either pure e-businesses, such as Amazon.com, or they have an EC presence, such as Wal-Mart Stores (Bidgoli, 2002; Steinfield, 2004). In this thesis, EC and e-business have used interchangeably.

The beyond business influence of EC is its impact on every aspects of human society, such as production and employment, government function, working talent, law systems and education (Qin, 2009). The significance of EC can be realized from Qin (2009) study where he mentioned EC as the most significant industrial revolution since Industrial Revolution, with deeper influence on mankind than the former two industrial revolutions.

EC appears in not only in the industry but also in the society in different forms. According to Turban & King (2003) the commonly distinguished types of EC are as follow:

Business-to-business (B2B): an EC model in which all the participants are businesses or other organizations.

Business-to-customer (B2C): an EC model in which businesses sell to individual shoppers.

E-tailing: online retailing usually B2C.

Business-to-business-to-customer (B2B2C): an EC model in which a business provides some product or service to a client business that maintains its own customers.

Customer-to-business (C2B): an EC model in which individuals use the Internet to sell products or services to organizations or individuals who seek sellers to bid on products or services they need.

Consumer-to-consumer (C2C): an EC model in which consumers sell directly to other consumers.

Intrabusiness (organizational) EC: EC category that includes all the activities inside an organization that involves the exchange of goods, services, or information among various units and individuals.

E-government or Government-to-citizens (G2C): EC model in which a government entity buys or provides goods, services, or information from or to businesses or individual citizens.

Collaborative commerce (c-commerce): EC model in which individuals or groups communicate or collaborate online.

Exchange: a public electronic market with many buyers and sellers.

Exchange-to-exchange (E2E): EC model in which electronic exchanges formally connect to one another for the purpose of exchange information.

Nonbusiness EC: a large number of nonbusiness institutes such as academic institutions, nonprofit organizations, religious organizations, social organizations, and government agencies which are used EC to reduce costs and enhance customer services.

2.2 Benefits and challenges of electronic commerce

Adopting EC is a major step toward developing businesses. However, this step is not an obligation that every business can or must do. EC has its own advantages and challenges.

According to Bidgoli (2002), Napier, et al. (2006), and Schneider (2010), some of the benefits of EC are reducing the cost of doing business, improving product quality, reaching new customers or suppliers, and creating new ways of selling existing products.

A comprehensive categorization of EC benefits and challenges has been proposed (Turban & King, 2003; Napier, et al., 2006; Goel, 2008; Schneider, 2010).

Turban & King (2003), described benefits of EC by dividing them into three main categories of organization, customer, and society. Therefore, the same approach is followed and the benefits of EC are discussed in Table 1.

Table 1 Benefits of EC

Category	Reference	Realized benefits
Benefits to organization	(Schneider, 2010)	Increase profit Increase sale Decrease costs Increase speed and accuracy
	(Goel, 2008)	Direct marketing, selling, and services
	(Napier, et al., 2006)	Increase sales opportunities Decrease costs 24 hours a day, 7 days a week sales Access to narrow market segments Access to global markets Increase speed and accuracy of information delivery Data collection and customer preference tracking
	(Turban & King, 2003)	Expands a company's marketplace to national and international markets Enables companies to procure material and services from other companies, rapidly and at less cost Shortens or even eliminates marketing distribution channels, making products cheaper and vendors' profits higher Decreases the cost of creating, processing, distributing, storing, and retrieving information by digitizing the process Allows lower inventories by facilitating pull-type supply chain management Lowers telecommunications costs Helps small businesses compete against large companies Enables a very specialized niche market
Benefits to customers	(Schneider, 2010)	Global market place Increase purchasing opportunities
	(Goel, 2008)	Online tracking of shipments Quicker delivery
	(Napier, et al., 2006)	Wider product availability Customized and personalized information and buying options 24 hours a day, 7 days a week shopping Easy comparison shopping Access to global market Quick delivery of digital goods
	(Turban & King, 2003)	Frequently provides less expensive products and services by allowing consumers to conduct quick online comparisons

		Gives consumers more choices than they could easily locate otherwise Enables customers to shop or make other transactions 24 hours a day, from almost any location Delivers relevant and detailed information in seconds Enables consumers to get customized products, from PCs to cars, at competitive prices Makes it possible for people to work and study at home. Makes possible electronic auctions Allows interaction between customers
Benefits to society	(Schneider, 2010)	Provides virtual communities Facilitate delivery of public services reduction in commuter-caused traffic and pollution
	(Turban & King, 2003)	Enables individuals to work at home and to do less traveling, resulting in less road traffic and lower air pollution Allows some merchandise to be sold at lower prices, thereby increasing people's standard of living Enables people in developing countries and rural areas to enjoy products and services that are otherwise are not available Facilitates delivery of public services, such as government entitlements, reducing the cost of distribution and chance of fraud, and increasing the quality of social services, police work, health care, and education

Most of studies divided challenges of EC into technical and non-technical challenges; therefore, challenges of EC are described in Table 2 based on this category.

Table 2 Challenges of EC

Category	Reference	Realized limitations
Technical limitations	(Schneider, 2010)	Difficulty of integrating existing databases and transaction-processing software Trouble with recruiting and retaining employees
	(Napier, et al., 2006)	Rapidly changing technologies Greater telecommunication capacity or bandwidth demands Difficulty of integrating existing business systems with EC transactions Problem inherent in maintaining EC systems
	(Turban & King, 2003)	Lack of universal standards for quality, security, and reliability The telecommunications bandwidth is insufficient Difficulty in integrating e-commerce infrastructure with current organizational IT systems Still-evolving software development tools Need for special Web servers in addition to the network servers
Nontechnical limitations	(Schneider, 2010)	Cultural and legal obstacles Lack of trust and user resistance Security and privacy
	(Napier, et al., 2006)	Growing competition from other e-businesses Unknown political environments Currency conversion Lack of touch and feel online
	(Turban & King, 2003)	Unresolved legal issues Lack of government regulations and industry standards Lack of mature methodologies for measuring benefits of and justifying EC Customer resistance to changing Perception that EC is expensive and unsecured

2.3 Factors of electronic commerce that bring value to the enterprise

According to Grandon & Pearson (2004) study, three main factors are known as sources of strategic value of EC, which are operational support, managerial productivity, and strategic decision aids. They considered operational support as the ways of measuring on how to reduce costs, support connections with suppliers, and raise the competition ability by adapting EC. Managerial productivity advocates on how information access can be enhanced, how to making decision by applying generic methods, enhances organizational communications, and improves managers' productivity by applying EC. Eventually, strategic decision aids, ascertain managers strategic decision supports, industry's cooperative partnership support, and supplying managers' strategic decisions information by applying EC.

The identified factors from prior researches can be categories in into four groups based on similarity: organizational readiness, external pressure, perceived ease of use, and perceived usefulness. Table 3 distinguished these categories and their resources.

Table 3 Summary of adoption factors in Grandon & Pearson (2004) study

Factors in Grangon and Pearson study	**Factors in previous studies**	**source**
Organizational readiness	Organizational readiness	(Iacovou, et al., 1995) (Chwelos, et al., 2001) (Kuan & Chau, 2001) (Mehrtens, et al., 2001)
	Facilitating condition	(Chang & Cheung, 2001)
	Compatibility with company	(Thong, 1999)
	Intra/extra organizational factors	(Igbaria, et al., 1997)
External pressure	External pressure	(Iacovou, et al., 1995) (Chwelos, et al., 2001) (Mehrtens, et al., 2001)
	Environment	(Kuan & Chau, 2001)
	Social factors	(Chang & Cheung, 2001)
	External competitive pressure	(Premkumar & Roberts, 1999)
	Subjective norm	(Riemenschneider, et al., 2003)
Perceived ease of use	Perceived ease of use	(Davis, 1989) (Igbaria, et al., 1997) (Riemenschneider, et al., 2003)

Perceived usefulness	Perceived usefulness	(Davis, 1989) (Igbaria, et al., 1997) (Riemenschneider, et al., 2003)

2.4 Electronic commerce adoption

In this section the factors which influence the adoption of EC by enterprises are studied through examining 60 researches in this field. Moreover, later in this section the barriers of EC adoption are discussed.

As it is illustrated in Figure 2, Li & Xie (2012) divided EC adoption into three dimensions: environment (institutional environment, economic environment, and sociocultural environment), firm (firm size and structure, corporate strategy, globalization, managerial attitudes, pressures from customers and suppliers), and technology (Macro technology environment, firms' technical strength).

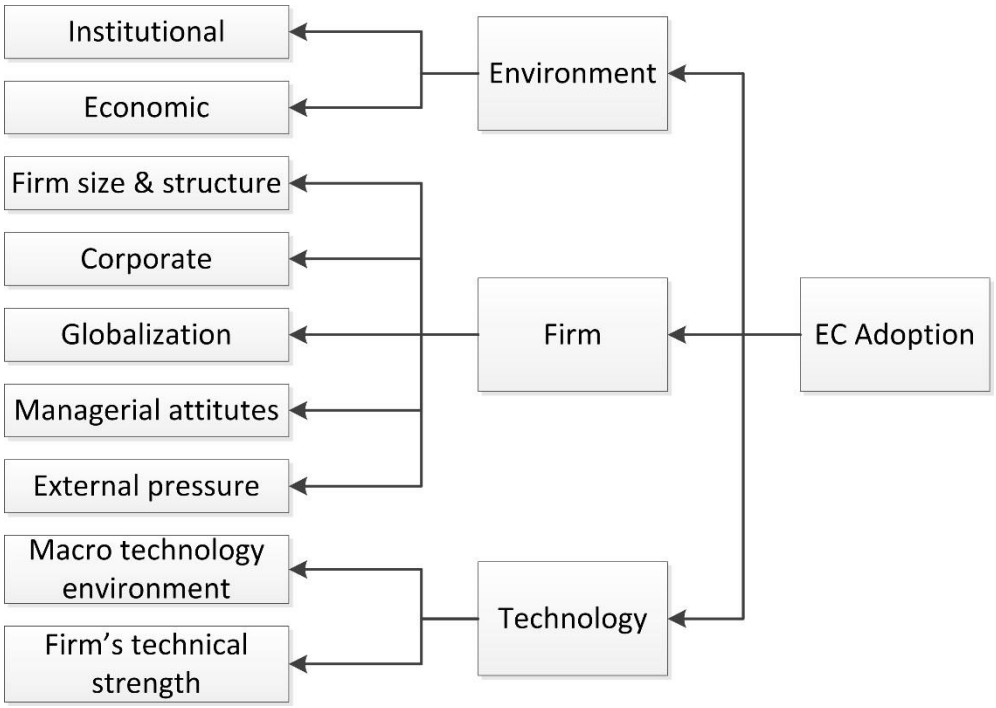

Figure 2 EC adoption dimensions (Li & Xie, 2012)

A linear regression analysis of 4570 European companies by Nurmilaakso (2008), indicated that the firm scope (the number of organizational units), enterprise Information Systems (ERP, SCM, and CRM), and exchange of standardized data (e.g. EDIFACT, RosettaNet, or STEP) influence positively the adoption of e-business

functions (online sales, purchases, product design, demand forecasting, and resource management) in supply chain integration. Accordingly, technological factors have significant influence on adoption, and organizational factors on migration.

In another study, Crespi, et al. (2006) identified the factors that may influence EC adoption in the UK. Based on this study accessing Web technologies, implementing of EC for buying and selling have increased in different manufacturing sectors over the time in UK. Also, this study indicated that the main factors that encourage a firm to adopt these technologies are the price of information telecommunication and technology, firm size, network externalities, and learning externalities. Moreover, it is mentioned that the existence of some unobserved factors also influence a firm's decision to adopt the technologies.

Vilaseca-Requena, et al. (2007), aimed to define a specific model on the adoption and extent of EC on the Internet. As a result they considered six factors which influence the adoption and extent of EC on the Internet: the characteristics of the competitive environment, the organizational characteristics of the firm, its strategic orientation, its innovative capacity, its managers ' characteristics, and the IT equipment possessed and applied methods of it by the firm.

Also in a similar study Grandon & Pearson (2004), declared that the benefits of EC is not limited to the large enterprises. Small and medium sized enterprises can also take advantage of EC. EC provides the opportunities of cooperating with large businesses, provide location and time independency, and ease communication (Iacovou, et al., 1995; Ling, 2001; Longenecker, et al., 2006).

The detailed information about the influential factor of EC adoption in enterprises based on reviewed literature can be found in appendix I.

2.4.1 Barriers to electronic commerce adoption

The factors which have influence on EC adoption by enterprises are mentioned in the previous section. It is obvious that each of the mentioned factors can become barriers to the system. Therefore in this section main factors of barriers will be discussed.

In MacGregor & Vrazalic (2006) study, the main EC adoption barriers from various studies are extracted. A list of these barriers is as follow:

- High cost of implementation.
- EC is too complex to implement.
- Small businesses require short-term ROI and EC is long-term.
- Resistance to change among employees due to of the fear of new technology.
- Preference for and satisfaction with traditional manual methods (phone, fax).
- Lack of technical skills and IT knowledge among employees; lack of computer-literate/specialized staff.
- Lack of time to implement EC.
- EC not demand to be suited to the way the organization does business or the way clients do business.
- EC perceived as a technology lacking direction.
- Lack of awareness about business advantages/opportunities that EC can provide.
- Lack of available information about EC.
- Lack of integration among customers, suppliers, and business partners.
- Heavy reliance on external consultants to provide necessary expertise.
- Lack of EC standards.

In another study Love, et al. (2001), a conceptual model to classify the barriers into the four categories, of organizational, technical, financial, and behavioral is proposed. This model is shown in Figure 3.

Figure 3 Barriers to adopting EC (Love, et al., 2001)

This figure pointed out that risks are placed within financial and technical barriers, uncertainties come from financial and behavioral issues of an organization, change is within behavioral and organizational factors, and knowledge influences technical and organizational barriers.

3 ENTERPRISE SYSTEMS

Enterprise system as a combination of people, systems, and processes plays a major role in an organization. Enterprise systems are inseparable parts of organizations.

This section provides a concise description regarding the enterprise systems. First the definition of enterprise is explained based on previous studies, after that core system of an enterprise which is ERP (enterprise resource planning) system is described, and at the end the benefits and limitations of the ERP are discussed.

3.1 Enterprise definition

Enterprise can be defined as the purposeful combination of people who make decisions, their workflow processes, and the technical systems they use to carry out their decision making and workflow (Rebovich & White, 2011). Through enterprises, business requirements are met and the organizations are reached to their goals (Friedman, 2007).

Enterprises consist of the integration of complex systems, processes, organizations, information, and supporting technologies with multifaceted interdependencies and interrelationships across their boundaries and which can often be characterized by a set of special additional properties, such as emergent behavior, non-determinism, and environmental dependencies (Nightingale & Rhodes, 2004; Swarz & DeRose, 2006).

Giachetti (2011), defines enterprise systems as interactions that are important to enterprise behavior. Interactions consist of such activities as coordination of functions, sharing of information, and allocation of resources.

Most of the enterprise system software solutions are from vendors such as SAP, Oracle, PeopleSoft, Siebel, and I2 Corporation. Such software systems provide cheaper access to the Information Systems (Shanks, et al., 2003). Enterprise systems can solve the fragmentation of information in large business organizations. The commercial software packages can provide the seamless information integration across company (Davenport, 1998).

ERP (Enterprise Resource Planning) systems, CRM (Customer Relationship Management), PRM (Partner Relationship Management), DSS (Decision Support System), KM (Knowledge Management) systems, business intelligence, and intelligent systems are different types of enterprise systems which are often built on software platforms, such as SAP's NetWeaver and Oracle's Fusion (Turban, et al., 2008; Stair & Reynolds, 2010).

3.2 Enterprise resource planning systems

In the current century, to provide the external demands and business challenges, organizations need fast, efficient, and flexible services. Also customers' expectations have been increased, traditional business routines are insufficient and organizations change rapidly to survive in competitive era (Sharma, et al., 2006).

Term ERP systems emerged in the early 1990s, and at first provide not only planning but also other management functions such as organizing, controlling, scheduling, reporting, and analyzing business processes.

The implementation of ERP systems boosted in the 1990s when the companies faced with Y2K problem in their legacy systems and in this situation many companies replaced their Information Systems with ERP systems. This rapid growth did not last long and in 1999 sale of ERP systems declined due to the implemented solutions for Y2K problem (Hatamirad & Mehrjerdi, 2010).

ERP systems are defined as commercial software packages provided to integrate internal and external processes including planning, manufacturing, sales, marketing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, transportation and e-business. They can be configured, customized, and extended according to organizational processes and needs (Davenport, 1998; Holland & Light, 1999a; Esteves & Pastor, 2000; Lee & Lee, 2000; Markus, et al., 2000; O'Leary, 2000; Nah, et al., 2001; Hossain, et al., 2002; Skok & Legge, 2002; Araujo, 2006).

ERP systems can also be defined as configurable Information System packages which accomplish business goals by integrating the Information Systems and helping the

organization to work and move forward as a single entity and facilitate integrated and real-time planning, production, and customer response (O'Leary, 2000; Hui, et al., 2010).

The main objective of ERP is to integrate all departments and functional information flows across a company through a dynamic and immediate information flow (Turban, et al., 2008; Motiwalla & Thompson, 2009). ERP systems are identified as a major determinant to gain competitive advantages (Dezdar & Ainin, 2011). Moreover, ERP system is a central repository which reduces data redundancy, provides flexibility, increases supply chain efficiency, increase customer access to products and services, reduce operating costs, responds more rapidly to a changing marketplace, and extracts business intelligence from the data (Fan & Fang, 2006; Motiwalla & Thompson, 2009).

Initially, ERP systems were considered as “back-end” systems which were in charge of managing the intra-organizational resources. However, ERP went over the limitation of internal resource planning and expand to external resources such as CRM, SCM, and B2B EC. Therefore, the integration of external (frontend) and internal (back-end) business applications are defined as an extended enterprise management systems or extended ERP systems (Radovilsky, 2004).

CRM as a profitable resource for organizations manage the relationships with customers effectively and consequently provides enhancement in relationship with customers and their loyalty (Ngai, 2005). CRM build a long term and profitable relationship with certain customers through a set of processes and business strategies (Ngai, et al., 2009). CRM makes it possible to collect, analyze, and translate precious customer information into managerial action (Ernst, et al., 2011).

SCM is referred to as the management of several relationships across the supply chain. SCM provides the integration and management of intra- and intercompany cooperation (Lambert & Cooper, 2000). SCM is the task of coordinating material, information, and financial flows in order to fulfill customer demands (Stadtler, 2008).

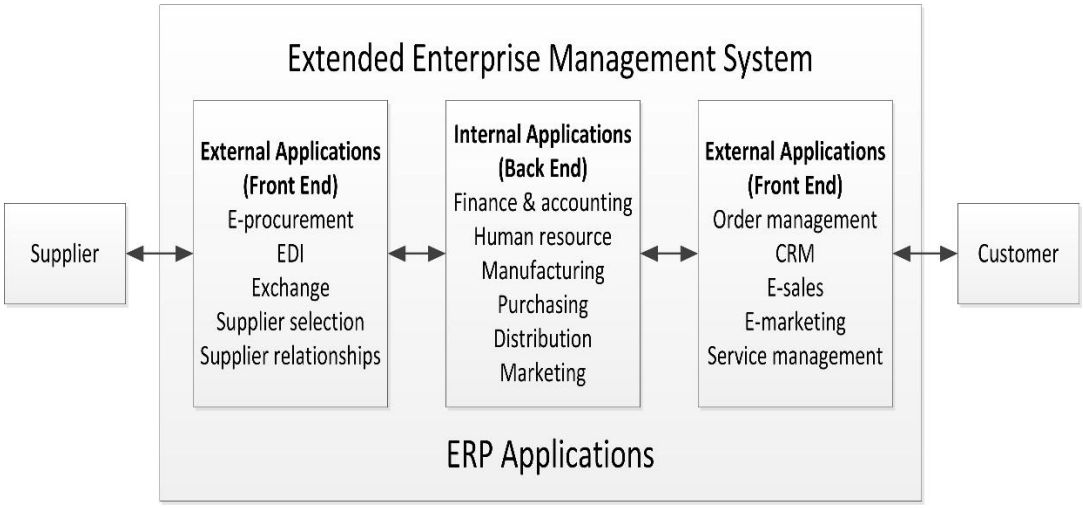

Figure 4 ERP structure (Radovilsky, 2004)

Figure 4 is shown a general structure of ERP where suppliers and customers are placed in the front ends of the system, and internal applications works as a core between these two frontends. Moreover, this figure shows the ERP internal (backend) and external (frontend) applications.

3.3 Benefits and limitations of ERP

To implement an ERP system, organizational investment in terms of cost, time, and people are required (Motiwalla & Thompson, 2009).

Table 4 and Table 5 are created based on previous literature on benefits and limitation of ERP systems.

Table 4 Benefits of ERP systems

Category	Identified benefits	Resource
Technical	Increased interaction across the enterprise Improved supplier interaction	(Mabert, et al., 2001)
	Planning and control process Cross-functional unification Internal communication Information sharing Single interface Collaborative forecasting and planning	(Su & Yang, 2010)
	Faster information transaction Laying the groundwork for EC	(Davenport, 2000)
	Applications and data integration Linking the entire organization together seamlessly	(Shatet & Udin, 2012)
	People and data integration	(Monk & Wagner, 2009)
	Business process efficiency Enhanced security of data and applications	(Subramoniam, et al., 2009)
	Organization agility Ease of maintenance and support Centralized IT control	(Motiwalla & Thompson, 2009)
Non-technical	Improved cash management Reduce direct operating costs Lowered inventory levels Improved on-time delivery Quickened response time	(Mabert, et al., 2001)
	Cost reduction Role specificity Productivity improvement Quality management Error reduction Flexibility Enabling e-commerce IT cost reduction	(Su & Yang, 2010)
	Cost-cutting in internal operations Enhance customer service and network relationships Better customers' service quality	(Davenport & Brooks, 2004)
	Cycle-time reduction Better financial management	(Davenport, 2000)
	Improve productivity Improve operational efficiency Real-time information exchange	(Shatet & Udin, 2012)
	Easier global integration Operations management Improve operational efficiency	(Monk & Wagner, 2009)
	Less employee training Easy collaboration and team work	(Motiwalla & Thompson, 2009)

Table 5 Limitations of ERP systems

Category	Identified limitations	Resource
Technical	Overly hierarchical organizations	(Davenport, 2000)
	Increase complexity of installing, configuring, and maintaining the system Hardware and software need to be upgraded Sophistication of the software Complex process of data conversion from old system to a new system	(Kumar, et al., 2003)
	Difficulties with stabilizing the resources Limited industry specific versions Standstills due to failures Some legislated procedures not supported	(Motiwalla & Thompson, 2009)
Non-technical	Inflexibility Long implementation period	(Davenport, 2000)
	Unavailability of skilled people High cost of implementation Significant resistance from staff	(Kumar, et al., 2003)
	Professional IT staffs are required Retraining of IT staff and personnel is time consuming and costly	(Motiwalla & Thompson, 2009)

4 ENTERPRISE INTEGRATION

An appropriate enterprise system leads the company to become integrated, and eventually, it persuades the company to follow generic processes. The dream of integration can abruptly change into a nightmare, if the company installs an enterprise system without first having a clear concept of business. The system logic and business logic may conflict, and the implementation will face with failure, causing to waste a lot of money and the system will lose the important source of competitive advantage of the company (Davenport, 1998).

The most of the enterprise systems are customizable or modular, which means the company, can decide what functions the system should perform and what not. Generally, the greater the number of modules chosen, the greater the integration benefits, but consequently, costs, risks and changes will be greater. To improve the organizational goals and operations, organizations challenge to integrate their distributed organizational units, Information Systems, and business processes. (Davenport, 1998; Giachetti, 2004)

Many attempts have been done to study about enterprise integration. Various research approaches address integration within different studies such as, database researches (Batini, et al., 1986; Parent & Spaccapietra, 1998; Seligman, et al., 2010; Calì, et al., 2013), Information Systems development (Henderson & Venkatraman, 1993; Chan, et al., 1997; Papazoglou, et al., 2000; Chapman & Kihn, 2009; Lin, et al., 2010), software engineering (Chalmeta, et al., 2001; Schantz & Schmidt, 2002; Bosch & Bosch-Sijtsema, 2010; Labiche, 2011), and agent-based systems (Finin, et al., 1994; Crow & Shadbolt, 2001; Elalouf, et al., 2011; Gu, et al., 2011; Cranefield & Ranathunga, 2013). In all of these studies although the integration approaches are different but the goal of integration is similar, which is to provide an integrated platform for both upstream (suppliers) and downstream (manufacturing, sale, and end users) sides of an enterprise.

Studies in the enterprise integration field divided basically into two categories of theoretical enterprise adoption and technical enterprise integration approaches. Due to the huge number of different researches in this field and the vast amount of money

budgeted, it indicates the importance of integration to the companies as a challenge. Despite the widespread studies regarding the enterprise integration, still some lacks can be observed in having a comprehensive definition of enterprise integration.

According to Vicens, et al. (2001), to develop an enterprise integration project three fundamental elements are needed: methodology, architecture, and tools. It would be hard to follow an enterprise integration project without considering these elements. The project development is conducted through a methodology, the architecture has to provide the elements needed for an enterprise structured description in the enterprise integration context, and lastly the tools support the development of architectonic and methodological concepts of the project.

In this section first the enterprise integration is defined, then the EAI is discussed, after that the technologies, frameworks and architectures are explained. And finally the barriers and benefits of EAI are developed based on existing literature.

4.1 Enterprise integration definition

Although there is a significant number of enterprise integration definitions in the previous studies but, all of them eventually more or less pointed at a similar direction. Batini, et al. (1986), focused on the data schema integration. Petrie (1992, p. 2), defined enterprise integration as, "the task of improving the performance of large complex processes by managing the interactions among the participants". Bernus, et al. (1996), describes that enterprise integration captures and describes processes, strategies, organizational structures, resources, goals, and constrains of the enterprise. Nugent & Hamblin (1996), explained vertical integration as a coordination in supply chain between companies. Lim, et al. (1997), defined integration as, 'integration of several business processes is to make the running of these processes as if there is only one business process'. Kosanke, et al. (1999), realized the term enterprise integration as the integration of computer networks, business applications, and business integration of process networks. Alsène (1999), argued that the enterprise integration is achieved by the integration of the enterprise's computers or information. Brown (2000), believed that the enterprise integration is possible through the reduction of the complexity. Vernadat (2002), discussed that the business integration should be the

main concern of enterprise integration. Myerson (2002), defined enterprise systems integration as a significant marketing advantage.

According to Themistocleous, et al. (2001), EAI defined as a way of providing common and shareable business processes, functions, and services within the enterprise, through performing activates to integrate and harmonize enterprise's business applications, processes, and functions. Al Mosawi, et al. (2006), defined the EAI as a complex task which has both technical and business challenges. From the technological viewpoint, EAI involves integration of incompatible and heterogeneous technologies, and from the business viewpoint, EAI involves with integration of disparate business processes and functions. Linthicum (2000), described EAI as information sharing between enterprise applications and a set of technologies which are provided the information exchange among applications and business processes within and between organizations.

Erasala, et al. (2003), defined the EAI as "the integration of applications that enables information sharing and business processes, both of which result in efficient operations and flexible delivery of business services to the customer. Implementing EAI does not invariably involve discarding current or legacy applications; rather it unlocks the value of these applications and deploys their functionality in a scalable and robust way".

EAI provides flexible and maintainable integration solutions; also it addresses the needs for inter and intra-organizational integration. EAI brings traditional integration technologies, such as database-oriented middleware, interface-based technologies, and distributed object technologies; and new application integration technologies, such as message brokers together to efficiently support the cooperation of the Information Systems.

EAI supports data, object, and process integration as well as applications, packaged systems, and e-business solutions integration. EAI aims at an integrated infrastructure by bringing the incompatible and heterogeneous applications together. It combined inter and intra-organizational systems with several integration technologies such as Web Services, message and process brokers to build a centralized integration infrastructure (Linthicum, 2000; Linthicum, 2001; Lam, 2005).

The major advantages of EAI are firstly, support of more functions and enhance services comparing with the single systems; secondly, reduction of data redundancy and overlapping and provides a greater degree of data integrity and consistency. (Themistocleous, et al., 2001)

To sum up, enterprise integration reflects the capability of integrating functionalities of different systems. EAI is a business computing term for plans, methods, and tools aimed to modernize, consolidate, and coordinate the overall computer functionality in an enterprise. The ultimate goal of EAI is the flexibility or agility that EAI brings to the enterprise. EAI provides integration at business process level (Lee, et al., 2003).

4.2 Different EAI layers and frameworks

Different studies proposed different perspectives of EAI layers and frameworks. Hasselbring (2000), categorized integration into three levels: Business level (business to business integration), Application level (application to application integration) and Software Platform level (integration of different software platforms with each other).

Giachetti (2004), proposed a conceptual framework to classify several literature on enterprise integration. According to Giachetti (2004), an enterprise system has four levels and accordingly, there are four different levels of integration. The four levels are network/platform level, data level, application level, and process level. Figure 5 illustrates levels of information integration in an enterprise.

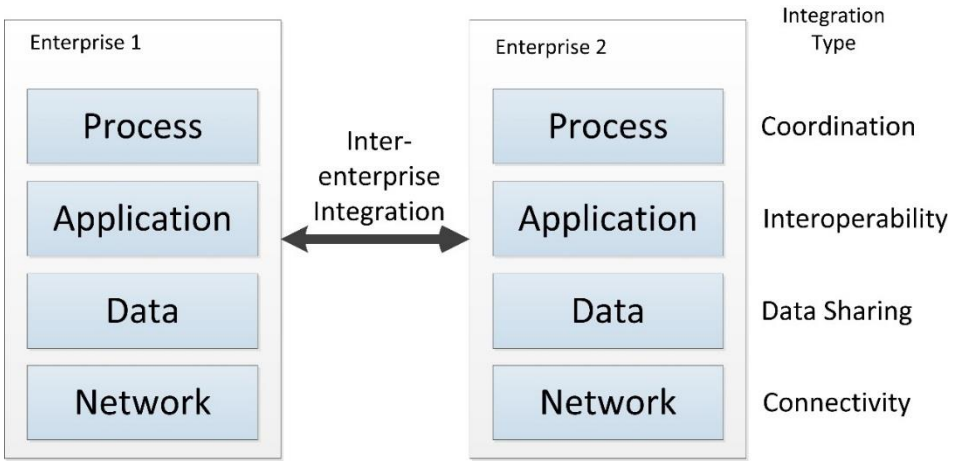

Figure 5 Levels of information integration in an enterprise (Giachetti, 2004)

Network level; this level is the physical integration of hardware, machines, devices, and their operating systems. The goal of integration in this level is to provide connectivity and linkage between systems, applications, and modules.

Data level; the goal of this level is to share data in exchanging data between two or more subsystems or organizational units. Data sharing must solve the problems of data schema which are based on Batini, et al. (1986), divided into four categories different perspectives, equivalence among properties, inter-schema properties, and weak semantics. According to Batini, et al. (1986), there are several approaches to integrate data level of enterprise information integration, such as shared data schema, federated database, XML, data warehouse, and integration ontologies.

Application level; applications are the Information Systems that provide services. Each application has the tendency to use locally defined data and message formats which causes fragmentation in an enterprise. In this situation to overcome this problem, interoperability is set as the target. Interoperability means to use the produced data of software system by another application. As a base to support component-based applications and systems, interoperability, can be achieved through the application programming interfaces (APIs). Moreover, mediators are used in this level. According to Wiederhold & Genesereth (1997), "mediators are intermediaries between the applications and distributed data resources that provide services to extract data from multiple data sources and integrate the data using its knowledge to provide information to the requestor without using a shared data model." Mediators can be considered as an intelligent middleware which can handle the schema diversity by providing additional services (Singh, 1998).

Business process level; process level represents the several business tasks which are part of a business process supported by applications. Business process detaches functional units and align overall organizational goal with goal of each unit. This kind of integration called coordination which labels two problems of dependencies and goal alignment (Malone & Crowston, 1994). Increasingly, coordination attracts the researchers' attentions in the content of enterprise integration (Kim, 2000; Camarinha-Matos & Pantoja-Lima, 2001).The goal of process level integration is to manage the dependencies that arise between the process tasks, resources, and objects in order to

achieve effective and efficient process (Giachetti, 2004). Coordination is used to manage dependencies. Giachetti (2004), describes three coordination mechanisms through Information Systems which are: computer support collaborative work, workflow management systems, and ERP systems.

Another division for EAI is the one which proposed by Puschmann & Alt (2001). In this study, the integration of heterogeneous systems are divided into four levels of communication services (Standards for data communication and transport), syntax (data level integration), semantics (object level integration), and pragmatics (process level integration). Figure 6 illustrates these integration levels.

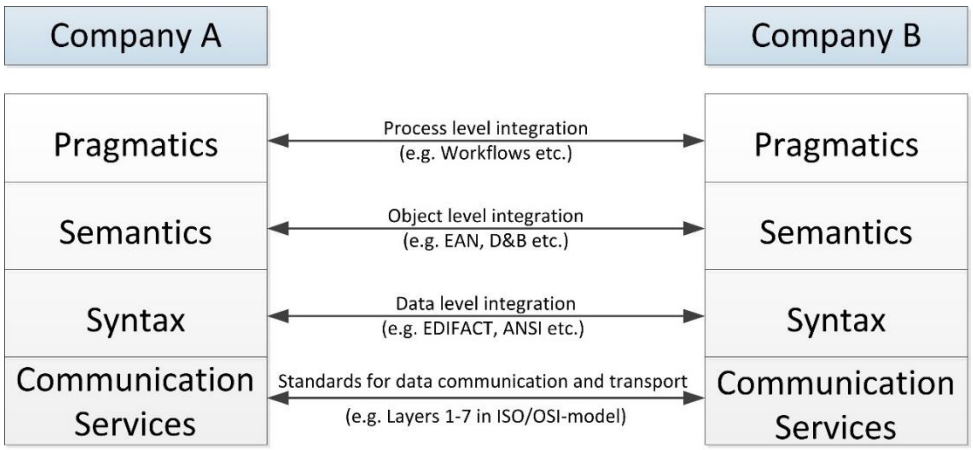

Figure 6 Integration levels (Puschmann & Alt, 2001)

In Al Mosawi, et al. (2006), study, a novel architecture in response to the need to separate the technological aspect from business aspect is proposed. This isolation provides flexibility and interoperability needed for EAI. In this respect, the Al Mosawi, et al. (2006), architecture divided the EAI area into five general types of models. As it is illustrated in Figure 7, the five model types are technology specific model, transaction service model, generic application service model, intra-application model, and inter application model. This architecture allows the interaction and cooperation of business domains through a set of common services. Technological facilities are bases for both business domains and common services, which provide physical connection and the interaction of the model.

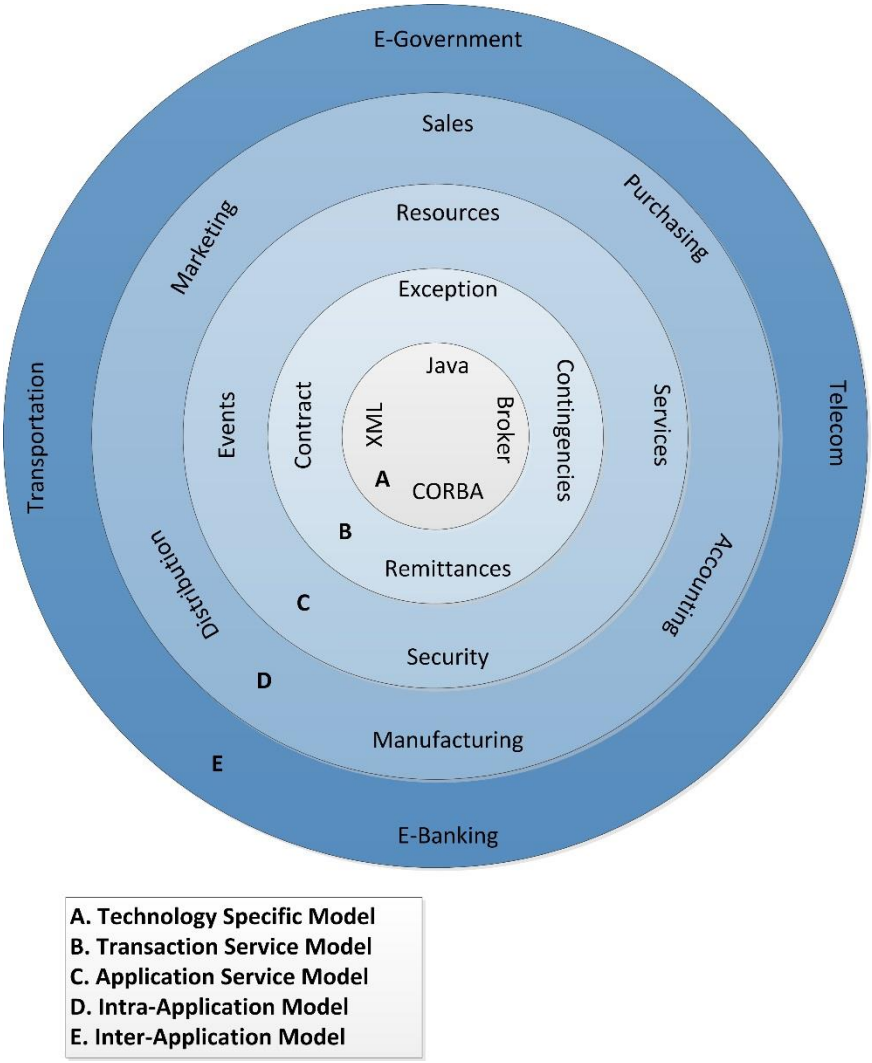

Figure 7 A model driven EAI architecture (Al Mosawi, et al., 2006)

All in all, the final architecture for EAI can be proposed based on Helo & Szekely (2005) study. Figure 8 illustrates the EAI architecture.

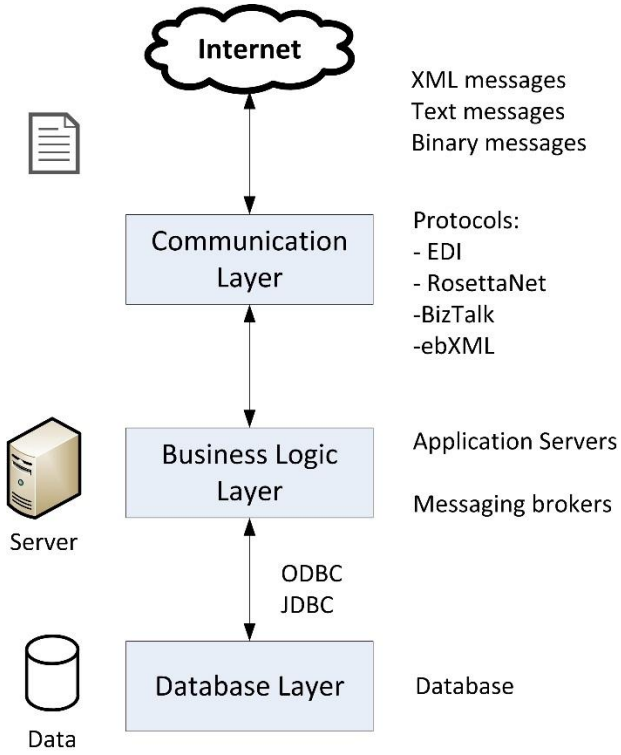

Figure 8 Architecture for EAI (Helo & Szekely, 2005)

In this architecture, lowest level is dedicated to store data in database system. The business logic layer has access to database through a standard interface. This layer is based on application server or message broker platform. The business logic of the software, controls messaging to external data systems and provides delivery verification. Moreover, messaging server guarantees security of connection. The communication layer is in charge of defining messaging format for various business partners. At last, a communication network which is Internet in this architecture is the message carrier.

4.3 Types of EAI

Based on Bytheway & Dhillon (1996), Brown (2000), Sharif, et al. (2005), and Al Mosawi, et al. (2006) study, there are three dimensions of EAI: inter-organizational application integration, intra-organizational application integration, and hybrid organizational application integration, Figure 9 illustrates these categories. Intra-organizational application integration is the incorporation of enterprise applications and exchanging information within enterprise. Inter-organizational application integration provides enterprises to integrate its business processes with its business

partner's processes, to improve business efficiency. Inter-organizational systems can be considered as the networks of systems for sharing information and interacting across organizational borders. On the other hand, intra-organizational solutions, transfer information and data within the enterprise (Bytheway & Dhillon, 1996). The third dimension of EAI is the hybrid application integration. According to Themifstocleous & Irani (2002) and Irani, et al. (2003) hybrid EAI, integrates business to consumer applications with IT infrastructure. Hybrid EAI supports transactions by integrating internal systems and external partners.

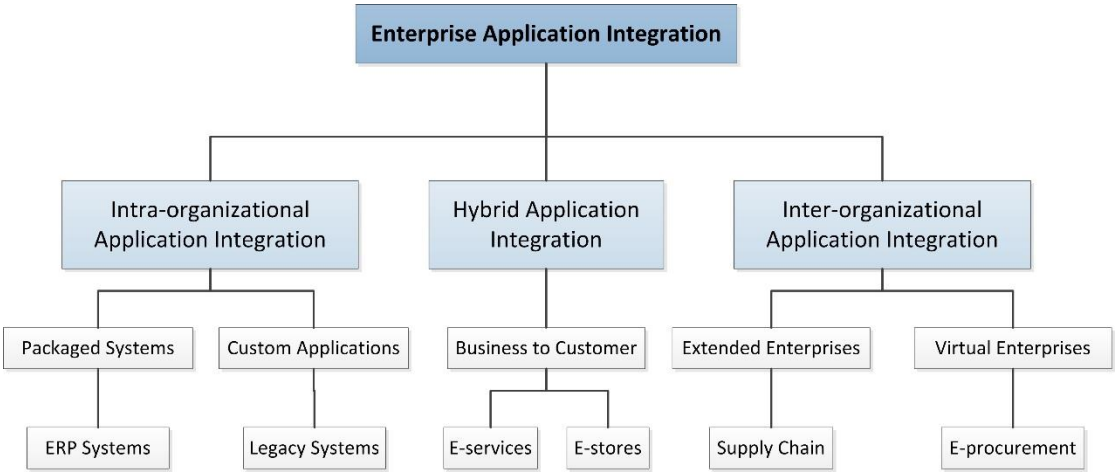

Figure 9 Taxonomy for EAI (Irani, et al., 2003)

4.3.1 Intra-organizational EAI

According to Al Mosawi, et al. (2006), intra-organizational EAI tries to fit enterprise applications and exchange information at enterprise level.

Intra-organizational sub categories consist of packaged and custom systems. In legacy systems data, logic, and interfaces are often bounded together, while in packaged and custom systems, have a three-tier architecture model in which data, logic and interfaces are separated from each other and can be updated and modified easily.

Additionally, packaged systems, such as ERP have a generic business requirements and processes, and they are not based on specific organizational requirements (Holland & Light, 1999). Therefore, the packaged systems like SAP are used by different organizations without implementing much customization.

However, Davenport (1998) declared that due to the less customizability of packaged systems, enterprises must consider some changes in their business processes and strategies in order to align with packaged systems. In this situation, EAI can efficiently supports custom applications and ERP systems integration. However, custom and packaged systems both have various difficulties in integration and consequently use different integration technologies (Themistocleous & Irani, 2003). Hence, packaged and custom applications can be considered as two subcategories of intra-organizational EAI.

4.3.2 Inter-organizational EAI

Inter-organizational integration tries to relate cross-enterprise business processes with systems like supply chain (Brown, 2000). E-business solutions are classified in inter-organizational applications. Linthicum (2000) declared that EAI can binds e-business through the technologies which support intra-organizational integration.

Brown (2000) and Puschmann & Alt (2001) divided application integration based on the degree of integration achieved (tight or loose). Inter-organizational EAI is somewhere between tight and loose integration. Tight application integration has more process dependency. When selecting tight integration, organizations develop a similar inter-organizational IT infrastructure to achieve better efficiency and function as a single enterprise (virtual enterprise).

According to Al Mosawi, et al. (2006) inter-organizational EAI support enterprises to improve business efficiency by integrating enterprise's business processes with its partner's business processes. To gain this kind of integration, enterprises must define the business processes and infrastructures between themselves and specify the relationships between different business entities. In this way not only the transactions tracking across enterprise boundaries are provided but also businesses can communicate efficiently over the Internet and reducing costs.

In a virtual enterprise environment, a cross-functional team from different organizations establishes a network of linked decisions with interdependencies (Danesh & Jin, 2001). Inter-enterprise integration is important in the supply chain,

virtual enterprise, and other enterprise structures that require transferring of information (Giachetti, 2004).

All in all, based on the nature of inter-organizational EAI, this type of integration can be considered the same as B2B integration.

4.3.3 Hybrid EAI

Integration of Business-to-Customer (B2C) applications and inter-organizational solutions is needed in some cases, because inter-organizational systems play a major role in taking care of EC application functionality (Bakos, 1998; Lee, 1998; Lohse & Spiller, 1998; Riggins & Rhee, 1998). Consequently, B2C applications works both as inter and intra-organizational applications.

The main B2C application users consist of the application owner company, which is the service provider and the users of Internet who are the customers that interacts with B2C solutions. In applications, such as e-services, customers can use the system as long as they have the credit to access the system. During their access period, the company, which is responsible for the B2C applications, provides services to the customers without involving them with other entities, such as suppliers. Therefore, these systems do not need to be integrated with the companies' partners. This type of systems work like intra-organizational applications, but functionality of other types of B2C applications are more similar to the extended or virtual enterprises such as, e-store applications which require the cross organizational integration, because systems like e-stores need to integrate with the systems of banks, suppliers, and distributes. This type of subcategory is known as hybrid EAI.

4.4 Benefits of EAI

Published studies in application integration area indicated the significant benefits of the EAI adoption to the organizations (Puschmann & Alt, 2001). From technical view, EAI integrates data, objects, interfaces, and processes due to the overcoming of the integration problems by providing integration technologies at all the integration levels (Giachetti, 2004). Standard integration technologies provide flexibility, manageability, and maintainability. Due to the standard base integration technologies, a unified IT

infrastructure is provided which makes EAI to provide information sharing and achieves common business processes.

From a business perspective, EAI lower the overall integration costs due to the reduction in integration time and maintenance costs. EAI leads to ROI by providing a flexible, manageable, and maintainable enterprise infrastructure that supports the variable business and technical requirements. Besides EAI, provides a central point of control, the reduction of skills required to integrate applications, faster time to marketing, and increased market share.

Themifstocleous & Irani (2002) declared that implementing EAI increased operational performance and consequently provide a higher customer satisfaction. In their study they classified EAI benefits into five categories: organizational (results in more organized business processes), managerial (achieves ROI), strategic (increases collaboration among partners), technical (achieves data, object, and process integration), and operational (reduce cost).

In addition to the mentioned benefits, Themistocleous, et al. (2004), declared three more EAI implementation benefits in their study which are, extended Information Systems' lifecycles, speed up business process, and reduce data redundancy.

4.5 Barriers of EAI

From technical view, due to the fact that EAI is based on several technologies, integration must be provided in different levels. However, there is no single integration technology to support integration in all levels. The effectiveness of a specific technology on a certain level is more than the other levels of integration. Therefore, application integration solutions are based on a combination of technologies, because there is no single EAI product that can addresses all integration problems. Based on Markus, et al. (2000), EAI requires a significant amount of technical expertise and skills. Nevertheless, there is a lack of skilled staff that has experiment in application integration. Besides the required knowledge of integration technique and tools, knowledge of middleware technologies is also necessary for staff.

Additionally, the high salaries of skilled staffs and the cost of integration could be also the financial points that many companies have considered integration as a major investment.

Another barrier is the organizational culture, because of the unwillingness of some enterprises or departments to share data with other departments within the same company or external partners.

Themistocleous (2004), in his study categories EAI barriers into five categories:

Operational; Extra cost for redesign and change business structure, and processes.

Managerial; high complexity in understanding the processes and systems in order to redesign and integrate them; complexity of business processes; earlier approaches on EAI had proven problematic.

Strategic; politics issues; political impact.

Technical; no single EAI product solves all integration problems; lack of employees with EAI skills; EAI has a high cost.

Organizational; resistance to change; no time for training employees on integration technologies; cultural issues.

5 INTEGRATION TECHNOLOGIES

Moradi & Bahreininejad (2013), proposed a list of integration technologies. They classified integration technologies into eleven categories: elementary message oriented middleware, database access technologies, application access technologies, service oriented technologies, distributed objects technologies, data oriented technologies, information oriented technologies, transaction oriented technologies, modern brokers, modeler and simulator technologies and B2B integration technologies. Due to the classification of integration into four levels of physical, data, application, and process Table 6, summarized the extracted integration technologies based on these levels of integration. This list can be used as a reference to review different integration technologies. The physical level is not mentioned here because physical integration focuses more on networking.

Table 6 Integration Technologies

Level	Technology	Reference
Data	XML	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Vandersluis, 2004) (Rizescu, 2006)
	ODBC	(Themistocleous, et al., 2004)
	JDBC	(Themistocleous, et al., 2004)
	Database Gateway	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Vandersluis, 2004) (Al Mosawi, et al., 2006)
	Data Replication	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Vandersluis, 2004)
	ETL	(Rizescu, 2006) (Al Mosawi, et al., 2006) (Brodie, 2006)
	Virtual database	(Johnson, 2002) (Linthicum, 2004) (Vandersluis, 2004)
	EDI	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004)
Application	MOM	(Themistocleous, et al., 2004) (Linthicum, 2004)

	Publish/Subscribe	(Themistocleous, et al., 2004) (Linthicum, 2004) (Johannesson & Perjons, 2000)
	RPC	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004)
	Application Adapter	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004)
	Screen Scraper	(Johnson, 2002) (Linthicum, 2004)
	API	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Al Mosawi, et al., 2006) (Gulledge, 2006)
	Web Services	(Johnson, 2002) (Linthicum, 2004) (Zimmermann, et al., 2005) (Brodie, 2006)
	ESB	(Linthicum, 2004) (Zimmermann, et al., 2005) (Brodie, 2006)
	CORBA	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Al Mosawi, et al., 2006)
	COM/DCOM	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Al Mosawi, et al., 2006)
	EJB	(Johnson, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004)
	TPM	(Themistocleous, et al., 2004)
	Application Server	(Johnson, 2002) (Linthicum, 2004) (Gulledge, 2006)
	EAI	(Johnson, 2002) (Evgeniou, 2002) (Themistocleous, et al., 2004) (Linthicum, 2004) (Rizescu, 2006) (Al Mosawi, et al., 2006) (Gulledge, 2006) (Brodie, 2006)
Process	BPM	(Linthicum, 2004) (Al Mosawi, et al., 2006) (Johannesson & Perjons, 2000)

	Process Modeler	(Linthicum, 2004) (Al Mosawi, et al., 2006) (Johannesson & Perjons, 2000)
	Process-Oriented standards	(Linthicum, 2004) (Al Mosawi, et al., 2006)
	ebXML	(Themistocleous, et al., 2004) (Linthicum, 2004)
	RosettaNet	(Linthicum, 2004)
	BPML	(Linthicum, 2004) (Al Mosawi, et al., 2006) (Johannesson & Perjons, 2000)

5.1 Middleware

According to Erasala, et al. (2003) the traditional approach known as middleware that two systems can communicate with each other was to integrate them through program code. This approach was only one-to-one connectivity and unaware of any other transactions occurring in the same IT environment.

Middleware is an application dependent technology which provides little or no visibility of business processes (Linthicum, 2000). Traditionally, middleware is composed of communication and distribution services (Erasala, et al., 2003).

However, benefits of employing middleware are significant. Through middleware, the complexity of the source and target systems become invisible, thereby providing developers to focus more on information sharing than on low-level interfacing (Schantz & Schmidt, 2002). Middleware is an ideal solution when it comes to the information transferring between applications (Bernstein, 1996).

Linthicum (2000), labeled different types of middleware, each one is suitable for a specific type of integration problem. Linthicum defined EAI's engine as a middleware which contains many-to-many connection based middleware. This type of middleware is capable of providing many desirable features such as secure and reliable message transfer, data transformation, broadcasting, and communications.

Another advantage of middleware is that the needs of EC can be address effectively (Erasala, et al., 2003). Application servers, which are kind of middleware products, perform as hosts for component groups, and in the time that specific numbers of clients got access to the components, the load balancing process is carried out where

the workloads can be automatically shift to an alternative hardware. Moreover, in the application server failure situation, other servers can take place.

In the following sections CORBA as a distributed object and MOM as a message-oriented middleware are chosen as the main middleware integration technologies and discussed in detail.

5.1.1 Distributed object systems

Industrial enterprises use middleware technologies as the major integration technology to integrate new applications, emerging technologies, and legacy systems (Da Xu, 2011). Moreover, middleware can provide functions to ensure reliability, scalability, and performance to enterprise systems (Bernstein, 1996; Ooi & Su, 2006). Figure 10 illustrates the use of middleware in distributed applications.

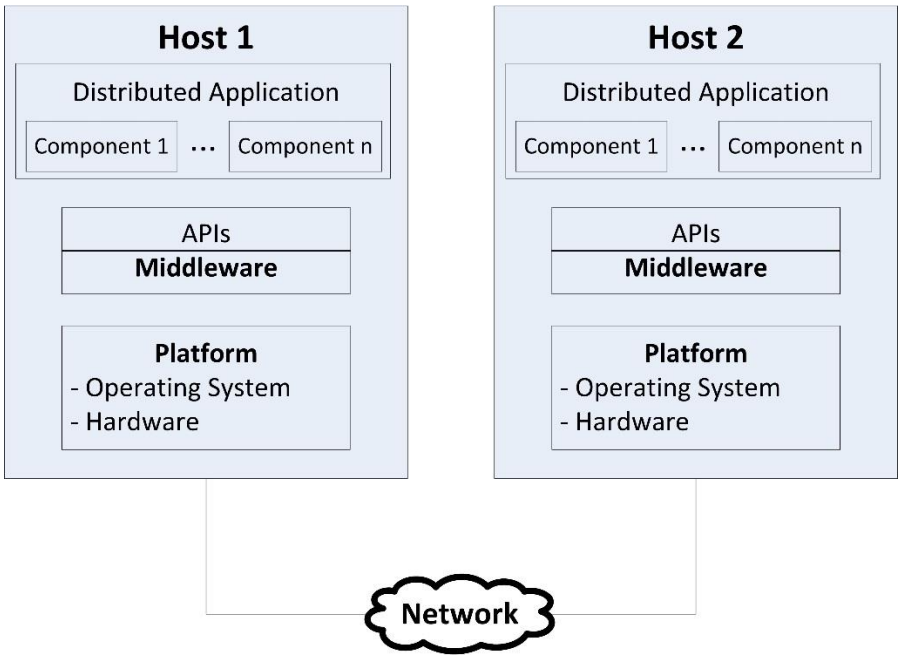

Figure 10 Use of middleware in the distributed applications (He & Xu, 2012)

There are various types of standard middleware. According to Giachetti (2004) and Blair, et al. (2009) the most popular among them are Microsoft's COM/DCOM (Component Object Model/Distributed Component Object Model), Java RMI (Remote Method Invocation), and CORBA (Common Object Request Broker Architecture). However, technologies, such as .NET and J2EE are the recent standard middleware technologies, which are used commonly by the enterprises.

DCOM is a Microsoft technology which enhances the communication among software modules or network components. Through this middleware two objects on two different systems can call each other's methods. DCOM is limited to support just a few non-Windows operating systems (He & Xu, 2012).

.NET is a platform dependent Microsoft solution. Microsoft characterized .NET as software that connects information, people, systems, and devices. .Net provides a multi-tier framework for enterprise application development. .NET is a successor to the older Microsoft technologies, such as COM and DCOM. The significant difference of .NET comparing to older technologies are the language independent nature of .NET and integrated support for Web Services. Figure 11, illustrates the .NET architecture in four levels of runtime, connectivity, business logic, and presentation and access (Kachru & Gehringer, 2004).

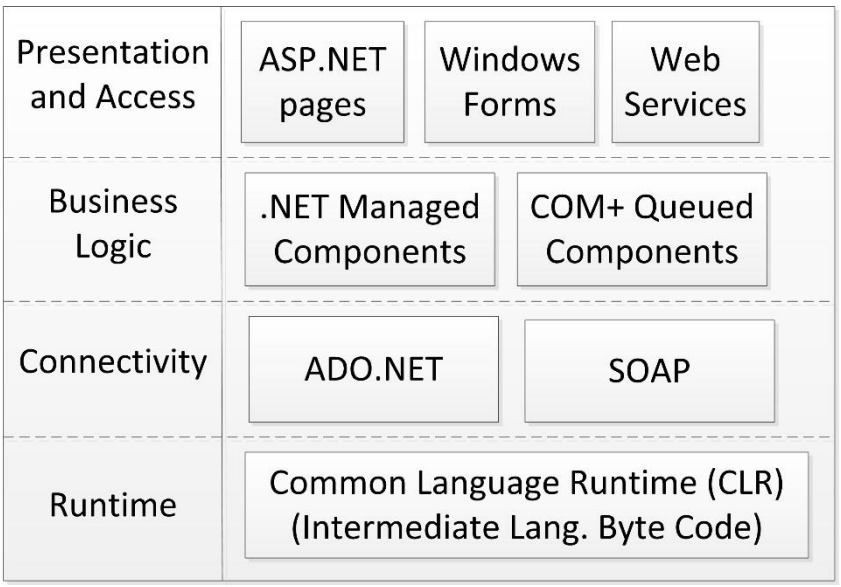

Figure 11 .NET Architecture (Kachru & Gehringer, 2004)

J2EE is framework for developing enterprise level multi-tier applications. J2EE is also capable of supporting Web Services. The main benefits of J2EE are the platform independent which allows working independently of any hardware architecture or operating systems, and the other benefit is the ability to support multiple-vendors. Figure 12 shows the different levels in J2EE architecture (Kachru & Gehringer, 2004).

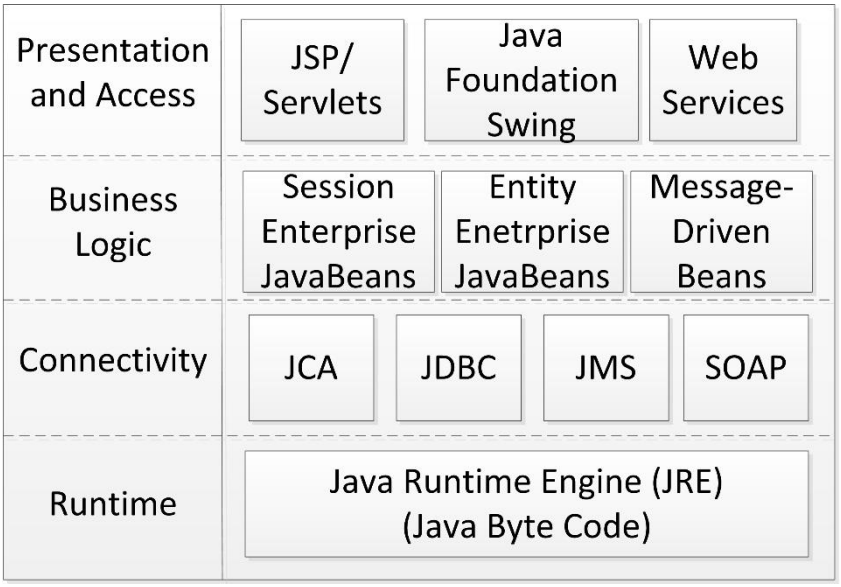

Figure 12 J2EE Architecture (Kachru & Gehringer, 2004)

Java RMI was released by Sun around 1997 and it supports the development of distributed applications using Java language (Maassen, et al., 2001). Java RMI makes it possible for the developers to create distributed Java applications. For example, a Java application on a computer can invoke the methods of other remote Java objects on different computers. Java RMI-based applications can be run on many different computing platforms due to the platform independence nature of Java (He & Xu, 2012).

In the past few years, CORBA has become a popular middleware for distributed computation (Toral, et al., 2013). CORBA is a standard introduced by OMG (Object Management Group) that allows distributed software components, written in multiple programming code and running on multiple hardware platforms to communicate with one another like a single application or set of services. The major difference between CORBA and other middleware technologies, such as COM/DCOM is that the COM/DCOM can be written in many languages but it is still limited to a windows operating system, Java RMI allows the remote method invocation of distributed Java applications. When it comes to interoperability, these technologies comprise a similar approach as CORBA.

A significant advantage of CORBA is its ability to support heterogeneous environments, different vendors' products, and several popular programming languages (Toral, et al., 2013).

In CORBA, ORB (Object Request Broker) is responsible for objects' communications which support broking services, such as server object location, message delivery, and method binding. In this method, clients request to perform specific services by sending requests to the ORB after that ORB discovers a server, which is capable to fulfill the requested service from client to the server. Location transparency is the result, such that calls to a remote object appear as if they are local to the client. CORBA's communication is demanding the client to wait for a response from the server due to the synchronous communication, which is built on the top of RPC (Remote Procedure Call) mechanism.

IDL (Interface Definition Language) defines the public interface to the object. The IDL define interface to follow two objectives: (1) it informs clients about the provided services and how to invoke them; and (2) it informs the communications infrastructure of the format and syntax of the access methods (Giachetti, 2004). An interface in OMG IDL can be defined for each object type. The interface is considered as the syntax part of the contract which sever object offer to the clients that invoke it. To specify the wanted operation to perform and to marshal the sent arguments, any client who wants to invoke an operation on the object must refer to IDL interface (OMG, 2013).

Figure 13 is illustrated in Giachetti (2004) study as a middleware architecture which provides the information exchange by messages between distributed applications over network. Referring to Figure 11, when a message is sent, the IDL stub on the client performs a task called marshaling that converts the message from local application format to a bit stream to send over the network. The server IDL skeleton unmarshals the message by converting it to its local representation format. In fact, CORBA wraps each object with IDL and thus conceals the object's semantics allowing access only through the operations defined by the IDL. The strength of IDL is the possibility to wrap any application, even difficult to integrate applications, such as legacy applications can be integrated into the enterprise (Bullinger, et al., 1998).

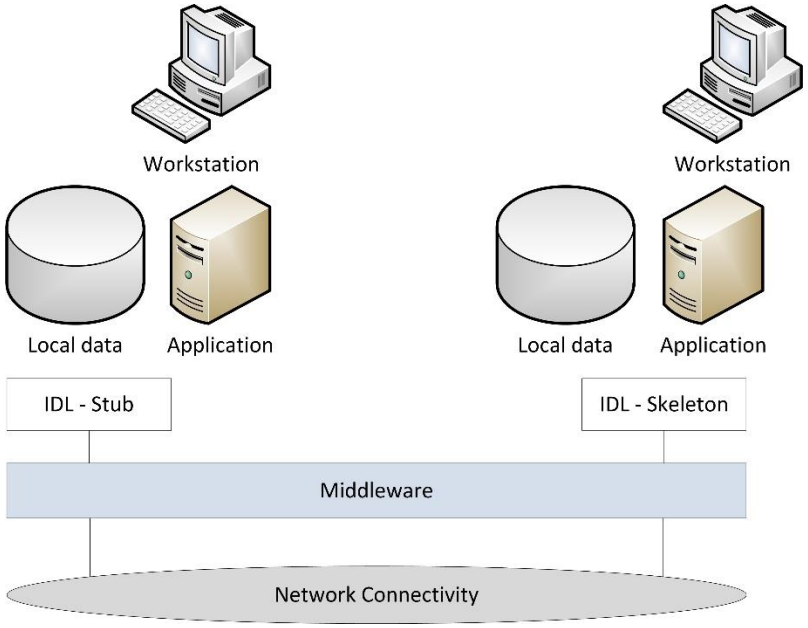

Figure 13 Message-oriented Approach (Giachetti, 2004)

5.1.2 Message-oriented middleware

MOM (Message-oriented middleware) is an approach that is based on queues which enables asynchronous communication by separating sender from receiver. Messages which are sent from clients remain in a queue until the server application retrieves them. The main differences between MOM and a middleware standard like CORBA are first, their difference in communication; MOM uses asynchronous communication, whereas CORBA is synchronous. Second, MOM does not follow any standard approach, whereas CORBA is a standard approach. MOM does not have any standard and the implementations are based on proprietary formats as exemplified by IBM's MQSeries and the Microsoft's MSMQ (Linthicum, 2000).

According to Menge (2007), MOM is the traditional EAI solution. This means, to decouple applications, asynchronous messaging is used. The heart of MOM is message broker, which is a message queue system. Using unified interface, all the applications are connected to the message broker to send and receive messages. Figure 14 illustrates a simple architecture of MOM.

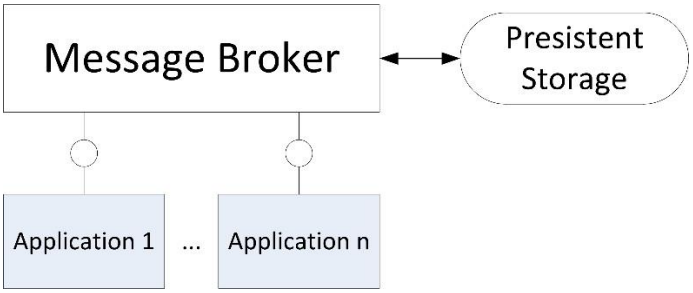

Figure 14 Simplified architecture of a Message-oriented Middleware (Menge, 2007)

The simultaneous connection of sender and receiver is not necessary because, the message broker is able to store the messages. It is possible that a message deliver to more than one recipient because of the routing feature within this middleware layer. Additionally, message broker can transform the messages to meet the requirements of the receiving application. Also, the transformation facilities provide the connected applications to use their own message formats.

As Menge (2007) explained, the major problem of MOM is that, they use their own specific protocols, platforms, and deployments. This problem leads to the infrastructure dependency, which is the reason of interoperability problem with other vendors of MOM products. Consequently, islands of MOM based infrastructures can often be found. JMS (Java Message Service) is the solution to address MOM's deficiency.

5.1.3 Java message service

JMS is known as one of the most important Java-based message-oriented middleware. As it was mentioned in previous section the problem of MOM products is their dependency on the respective running operating platform. Therefore, the scope of enterprise application operation become limited to specific types of software and hardware platforms. The JMS technology introduced in 1998 under the J2EE framework is able to address this problem (Zhang & Chen, 2010). JMS is an asynchronous, loosely coupled communication mechanism between system components, which enables a cross-platform, reliable, secure, and efficient way for messaging service between enterprise application programs.

JMS is a Java API which provides applications to create, send, receive, and read messages. JMS API designed by Sun Microsystem and other partner companies to

define a common group of interfaces and related semantics which allows the Java programming language applications to communicate with other messaging implementations.

According to Richards, et al. (2009), JSM is not a messaging system, but an abstraction of classes and interfaces, which is needed for communication of messaging client with messaging systems. As the JDBC (Java DataBase Connectivity) provides an abstraction to access relational databases and JNDI (Naming and Directory Interface) to naming and directory services, JMS abstract access to messaging providers. JMS provides portable clients of messaging application across messaging server products. JMS API has seven main interfaces for sending and receiving messages: ConnectionFactory, Destination, Connection, Session, Message, MessageProducer, MessageConsumer. Figure 15 illustrates the JMS general API core interfaces.

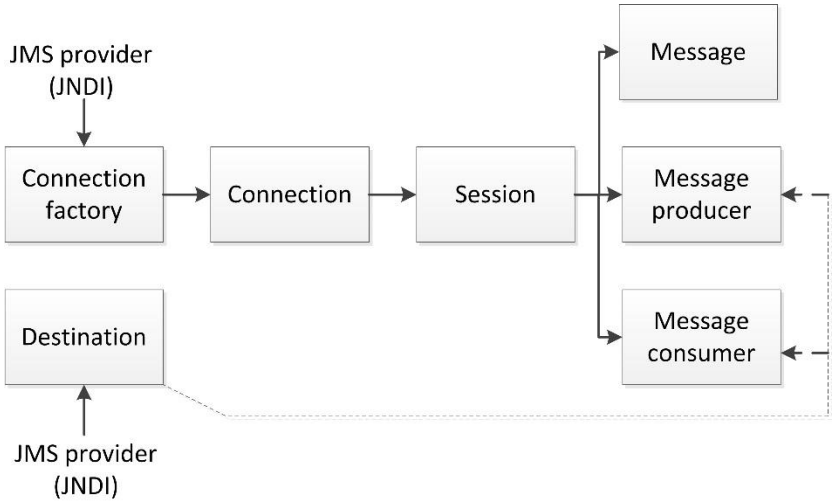

Figure 15 JMS general API core interfaces (Richards, et al., 2009, p. 13)

5.2 Service-oriented architecture

Several integration approaches and concepts have already explained. According to Sharpanskykh (2010), integration approaches and concepts can be differentiated by integration levels (for example data, functions, or process integration) and integration architecture (for example point-to-point, hub & spoke, and SOA). The service orientation concept is a hot debate among researchers of this field.

The World Wide Web Consortium (W3C) for example, refers to SOA (Service Oriented-Architecture) as "A set of components which can be invoked, and whose interface descriptions can be published and discovered". SOA is an architectural style which uses services of a network in building software systems (Diao & Ma, 2008). A service in SOA context is an autonomous, encapsulated, and well defined business function which can be access via a standardized interface (Menge, 2007). Thereby, SOA defines business functionality in the form of services. SOA is a way of moving to the next level of business computing through Web Services which can be easily integrated with legacy systems as well as current Information Systems (Chen, et al., 2006).

The ultimate goal of SOA is to integrate business activates in intra and inter-organizational applications to enhance business agility (Hurwitz, et al., 2009). SOA seems to be a suitable solution for the process oriented distributed integration. It can be specify from component orientation by the usage of services in its architecture. SOA offers easy connections and exchanges of services which simplifies the systems integration. Additionally, SOA enhance the enterprise systems adaption by providing high levels of interoperability and modularity. Service is the main concept of SOA in which sender does not want to know about the request procedures when it wants to achieve a specific result. With this approach the implementation of complex business process is provided through combination of several services, which is called service orchestration. In this respect, SOA is achieved considerable cost saving due to the reduction of maintenance costs and the fact that it can be seen as a BPO (Business Process Outsourcing) (Berbner, et al., 2005; Beimborn, et al., 2011).

In addition, SOA revolute the Information Systems approaches. Table 7 which extracted from Sulong, et al. (2012) study describe the key differences between SOA and Information Systems.

Table 7 Differences between SOA and Information Systems

Service-Oriented Architecture	Information Systems
Loose Coupling (Russell, et al., 2006)	Tight Coupling (Sutherland & van den Heuvel, 2002)
Services (Erl, 2005)	Processes (Middleton, 2007)
No redundancy (Schelp & Schwinn, 2005)	Redundancy (Słowiński & Stefanowski, 1989)
Ease of integration (Josuttis, 2007)	Complex integration (Giachetti, 2004)

SOA provides loose coupling between services and system integration, thereby supporting interchangeable implementations that offer dependable, available, and scalable systems (Russell, et al., 2006). SOA is based on Web Services while ISs are based on processes. Despite ISs, SOA has no data redundancy. Integration of SOA systems is more convenient than ISs. Agile methodology is one of the SOA foundations which provide dealing with changes in requirements.

Considering the mentioned differences from above table between SOA and IS, leading organization into adapting SOA approaches offers a great value to organizations.

5.2.1 Web Services

There are various definitions of Web Services in the literature. One of the definitions is that a Web Service is a software object with business logic, located on the Internet applying standard protocols such as HTTP and SMTP to perform functions or execute business processes (Chappell & Jewell, 2002; Fensel & Bussler, 2002). It is also defined as "loosely coupled applications using open, cross-platform standards and which interoperate across organizational and trust boundaries" (Tsur, et al., 2001). The W3C defines a Web Service as a "software application identified by a URI (Uniform Resource Identifier), whose interfaces and binding are capable of being defined, described and discovered by XML artifacts and supports direct interactions with other software applications using XML-based messages via Internet-based protocols".

Web Service's goal is to provide an interoperable distributed environment for machine-to machine communication between organizations over the network.

A Web Service has special behavioral characteristics such as: XML-based, loosely coupled, coarse-grained, ability to be synchronous or asynchronous, supports RPCs, and supports document exchange. The major Web Services technologies are: SOAP (Simple Object Access Protocol), (Web Service Description Language), UDDI (Universal Description, Discovery, and Integration). The most common platforms are: J2EE and .NET.

It is important to mention that SOA and Web Services are not necessarily bounded together, but due to the pervasiveness, simplicity, and platform-neutrality of Web Services, they are the most common way of implementing SOA (Diao & Ma, 2008).

Figure 16, illustrates three major standards to support interactions among Web Services.

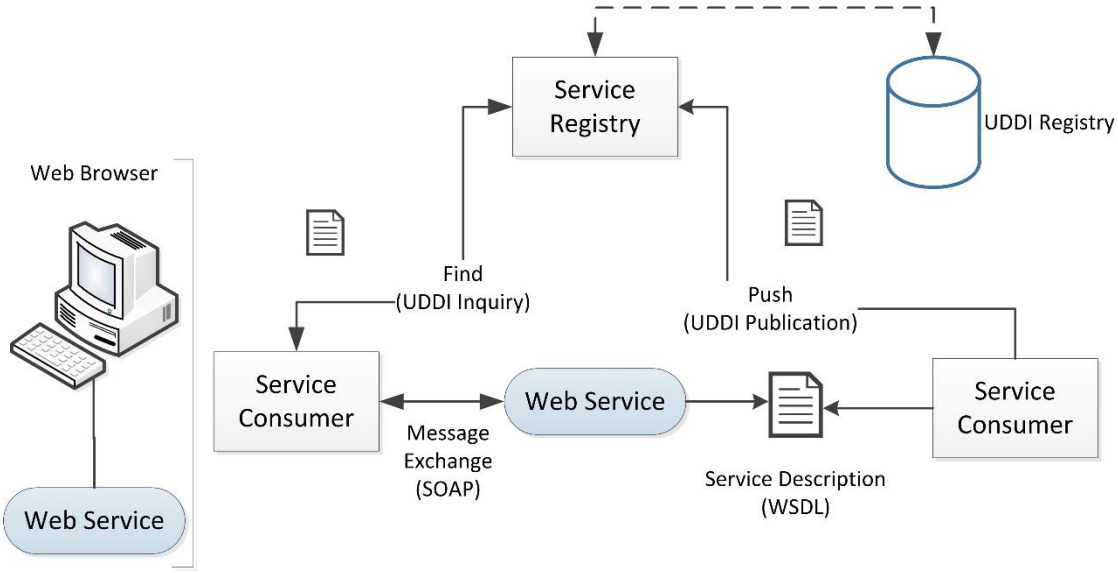

Figure 16 The Web Service reference model (Medjahed, et al., 2003)

WSDL defines services as collections of network endpoints and ports. WSDL is an XML vocabulary to describe operational information about the service such as access protocols and other implementation details (Tsur, et al., 2001; Fensel & Bussler, 2002; Medjahed, et al., 2003).

UDDI provides a mechanism for the client to fined Web Services. It acts as a directory of available services and service providers (Tsur, et al., 2001). UDDI registry can be thought of as a CORBA trader or DNS (Domain Name System) service for business

applications. UDDI registry has two kinds of clients: **Businesses** that want to publish a service description and its usage interfaces where businesses advertise services so that other businesses can find them, and **Clients** who want to obtain service descriptions of a certain kind and bind programmatically to them by using SOAP (Fensel & Bussler, 2002; Medjahed, et al., 2003). Conceptually, the information provided in a UDDI business registration consists of white pages (contact information), yellow pages (industrial categorization), and green pages (technical information about services).

SOAP is a framework to describe the message content and how to process it. SOAP acts as a messaging layer for Web Services, it is an XML protocol to invoke a method on a server to execute a requested operation and receives a response in XML. SOAP implements an "envelop and message" model consists of header and body, in which the SOAP envelop wraps the application-specific message that maybe in a different vocabulary. Additionally, to pass SOAP messages between two endpoints, it binds to HTTP, SMTP, and FTP as the underlying communication protocol (Tsur, et al., 2001; Fensel & Bussler, 2002; Medjahed, et al., 2003).

5.3 Enterprise service bus

Menge (2007) defines ESB (Enterprise Service Bus) as, "an open standards, message-based, distributed integration infrastructure that provides routing, invocation, and mediation services to facilitate the interactions of disparate distributed applications and services in a secure and reliable manner". To enable transparent service integration, ESB was introduced as the infrastructure for SOA service connection and message exchange (Chappell, 2009; Xin, et al., 2009). The key features of ESB contain message transformation, message transmission, and dynamic message routing.

ESBs are distributed over a networked environment through service containers. These containers provide several communication facilities to the integration services, such as routers, transformers, application adapters, or MOM bridges. To guarantee message delivery, ESB solutions are built on top of JMS-based middleware systems. Through application adapters or messaging mechanisms, applications can connect to the bus. All the necessary Web Service technologies must be included in ESB service containers in order to support SOA.

Based on García-Jiménez, et al. (2010) study, data transformation is one of the most important parts of ESB. Moreover, routing message capabilities and supporting IEP (Enterprise Integration Pattern) standards Hohpe & Woolf (2004) are provided by ESBs.

Mediation is the activities if transforming, routing, validating, and processing of messages to get the right message into the right format. Most of ESBs use JMS to manage the messages delivery among different components. REST, HTTP, JDBC, TCP, UDP, or CXF are the other technologies used in ESBs.

In addition, ESBs can also be implemented based on JBI (Java Business Integration) that specifies component based product integration architecture which can be used in JBI environment.

5.3.1 Java business integration

JBI proposed by Sun Microsystem aims at setting up an open, standard Java and EAI platform. JBI provides an approach to standardize ESB pattern by specifying a concrete, well-defined, and Java-centric ESB model (Psiuk & Bujok, 2012). The service-oriented JBI architecture is pluggable, portable, message-driven, and open framework which allows infusion of standard third-party vendors' component in JBI environment (Xin, et al., 2009). JBI specifies component/framework interfaces, behavior, and services. The primary goal of JBI is to allow much broader adoption beyond the handful of J2EE application server vendors (Chappell, 2009). The capabilities of JBI components described through an XML-based file.

5.4 The J2EE connector architecture

JCA or J2CA (J2EE Connector Architecture), connects legacy applications to a Java environment via standard connectors. Sharma, et al. (2001) defines JCA as a standard architecture for connecting the J2EE platform to heterogeneous enterprise Information Systems. In other words, JCA provides connectivity with enterprise Information Systems (Maréchaux, 2006). JCA makes the integration easier by assigning the container contract between an application server and middleware integration broker to an application adapter, and between the application adapter and an application. Any

third-party application which is based on JCA can be plugged into the container. JCA can be implemented in either application server container or ESB container. JCA provides connection management and connection pooling, transaction control, propagation of security context, a worker thread management, and delegation model.

JCA provides a simple integration of diverse enterprise Information Systems. Because of the adherence of J2EE connector architecture from J2EE connector specification, it provides the portability across compliant J2EE servers. Consequently, for each enterprise Information System just one JCA implementation is required. JAX-RPC (Java API for XML-Based Remote Procedure Call) and the JCA are complementary technologies for EAI and end-to-end business integration (Armstrong, et al., 2004).

For instance, the Apache CXF (Celtix and XFire) JCA connector is a JCA 1.5 resource adapter. It enables to expose Web Services to J2EE applications and allows exposing J2EE applications as Web Services (RedHat, 2013).

Figure 17 illustrates how the Apache CXF JCA connector exposes a Web Service to a J2EE application. It acts as a bridge between J2EE and SOAP over HTTP Web Services. It also illustrates that the Apache CXF JCA Connector can be used as a bridge between J2EE and a CORBA server.

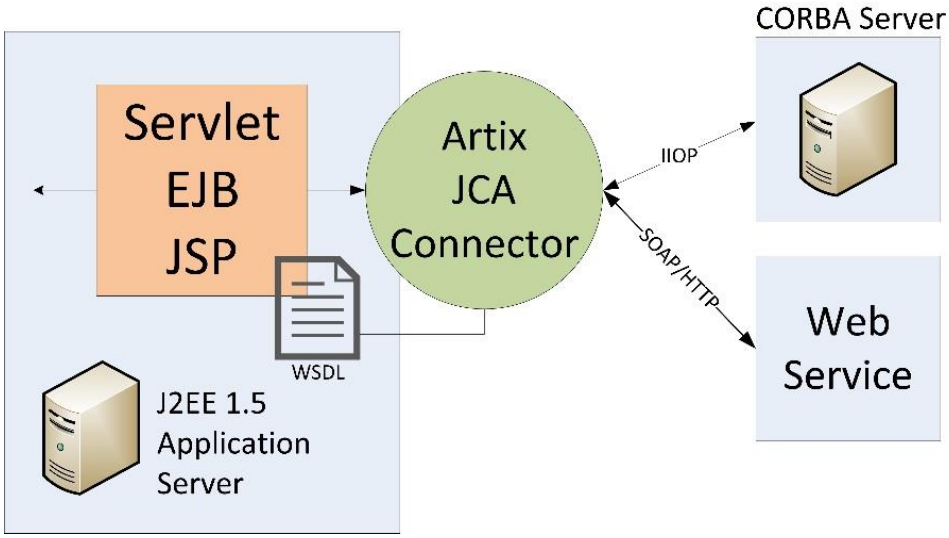

Figure 17 Connecting J2EE application to Web Services (RedHat, 2013)

5.5 Electronic commerce and enterprise systems

Several companies have attempted to adopt EC to enhance their competitive capabilities and build their own competitive advantages. Nevertheless, not all of firms met the desired performance.

As mentioned in previous sections, application integration is a vital necessity for enterprises. EC as an application package in enterprise environment must integrate with the rest of enterprise systems to benefit the company. It is crucial to integrate applications such as EC with the EISs (Enterprise Information Systems) in order to have a consistent and unified view of data and functionality in both the internal and external customers.

Using adapters is one way of integrating most of these package applications (Roshen, 2009). Adapters refer to software components in which the communication between application packages is provided through a package application' interfaces. The recent way of integrating applications such as EC with EISs is through conjunction of adapters and J2EE application server. Figure 18 is illustrated the integration through conjunction of J2EE application and adapter.

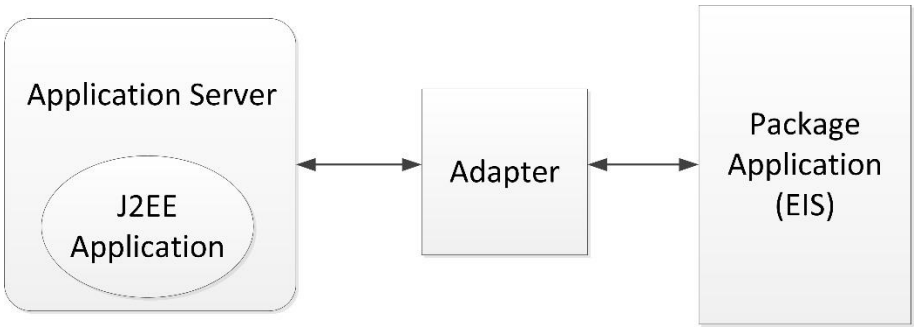

Figure 18 Integration of package application and modern application using adapter (Roshen, 2009)

In the cases that the integration of package application with wider range of applications is needed, the adapter can be used with an ESB. In addition, sometimes the EIS application is configured as a Web Service. For example, such is the case of SAP by integrating an application server with their EIS. Figure 19 shows the integration through applying both adapter and ESB.

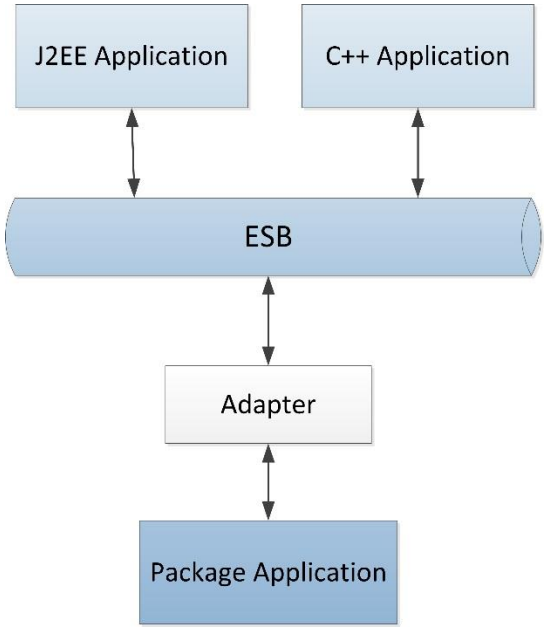

Figure 19 Integration of package application to a wider range of applications through the use of an adapter and ESB (Roshen, 2009)

Generally, deployment of adapter can be either at EIS side or the application server/ESB side, or somewhere in between. However, the common way of adapter deployment is at the application server or ESB side.

5.5.1 Electronic commerce integration using EAI

ERP has changed its face from internal management of the manufacturing to inter-enterprise transaction processing due to the development of ERP and EC. In this respect, EC has accelerated the pace of change by more involvement of EC into B2B field.

The integration of ERP and EC bring superior resources because of the complementary characteristics of them. Based on Liu, et al. (2010) study, Figure 20 illustrates the existing pattern of ERP and EC:

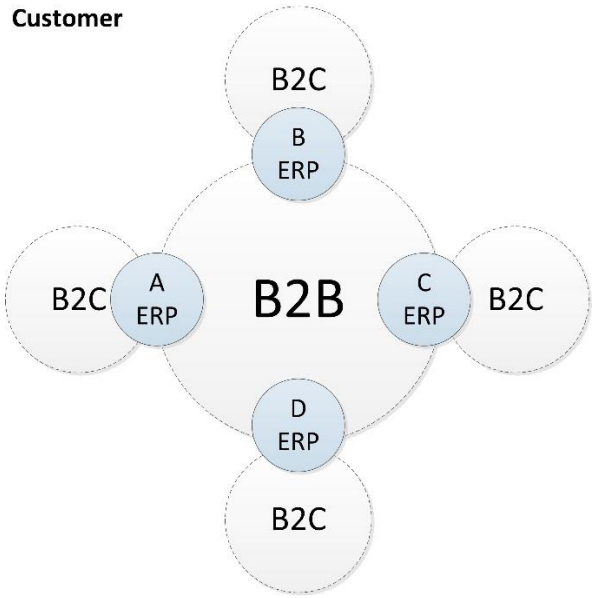

Figure 20 Existing pattern of ERP and EC (Liu, et al., 2010)

As it can be seen in this figure, each company builds a B2C EC Websites to deal directly with customers. Also to have business relationship with other business partners each company establish B2B EC platform. The current integration of ERP and EC is mainly focused on B2B, B2C, and ERP integration.

Based on Liu, et al. (2010), the problems of EC and ERP integration focuses on:

1) Data sharing and synchronization problems: it is required to integrate data within and across enterprises. Data, such as product, inventory, and suppliers are required to be synchronized.
2) The depth of integration: in order to have deeper integration to perform automated search and matching, a programmable interface needs to be between EC and ERP.
3) The breadth of integration: the integration of ERP and EC should be based on a strategic in order to become a strategic resource. Therefore, the integration of business processes and business intelligence are required.
4) The close cooperation of both sides: EC and ERP systems should be bilateral, and transformation is needed for both sides.

The main purpose of EC and ERP integration are data synchronization and sharing and financial integration. Besides, ERP and EC integration also need to meet some

conditions such as, unified strategies, optimizing processes in both sides, providing uniform outside call interface, and data synchronization.

Figure 21 illustrates ERP and EC integration using a third party to manage the ERP and EC integration issues.

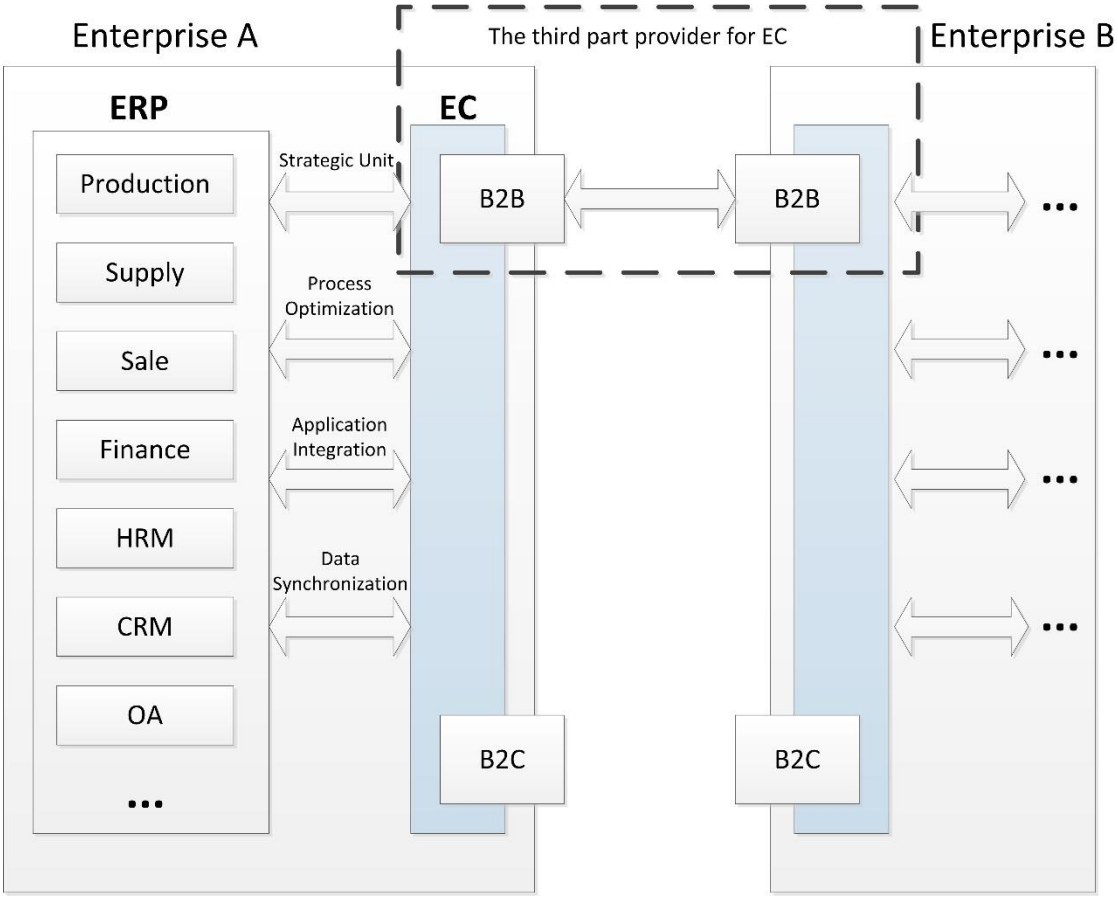

Figure 21 Approach of EC and ERP integration (Liu, et al., 2010)

Some technologies are proposed to integrate EC and ERP system. Ash & Burn (2003), suggested a comprehensive structure of technology platform needed in EC and ERP integration. Figure 22 shows this platform.

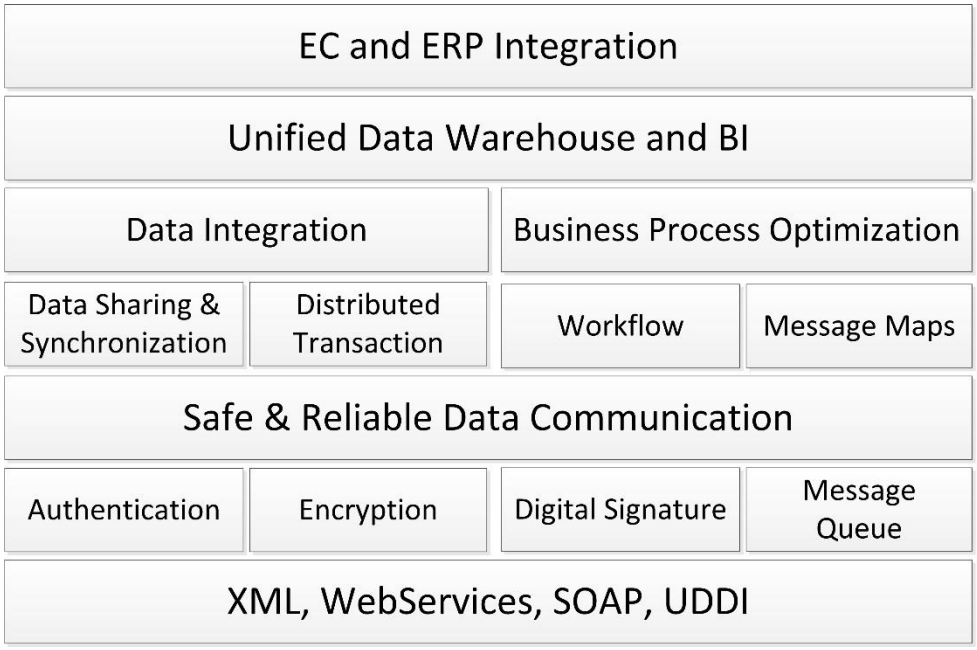

Figure 22 Overall platform of EC and ERP integration (Ash & Burn, 2003)

In this platform XML, Web Service, SOAP, and UDDI are the base technologies of EC and enterprise integration. On this basis a safe and reliable data communications are needed which can be provided on the upper layer by authentication, encryption, digital signature, and message queue technologies. In this respect, the integration of EC and ERP can be divided into two segments of data integration and business process integration. Data integration is to manage data sharing and synchronization issues and provide distributed transactions between heterogeneous databases. Business process optimization is provided through standard communication interface as the base and workflow technology as a support to address the process optimization issues. Unified data warehouse and business intelligence can be considered on the basis of data integration and business integration. In this situation EC and ERP have a central base for decision-making and reach to the realization of EC and ERP integration.

EC can be considered as one of the EAI drivers. Business processes such as, procurement, sales order processing, customer service, customer support, and supply chain management, and every action between companies, partners, and customers' needs to be integrated in EC. Extended enterprises emerged due to the need of integration at process level between firms. But before that to have Web applications functionality the internal systems should be integrated.

Eventually, Internet, intranets, or extranets are the keys of transactions integration which involves integration of legacy applications and exposing them to easy-to-use frontends that are Web-based. To understand customers better, once the applications are integrated, EAI provides improvement to the firm.

The advantages of this integration for companies are: the customer loyalty and reduce in time-to-market. In addition, the aid of EAI for developers is that they can simply integrate different applications by adding Web frontends, and rolling out new services (Erasala, et al., 2003).

5.5.2 Electronic commerce integration based on SOA

Nature of SOA is enabled it to meet services and business needs much more effectively. SOA provides three actors (Provider, Requestor, and Broker) to help an enterprise to choose among four business roles namely; Service Requestor, Service Provider, Broker, and Aggregator/Gateway (Bih, 2006). An integrated model of EC based on Web Services technology is shown in Figure 23.

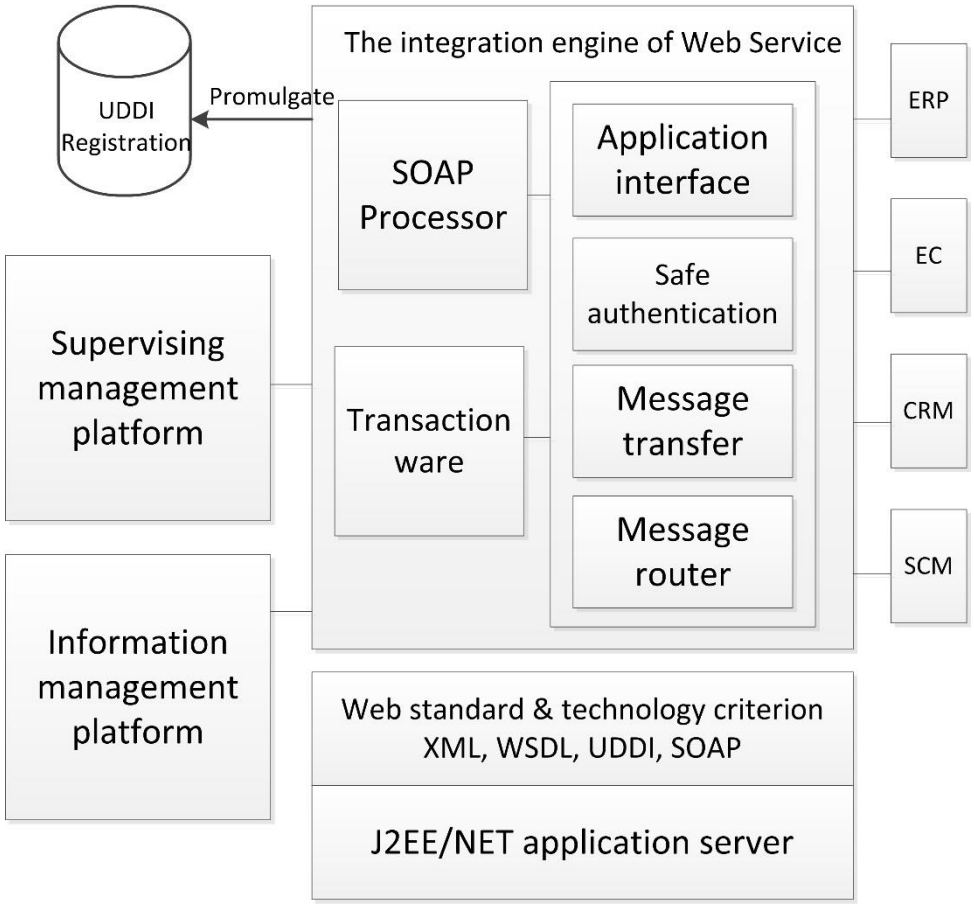

Figure 23 Integration model of EC based on Web Services (Bih, 2006)

In this model, the integrated engine of Web Services consists of different types of interfaces and modules. It works as a bridge to link various applications and by transferring the interface any application is capable of linking to the system. The integration engine embedded three modules: adapter, SOAP's processor and transaction ware.

SOAP's processor plays the main role in which customer can realize the transmission of SOAP's message. The transaction ware manages different transactions. Web Service's adapter is the center of integrated engine and consists of: application interface APIs, safe authentication, data conversion ware, and message router.

The process flow of integrating an application is as follow:

1- The application which needs to be integrated transfer the interface of integrated platform.

2- The services which can be described by WSDL notify UDDI registration through SOAP's message.
3- Here two conditions may happen:
    a. If registration center is privately owned, then the system integration is the application system inside the enterprise.
    b. If registration center is communally owned, the different systems among different enterprises can be integrated by Internet.

In this model, information management platform provides active configuration of the integrated application, service management of application resources, interface unification, and data services and model services for supervising center. Supervising management platform provides management and supervision of service operation, customers' management, trends management and safety management, information sharing management, and data manipulation management.

5.5.3 B2B integration

According to Markus (2000), to form a unified business process, various business activities performed by different individuals, work groups, and organizations should be integrated. The internal business integration is applied within one company, and the external B2B integration is the coordination of business processes across organizations. Generally, there are different sources which determine the benefits of B2B integration. Elimination of data entry, staff, and communication costs are the major cost saving sources. In addition, faster trading cycle, improved cash flow, security and error reduction, and improved corporate trading relationships are the sources of B2B integration benefits (Lim & Wen, 2002).

The integration of different computer-based Information Systems and databases is referring to as systems integration (Markus, 2000). To achieve systems integration, B2B integration is required. Different B2B integration have been proposed already (Bussler, 2003; Linthicum, 2000; Stohr & Nickerson, 2003). In all of these architectures the physical connectivity for data communication is common. Usually, the data fetch from source systems and saved in target systems, and mostly these fetching and storing needs data transformation in various business documents. Figure 24, illustrates a business integration framework developed by Stohr & Nickerson

(2003) which presents the relation of activities in organizations. This picture shows the required systems integration from the most concrete on the bottom to the most abstract on the top. Stohr & Nickerson (2003) pointed out that each layer of integration is depending on the integration of lower layers. For instance, the application integration needs the integration in data level.

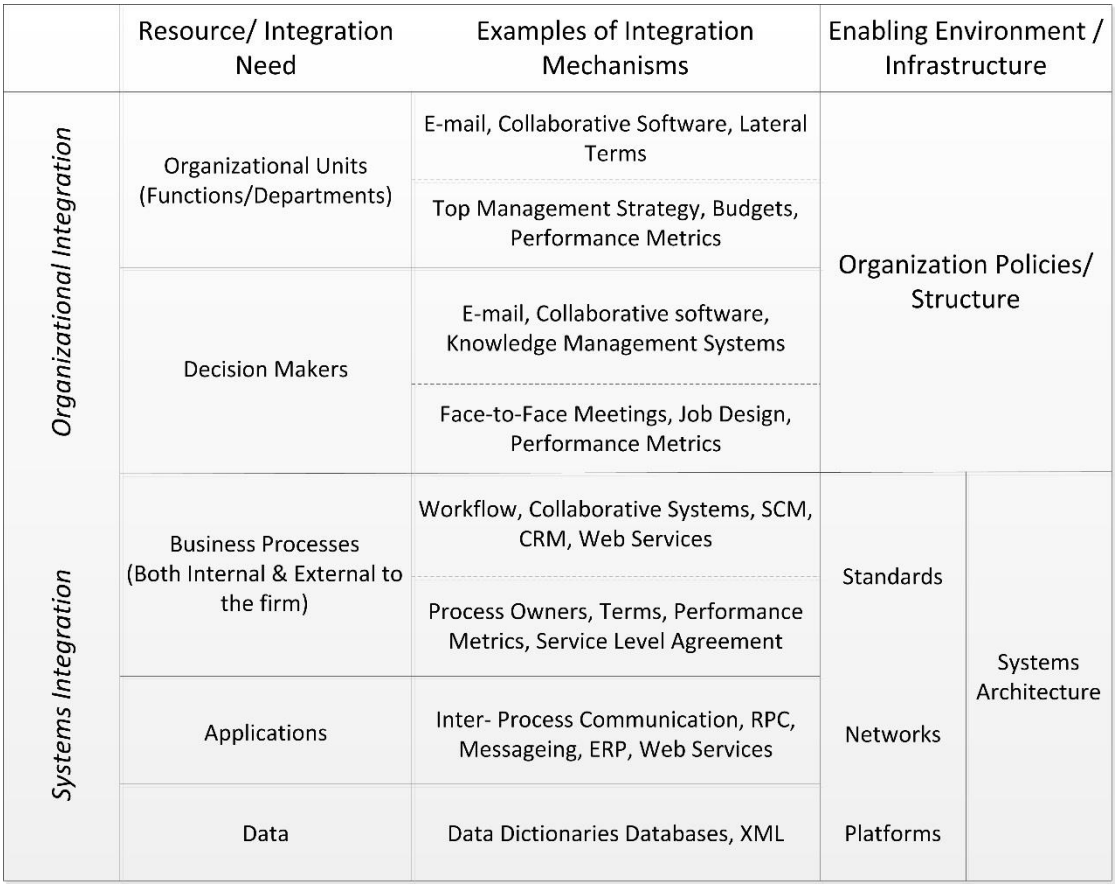

Figure 24 Enterprise integration framework (Stohr & Nickerson, 2003)

5.5.4 Standardization

The first B2B integrations were without the use of standards. The first industry which applied the standardize B2B integration were the car manufacturers (Reimers, 2001). Car manufacturers used their internal data standards for business document exchanges. During the time, big companies have imposed the use of their internal data formats to their business partners. In this situation business partners force to adapt their data format with the big companies in order to remain in business.

In general, by eliminating variety, standardization solves the uncertainty problem. By applying standards, the B2B integration negotiations will be simpler due to the existence of ready templates and common terminologies and structures for the exchanged information (Preist, et al., 2005). Standard technologies such as RosettaNet, BizTalk and ebXML (Electronic Business Extensible Markup Language) provide common semantics for B2B EAI (Linthicum, 2001).

RosettaNet and ebXML are the two popular B2B integration standards which support EC over existing Internet standards and lead to cost and extensibility benefits (Shim, et al., 2000). The ultimate goal of B2B standards is to facilitate integration and implementation for e-business partners of organization. Employing XML technologies and Internet, B2B standards provide easy document exchanges and the implementation effort of collaborations.

In the following sections RosettaNet and ebXML will be explained in detail and BizTalk will be discussed in the next chapter.

5.5.4.1 RosettaNet

RosettaNet was founded in the U.S. in February 1998; RosettaNet is a consortium that is focused on developing XML-based business standards for supply chain management for more than 500 organizations (Rau, et al., 2009). These organizations include some of the world's leading electronic components, computer and consumer electronics, semiconductor manufacturing, telecommunications, and logistics companies (Damodaran, 2004; Boh, et al., 2007; Chituc, et al., 2008). It defines the business processes and provides the technical specifications for data interchange. RosettaNet specifies XML as the data exchange format and Internet as the communication channel (Sundaram & Shim, 2001).

The key feature of RosettaNet standard is to improve speed, efficiency and reliability of B2B transactions in order to provide better circumstances between trading partners to communicate and collaborate. Conducting business over the Internet provides a common platform for the trading partners (Bussler, 2003). Due to the formal standard of RosettaNet, the automation of companies' business processes has enhanced (Chong & Ooi, 2008).

RosettaNet specifications are divided into three categories (Kotinurmi, et al., 2009):
Dictionaries define common sets of XML elements used in business documents. The RosettaNet business dictionary defines elements related to transactions between trading partners, while the technical dictionary defines elements used for describing products and services. PIP specifications employ elements defined in dictionaries.

PIPs (Partner Interface Processes) define business processes as XML-based business documents and messaging choreography. A single PIP specification defines these for a single business process, such as PIP 3A4 for Request Purchase Order. Business documents are specified using an XML DTD (Document Type Definition) schema document and additional textual description of the XML elements in a message guidelines document. A PIP specifies a set of activities, business document exchanges, which consists of sequentially executed actions. Each action corresponds to a business document that is sent in context of that action. A PIP also specifies a set of roles that trading partners play when executing an activity. These concepts are used to define the messaging choreography using standardized tables and UML activity and interaction diagrams. The specification does not facilitate fully automatic generation of implementations. A hierarchical identification of a PIP (such as 3A4) consists of a cluster number that specifies the process category, a segment letter that specifies the cross-enterprise process, and a number that specifies the individual PIP.

RosettaNet Implementation Framework (RNIF) defines a connectionless XML-based messaging scheme used to perform messaging specified by RosettaNet PIPs between trading partners, with features such as reliable messaging, digital signatures, and encryption. Amongst other things, RNIF defines message structure and header XML documents for business messages, for these, the specification is similar to PIP business document specification, with DTDs and message guidelines.

Viewed through the above definition of e-business frameworks, RosettaNet addresses business document issues in dictionaries and PIPs, business process issues in PIPs, and messaging in the implementation framework (Kauremaa, et al., 2010).

5.5.4.2 ebXML

ebXML stands for Electronic Business using XML and is governed by the OASIS (Organization for the Advancement of Structured Information Standards) and UN/CEFACT (United Nations Centre for Trade Facilitation and Electronic Business) (Patil & Newcomer, 2033). Despite RosettaNet, ebXML is more complex due to its promises to be suited for many different types of industries.

The organizations which are using ebXML as B2B integration solution mentioned reduction in cost for manual work, reduction of paper costs, and validation of business documents (Kim, 2002).

ebXML is an XML based standard that is used for B2B communication. Below is a short description of the different components of the standard.

BPSS (Business Process Specification Schema) is a schema that describes the dialog of messages that is sent between business partners. It is available as a DTD and a XSD (XML Schema Definition).

CPP (Collaboration Protocol Profile) describes technical capabilities and supported business collaboration types of an organization. CPPs can include BPSSs.

CPA (Collaboration Profile Agreement) is an agreement of business collaborations and technical capabilities two organizations have agreed to use in mutual communication, these must be supported by CPPs of both organizations.

ebRS (Registry Service) is storage for information needed to conduct interactions with other trading partners. The ebRS can hold different CPPs.

ebRIM (Registry Information **Model)** specifies the information model employed in the registry service

ebMS (Messaging Service**)** specifies information about the actual messaging such as encryption and security.

Table 8 has compared RosettaNet and ebXML standards briefly. This table illustrates the differences of these two B2B integration technologies based on their business

documents, business processes, managing issues, target industry, the originality, their validation method, and process description.

Table 8 Compared RosettaNet and ebXML

Factor	RosettaNet	ebXML
Business document	PIP specifications define business documents	No globally standardized documents
Business process	Step processes defined informally in PIPs	Processes can be defined formally with BPSS
Managing issues	RNIF: reliable and secure messaging framework over HTTP	ebMS: messaging over SOAP, reliable and secure messaging as extensions
Target industry	Information and communication technology industry	Cross industry
Based on	Open-EDI Reference Model	ASC X12, EDIFACT
Validation	DTD	DTD
Process description	Business scenarios, flow and dialog diagrams	DTD, XSD language

5.6 Summary

In this section, the popular technologies which are using for enterprise integration are discussed. Figure 25 illustrates the technologies which were discussed in this section.

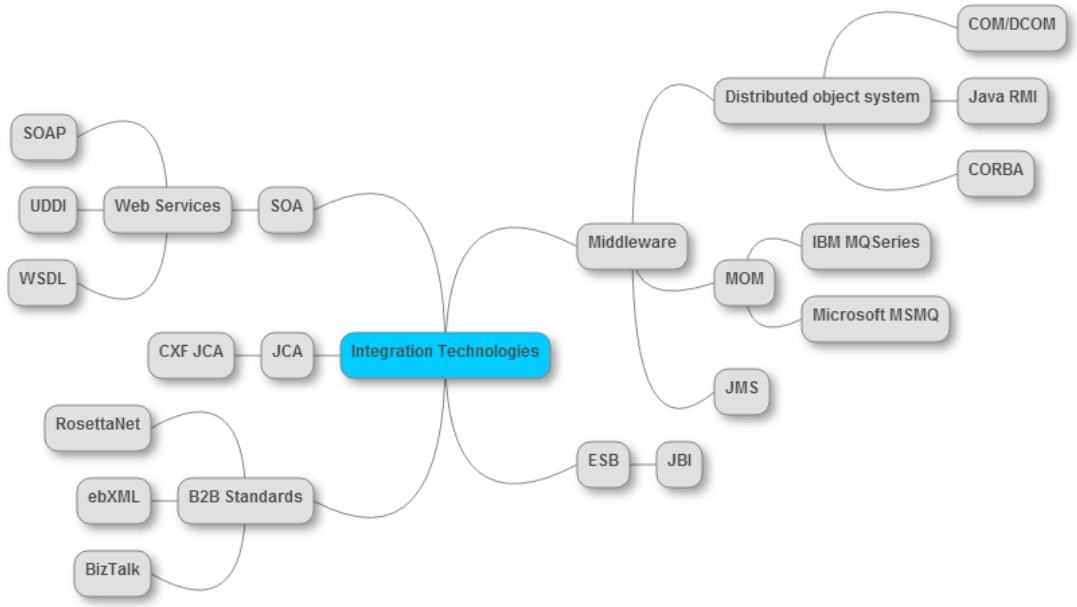

Figure 25 Integration technologies

Middleware, SOA, EBS, JCA, and B2B standards are the most popular integration technologies. EAI is considered as a method or plan to modernize, consolidate, and coordinate the overall computer functionality in an enterprise.

Middleware technologies provide a level of abstraction in which the complexities of business processes are hidden. COM/DCOM, Java RMI, and CORBA are considered as the middleware technologies for distributed object systems. MOMs are asynchronous, queue-based technologies. IBM's MQSeries and the Microsoft's MSMQ are the examples of this technology. MOM is infrastructure dependent and has the interoperability problem. JMS is an asynchronous mechanism which addresses the MOM interoperability problem.

SOA as an integration technology promises to integrate business activities in intra and inter-organizational applications. Web Services are the main components of SOA architecture. WSDL, UDDI, and SOAP are the major Web Services technologies.

Another integration technology is ESB, which is a message-based, distributed integration infrastructure. ESBs can be implemented based on JBI which is a Java standard and follows EAI platform. JCA as another integration technology connects legacy applications to a Java environment via standard connectors.

In addition, EAI as a methodology to integrate EC with enterprise systems was discussed. EAI provides easy approaches in order to integrate intra and inter-organizational applications.

B2B integration is the coordination of business processes across organizations. RosettaNet and ebXML as the most popular B2B integration standards were investigated and compared.

Table 9 highlights different integration technologies specifications.

Table 9 Integration technologies specifications

Technology	Communication	Platform	Description	Origin
COM/DCOM	Synchronous	Dependent	Communication enhancement among software modules	Microsoft
Java RMI	Synchronous	Independent	supports the development of distributed applications	Sun
CORBA	Synchronous	Independent	popular middleware for distributed computation	OMG
MOM	Asynchronous	Dependent	A queue-based middleware approach	
JMS	Asynchronous	Independent	Java MOM API for sending messages between clients	Oracle
Web Service	Synchronous/ Asynchronous	Independent	An XML-based communication method between applications	
ESB	Synchronous/ Asynchronous	Independent	Provides routing, invocation, and mediation services to facilitate the interactions of distributed applications	Gartner Group
JBI	Synchronous/ Asynchronous	Independent	Provides an approach to standardize ESB pattern by specifying a Java-centric ESB model	Sun
JCA	Synchronous	Independent	connects legacy applications to a Java environment via standard connectors	Oracle

6 ELECTRONIC COMMERCE INTEGRATION SOLUTIONS

In this section, different EC integration solutions by large software vendors, such as Oracle, IBM, Microsoft, and SAP are discussed. Most of these companies, such as SAP are among the biggest ERP providers. Therefore, the most common integration solution techniques and EC solutions of these companies are selected and explained in detail.

6.1 Oracle solution

Oracle as one of the biggest computer technology corporation provides some integration technologies and platforms. Current integration tools and technologies of Oracle are Fusion Middleware, E-business Suite, and Application Integration Architecture. Fusion Middleware consist of Oracle SOA Suite and Oracle Applications Adapter. E-business Suite is contained Integration Repository and Integrated SOA Gateway. AIA (Application Integration Architecture) is embraced Foundation Pack and Pre-built PIPs (Process Integration Packs).

Oracle Service-Oriented Architecture B2B integration facilitates the cooperation between organizations and trading partners (Oracle, 2007).

Oracle Fusion Middleware, offers online collaboration and automate processes with business partners through a single integrated solution by employing industry standard protocols such as RosettaNet, EDI, AS2 (Applicability Statement 2), and UCCnet (Uniform Code Council Network). Besides, Oracle Fusion Middleware supports Wal-Mart, Cisco, and Intel industry hubs connection.

6.1.1 Oracle AIA

Oracle AIA facilitates integration of cross-application business process by applying standard approaches (Oracle, 2009). AIA provides deployment, reusability, configurability of business processes by engaging SOA approaches.

Oracle AIA provides enterprises to create business process integrations across their Oracle and non-Oracle applications through application independent EBOs (Enterprise Business Objects) and EBSs (Enterprise Business Services), a standards-based

reference architecture, programming methodology, and process governance tools. Built on Oracle Fusion Middleware, Oracle AIA provides connection between applications and business partners, structured or unstructured business process management, and governance and monitoring using a unified framework (Oracle, 2009).

6.1.2 Oracle e-business suite

Oracle provides EC solutions by introducing Oracle E-business Suite through building a system on a unified architecture. According to manufacturer, Oracle E-business Suite, manages customer interactions, deliver services, manufacture products, ship orders, and collect payments by providing a set of applications (Oracle, 2008). It enables the customers to run their businesses on a single global instance by adopting an architecture. Oracle E-business Suite established a meaning of customers, suppliers, partners, employees, and all business entities across the enterprise. Moreover, it provides data unification from both Oracle and non-Oracle applications.

Oracle E-business Suite works around an integrated and single, common data model. Oracle E-business Suite is built upon a modular structure and facilitates application integration in a heterogeneous environment. It also provides solutions for application integration such as messaging, data transformation, validation, and adapters for connectivity to third-party applications and legacy systems.

Oracle E-business Suite is based on Oracle Application Server which means, organizations are able to communicate with their trading partners using B2B protocols, such as EDI and XML. Web Services provide next generation of distributed computing through using Internet as the backbone and open connector standards, such as SOAP, WSDL, and UDDI (Anthony, 2010).

6.1.2.1 Oracle e-business suite adapter- integration methodology

According to Chauhan (2009) most of IT applications cannot perform the integration actions due to the lack of Web Services support. Besides, most of these kinds of applications are not metadata-based which makes the integration even harder. In this kind of systems, application integration is hard, time consuming, and costly. An

Adapter addresses these challenges and provides real-time, bi-directional, and comprehensive connectivity to various backend applications.

The Adapters are metadata-driven and can be integrated with one or more integration interfaces. They provide standard data format, such as XML.

Oracle Fusion Middleware provides standard solutions for enterprise integration based on SOA principles. The Oracle E-business Suite Adapter is a part of Oracle Fusion Middleware stack, which is a service provider for Oracle E-business Suite to enable integration through extended enterprise.

Oracle E-Business Suite Adapter is based on a set of standards, such as JCA, XML, WSIF (Web Service Invocation Framework), WSIL (Web Service Inspection Language), and WSDL. According to Chauhan (2009), the support for standards facilitates interoperability and eliminates vendor lock-in. Figure 26 illustrates how Oracle E-business Suite Adapter provides connection between Oracle SOA Suite and Oracle E-business Suite.

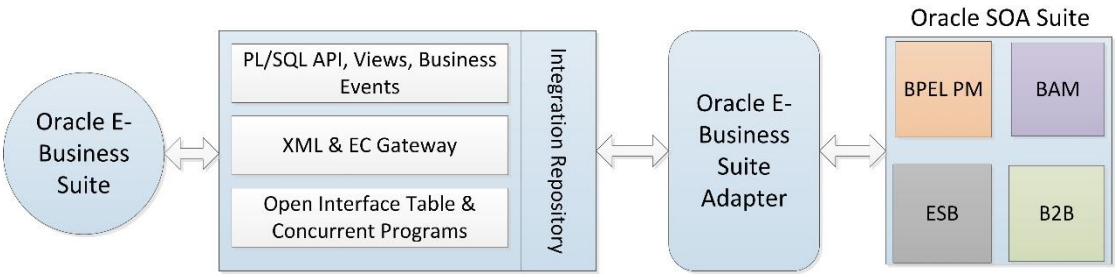

Figure 26 Oracle E-business Suite Adapter (Chauhan, 2009)

6.1.3 Oracle fusion middleware

Oracle Fusion Middleware application is supported by Oracle E-business Suite. Some of the Oracle Fusion Middleware products are Oracle Access Manager, Oracle Internet Directory, WebCenter, SOA Suite, and BPEL (Business Process Execution Language). According to manufacturer (Oracle, 2010), Oracle Fusion Middleware is one of the best's application infrastructure foundations; it benefits enterprises by providing agile and intelligent business applications and bring efficiency by applying modern hardware and software architectures, reliability, and performance at any scale.

Through Fusion Middleware components, Oracle E-business Suite users are able to:

- Provide integrity with other applications and third-party's applications via SOA.
- Extend the E-business suite with Oracle JDeveloper.
- Provide better security through Oracle Identity Management.
- Establish enterprise portals and create applications with Oracle WebCenter.
- Manage enterprise information via Oracle Content Management.
- Manage environment with Oracle Enterprise Management.

6.2 IBM solution

IBM (International Business Machines) is a multinational technology and consulting cooperation. IBM also addresses software, hardware, and infrastructure problems. In this respect, IBM provides several solutions to solve the integration problems of businesses (Forlenza & Cavallero, 2003). IBM recognized Business Integration and Technology Integration as the most critical areas in integration field and paid a significant attention to these areas.

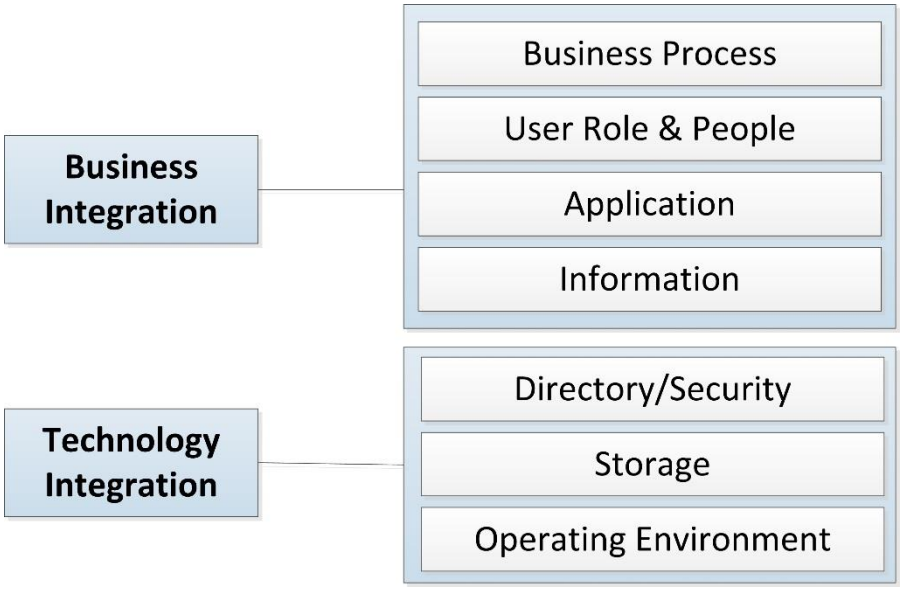

Figure 27 IBM integration levels (Forlenza & Cavallero, 2003)

As it can be seen in Figure 27, IBM classification of integration as mentioned previously is Business Integration and Technology Integration. Business Integration is the unification of business processes, user roles and people, application, and

information. Technology Integration is the integration of directory storage, and environment.

6.2.1 IBM middleware

According to Forlenza & Cavallero (2003), IBM has provided the most comprehensive set of technologies and products offering in the industry. Four IBM software which are, forms the backbone of e-business infrastructure are IBM WebSphere, IBM DB2, IBM Lotus, and IBM Tivoli. Through IBM integration solutions, all the business processes from customer's demand to deliver goods and services are integrated across value chain. Commonly, businesses use various platforms, and IBM middleware provides a broad range of platforms in the industry.

The four main business integration levels and technologies according to IBM are as follow:

- Information Integration (IBM DB2 and IBM Data management Software)
- Application Integration (IBM WebSphere platform)
- User Role and People Integration (IBM WebSpher Portal)
- Business Process Integration (IBM WebSpher Business Integration)

6.2.2 Integration services

IBM Application Framework has identified approaches for e-business. These approaches are presented in order to increase isolation from the underlying integration technologies and their ability to support higher levels of abstraction. Figure 28, indicates application integration approaches (Naick, et al., 2000).

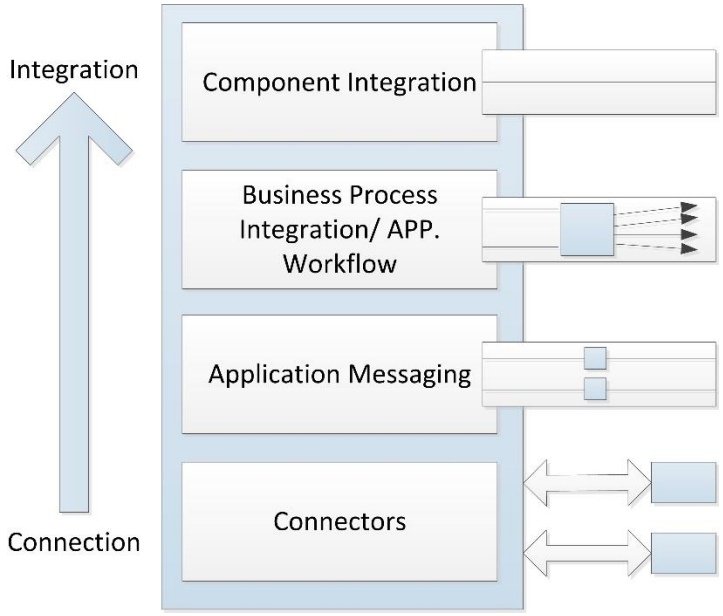

Figure 28 Application integration approaches (Naick, et al., 2000)

In the above figure, Connectors work as gateways which connect Web application server to the services via application protocols. Application Messaging provides message-based communication services with delivery assurance. Business Process Integration and Workflow services extend the base messaging services with message brokering, intelligent message routing, and message translation. Component Integration services provide existing application logic to extend to object-oriented environment (Naick, et al., 2000).

6.2.3 MQSeries and MQSeries integrator

MQSeries is the base of IBM business integration approaches (Naick, et al., 2000). Due to support of MQSeries from more than 30 different platforms using different communication protocols, most of the industry platforms can be connected. MQSeries is the messaging standard of more than 5000 customer sites.

MQI (Message Queue Interface) and JMS are the different application programming interfaces, and point-to-point and publish/subscribe are the communication models which are supported by MQSeries. Lotus Domino, Microsoft Exchange, SAP/R3, CICS (Customer Information Control System), and IMS (Integrated Management Systems) are the different products which MQSeries provide them with numbers of connectors and gateways.

Adding message broker capability, MQSeries Integrator extends the messaging capabilities of MQSeries. MQSeries Integrator provides direction and transformation of messages, message filtering, database capabilities, and functionality extension through plugins (Naick, et al., 2000).

MQSeries Workflow is another component of IBM to integrate business. It is not just about application integration but also about all business process resources integration. Workflow is on MQSeries messaging technology. Figure 29 illustrates the MQSeries technologies for business integration.

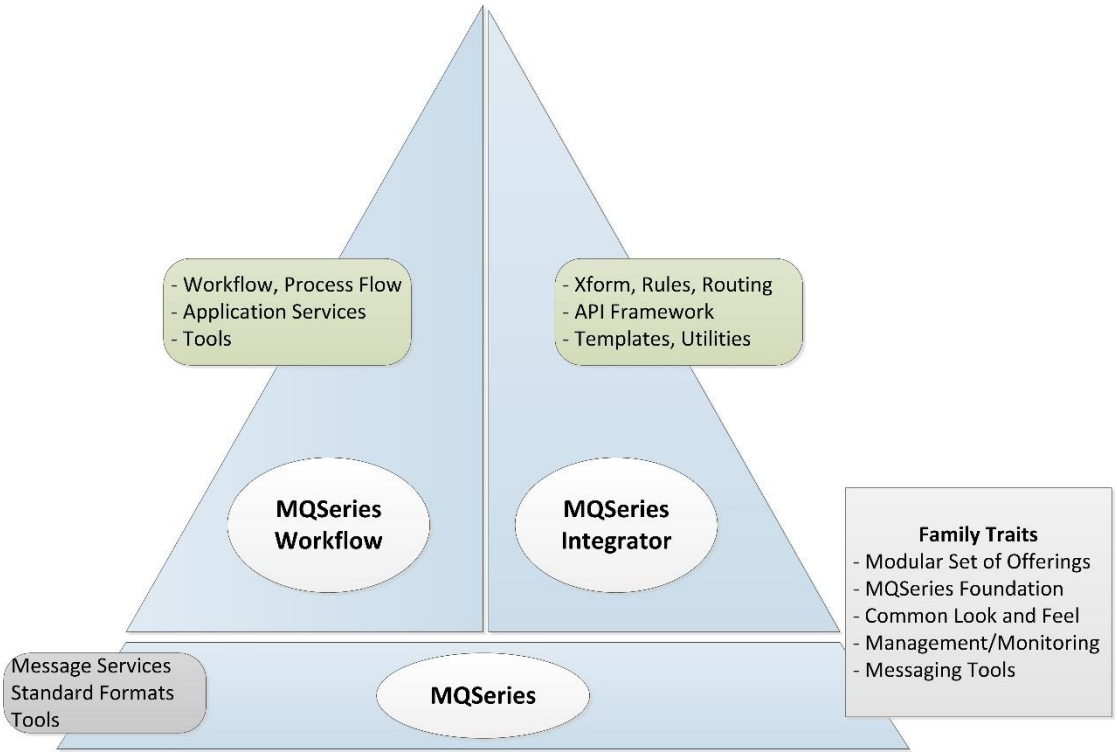

Figure 29 The MQSeries family for business integration (Naick, et al., 2000)

MQSeries products provide programs with dissimilar components in a network to communicate with each other. The API is constant in MQSeries programs. Figure 30 illustrates the run time view of MQSeries.

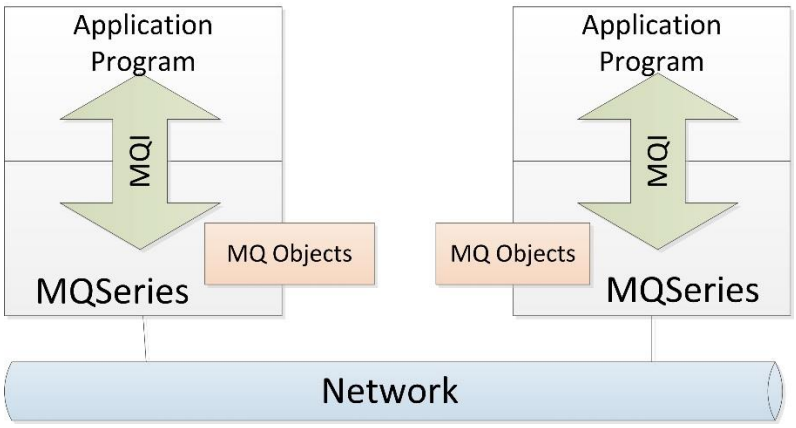

Figure 30 MQSeries at runtime (Naick, et al., 2000)

The runtime program of MQSeries is a queue manager (MQM), and the programs use MQSeries API calls, which is the Message Queue Interface (MQI) to communicate with MQM. Queue manager refers to queues and channels to do its work (Naick, et al., 2000).

6.2.4 WebSphere application server

To build a dynamic and flexible platform, organizations should be able to integrate and operate the both new and existing applications and systems in the enterprise (Reser, 2002). IBM WebSphere Application Server and IBM WebSphere studio tools integrate applications based on J2EE and Web Services. WebSphere use a single repository for metadata and a unique way of handling and transforming data.

IBM WebSphere Application Server provides continued services for transmission in both synchronous and asynchronous environment. For queue management and publish/subscribe components, JMS is included in IBM WebSphere Application Server.

IBM WebSphere Application Server also utilized process management which provides model of application interaction based on business process. According to Reser (2002), WebSphere Application Server provides dynamic e-business by facilitating the access to the information demanded by business model.

WebSphere Application Server provides a visual environment to create adapters to integrate with other applications in complex schemas. The JCA supports the

connection and communication with various enterprise systems and applications. These communications and data aggregations are based on XML and Web Services.

The JCA defines the WebSphere Application Server functions and which vendors such as IBM, SAP, PeopleSoft, Siebel, Oracle, and third-party connector developers can plug into the J2EE. Refer to Figure 17 in chapter 5.

6.3 Microsoft solution

Microsoft as a multinational software cooperation that develop wide range of products and services, addressed integration requirements with four technologies (Sikander & Sarma, 2010):

- BizTalk Server
- Windows Communication Foundation (WCF)
- Windows Workflow Foundation (WF)
- SQL Server Integration Services (SSIS)

As it is illustrated in Figure 31, Microsoft technologies provide a platform for EC and digital marketing system architecture. According to manufacturer, the infrastructure component can address specific needs due to the modularity and extensibility, and can be built at different scales of functionality and performance. Applying this platform various business requirements can be provided. It addresses the needs of someone who wants to start a small-scale Web presence and it might grow in the future.

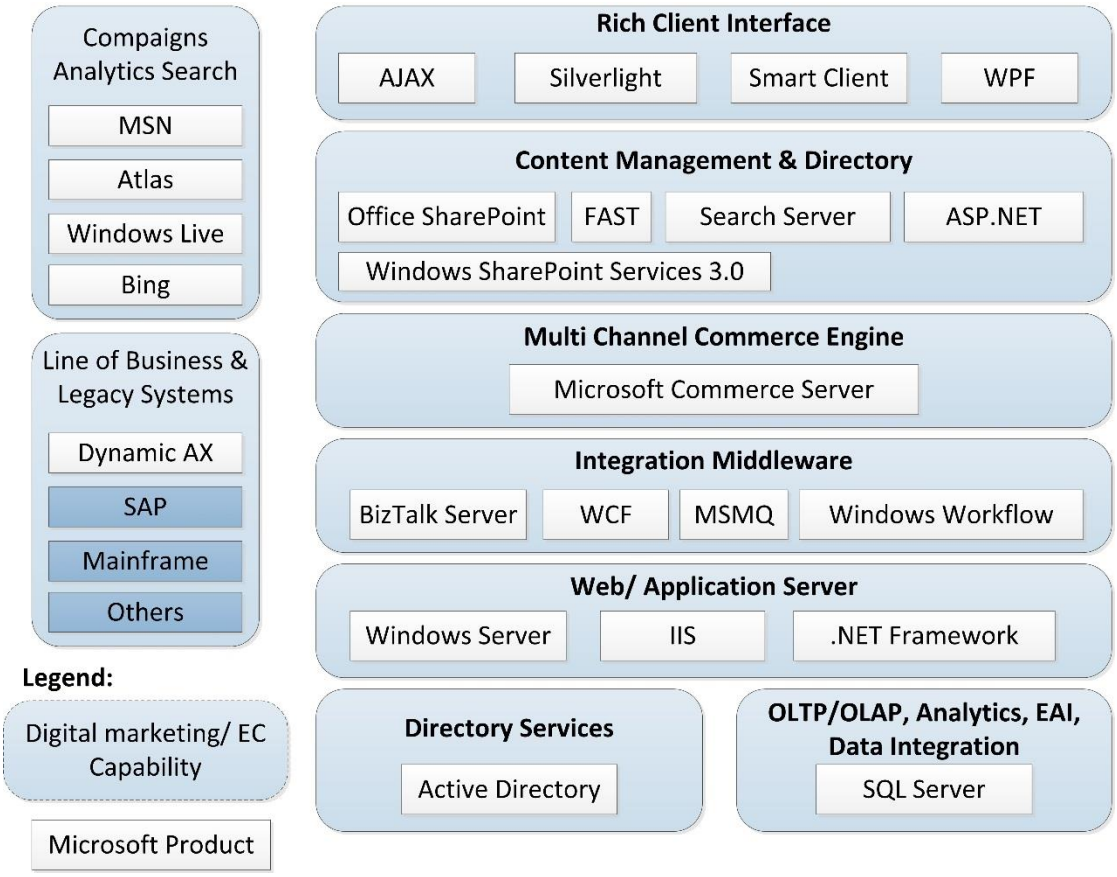

Figure 31 Microsoft platform for EC and digital marketing (Sikander & Sarma, 2010)

6.3.1 Microsoft's commerce server

Microsoft Commerce Server provides a collection of EC functionalities to manage catalogs, users, orders, campaigns, and service integration. Integration of Commerce Server and SharePoint Services provide ready to use EC Web parts and ability to manage contents. Figure 32, illustrates these capabilities, which are multi-channel commerce foundation, sub system integration, business management, content management, share point commerce services, multi-channel experience, data warehouse and analytics, and marketing (Sikander & Sarma, 2010).

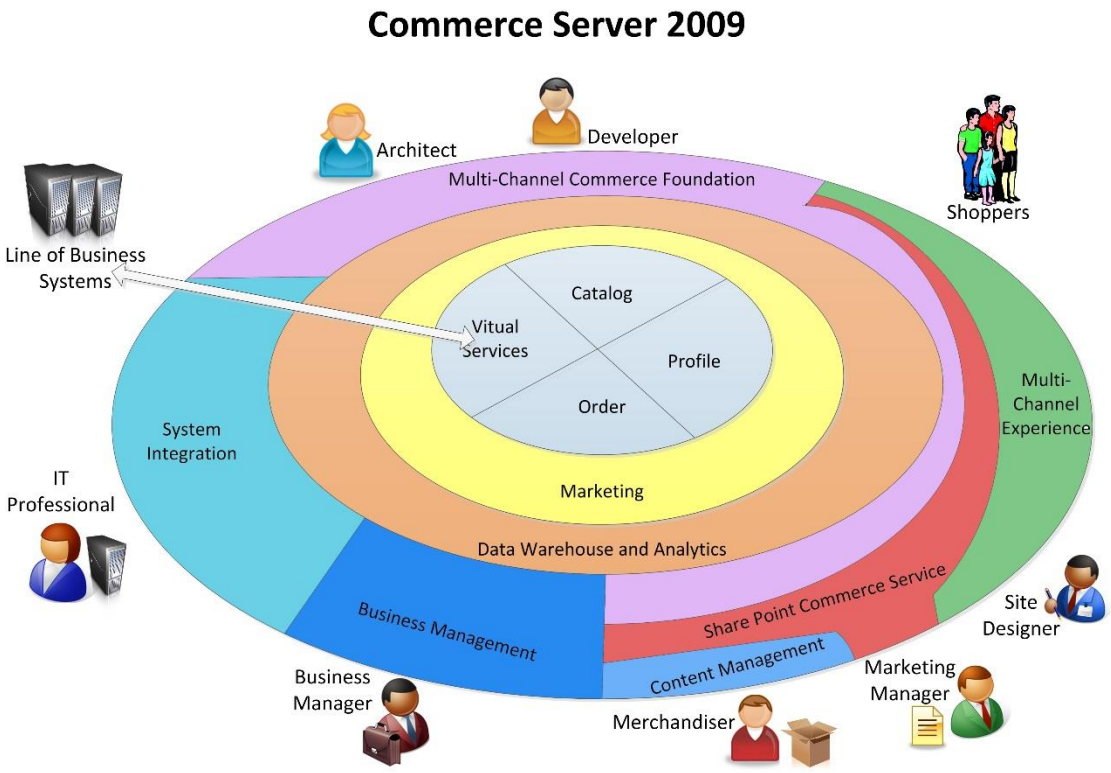

Figure 32 Commerce server capabilities (Sikander & Sarma, 2010)

6.3.1.1 System architecture

A conceptual view of an EC system based on Microsoft Commerce Server is illustrated in Figure 33.

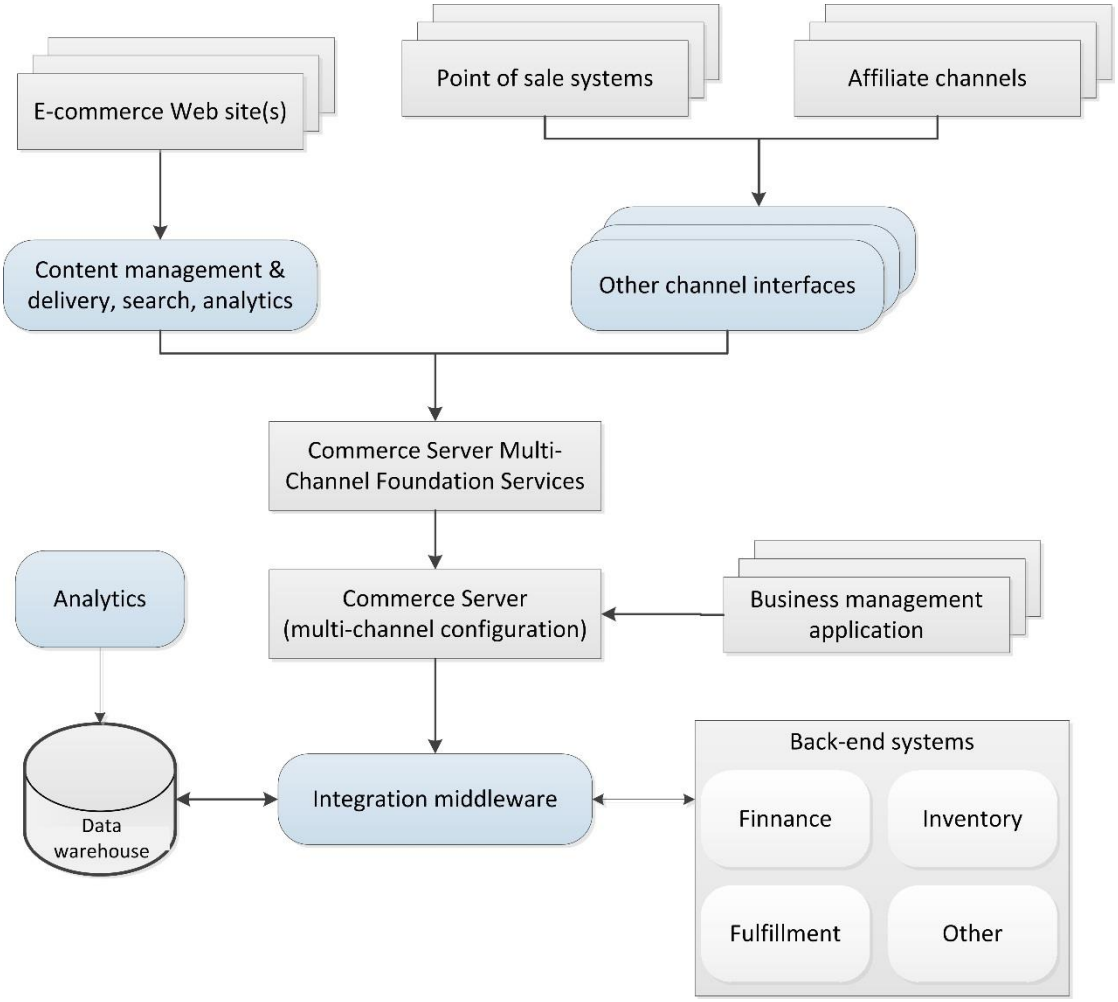

Figure 33 A conceptual view of EC system based on Microsoft Commerce Server (Sikander & Sarma, 2010)

In this system Content Management and Delivery, is in charge of delivering digital substances in B2B and B2C environment. Multimedia Channel Interface represents the other channels of delivering contents in EC, such as retail channel systems, affiliate systems, and partner interfaces. Multi-Channel Foundation Services, provide context services based on the context specify processing and transactions channel. Heart of Commerce Server represents by Commerce Engine which supply management, repository, and run-time capabilities for the core EC areas, such as product catalogs, user profiles, orders, and marketing campaigns. By enabling a user interface, Business Management Applications, manage and configure roles and functionalities within the commerce engine. Integration Middleware provides an abstraction layer between core EC system and other business systems from legacy to service-oriented integration systems. Data Warehouse is responsible for collecting data related to products, transactions, users, and campaigns from multi sources. Using

the data collected in the data warehouse, Data Analytics system provides different analytical reports. Web analysis provides analytical reports from data colleting from users who are browsing on the Web site. Search, in the part of EC system is a key success in online businesses in which customer can look for a specific product. Backend Systems are the core of the enterprise that act as repositories for data, as well as provide functionality, such as inventory management, order fulfillment, and payment processing and EC systems should connect to these backend systems via interfaces (Sikander & Sarma, 2010).

6.3.1.2 Commerce server full framework solution

Figure 34 shows a solution for EC based on Microsoft Commerce Server 2009. In this framework, Commerce Server 2009 is responsible for commerce engine and management specifications. For managing contents and searching features Microsoft Office SharePoint Services 2007 is employed and for integration with backend systems BizTalk is used.

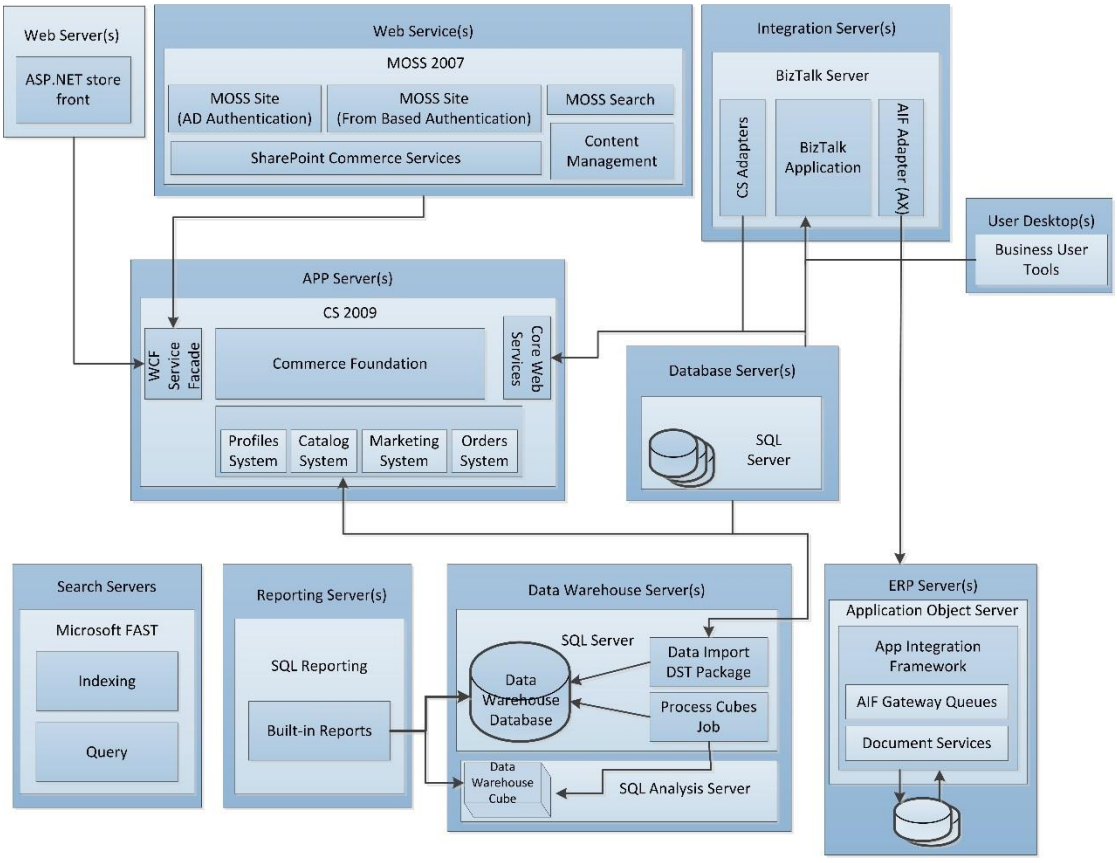

Figure 34 EC full framework solution based on Microsoft's technologies (Sikander & Sarma, 2010)

In this framework, Content Management is provided through Microsoft Office SharePoint Services, Web Site Deployment through a standard SharePoint deployment model, Web Commerce Functionality through SharePoint Commerce Services, Search through Office SharePoint Services and Microsoft FAST ESP, Product and Campaign Management through SharePoint Commerce Services, Integration through Line-of-Business, and Legacy Systems through BizTalk Server (Sikander & Sarma, 2010).

Scalability, reliability, and stability are core requirements in a digital Web and EC system. Many organizations and IT developers consider these features when they choose a platform. An extensible and scalable Web rendering engine that can support modern programming and transaction paradigms at both the server and client ends of Web experience is required. Core quality parameters, such as transactions, secure communications, session management, caching, and large scale concurrent access should be supported by the platform's Web framework. These set of capability in the Microsoft technology stack is provided by a combination of the Windows IIS (Internet Information Services) and ASP.NET services (Sikander & Sarma, 2010).

6.3.2 Microsoft BizTalk server

When it comes to transactional and EC systems deployment, integration appears as a key solution scope. Microsoft BizTalk Server enables several patterns for integration architecture. BizTalk Server provides solutions for message definition, transformation, exchange, and monitoring, and for deploying an enterprise-level integration system, including hub and spoke systems, middleware, and ESB, it provides core components and a scalable framework (Sikander & Sarma, 2010).

Due to the addressing the integration problems with backend systems that manage inventory, fulfillment, finance, and other areas, BizTalk features play a major role in EC systems.

Using business process management, BizTalk Server integrates systems, employees, and trading partners. Current versions of Microsoft BizTalk server is based on Microsoft Windows Server System integrated server software and Microsoft .NET Framework, which means it is possible to connect divers application and manipulate

business processes via a graphical user interface. BizTalk Server provides the integration of internal applications and business partner's applications via Internet.

According to manufacturer, Microsoft BizTalk Server fulfills the ambition of unifying separate applications through business processes into a homogeneous whole (Microsoft, 2004). BizTalk Server is built on .NET Framework and Microsoft Visual Studio .NET and support communications through Web Services.

Traditionally, the BizTalk Server application was connecting applications within a single organization or EAI and Connecting applications in different organizations or B2B integration.

Figure 35 shows the BizTalk Server solution for addressing EAI problem.

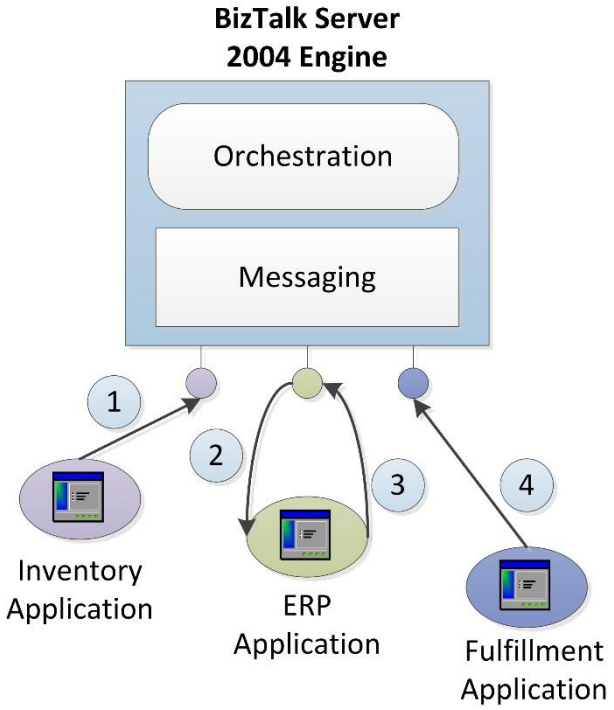

Figure 35 BizTalk Server used for EAI (Microsoft, 2004)

In this scenario, an inventory application, perhaps running on an IBM mainframe, notices that the stock of an item is low and issues a request to order more of that item. The following steps occur:

1. The request is sent to a BizTalk Server 2004 application.

2. The BizTalk Server 2004 application requests a purchase order (PO) from the Enterprise Resource Planning (ERP) application for the organization.

3. The ERP application, which might be running on a UNIX system, sends back the requested PO.

4. The BizTalk Server 2004 application informs a fulfillment application, perhaps built on Microsoft Windows by using the .NET Framework, that the item should be ordered.

Although connecting intra-enterprise applications is crucial but, sometimes connecting inter-enterprise applications bring even more value. Figure 36 illustrates a B2B integration scenario based in BizTalk Server.

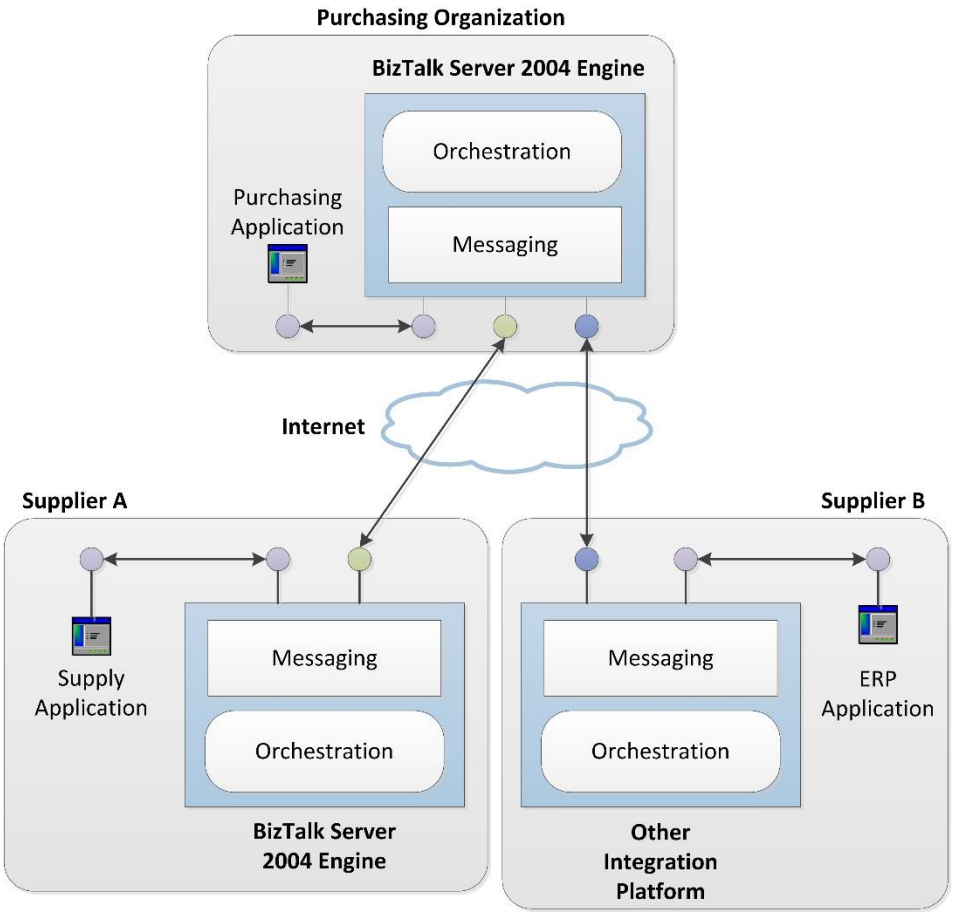

Figure 36 BizTalk Server used for B2B (Microsoft, 2004)

The applications are connected as follows:

- The purchasing organization at the top of the figure runs a BizTalk Server 2004 application that interacts with two supplier organizations.
- Supplier A also uses BizTalk Server 2004, providing indirect access to its Supply application.
- Supplier B uses an integration platform from another vendor, connecting to the BizTalk Server 2004 application for the purchasing organization by using, say, Web Services. Supplier B is executing the same business process as the others, and so it may have been sent a BPEL definition of that process by the purchasing organization, which exported this definition from BizTalk Server 2004.

6.3.3 Windows communication foundation

According to manufacturer, WCF (Windows Communication Foundation) is designed to offer a manageable approach to distributed computing, broad interoperability, and direct support for service orientation (Microsoft, 2011). It originally tagged with the code name "Indigo", which is a programming framework used to build applications that inter-communicate, and it is one of the SOA technologies. By employing new service-oriented programming model, WCF handle different development styles of distributed application. WCF is a framework to integrate business services from Microsoft Server. WCF provides data exchange transaction based on asynchronous and untyped message-passing architecture.

According to manufacturer, in this architecture, service model provides application development and distribution simple and provides developers with expertise in ASP.NET Web Services, .NET Framework remoting, and Enterprise Services. Figure 37, illustrates the major layer of WCF architecture.

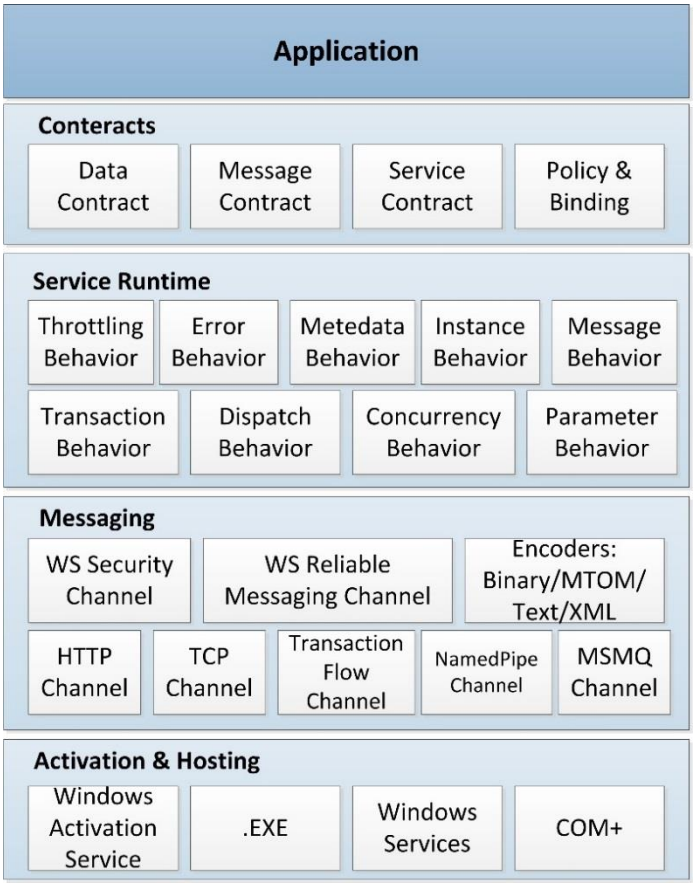

Figure 37 WCF architecture (Microsoft, 2013)

In this architecture, Contents describe different dimensions of message system, Service Runtime layer, define the runtime behavior of the service, Messaging layer is consist of channels to operate on messages and message headers, and Hosting and Activation in which the services are programs that can be hosted or executed and managed by an external agent (Microsoft, 2013).

6.4 SAP solution

SAP is the world's largest business software company. In this section the provided solutions for EC and ERP integration by SAP are discussed. SAP NetWeaver provides a platform to execute business applications. SAP Business Suite as business solution applications runs on top of the SAP NetWeaver platform (Mereddy, 2011).

6.4.1 SAP NetWeaver

SAP NetWeaver, is an open integration and application platform. SAP NetWeaver, works as a foundation for SOA due to its Web-based nature. It provides an

infrastructure which supply a central platform for both SAP and non-SAP vendors (SAP HANA, 2013).

SAP NetWeaver is a middleware solution which coordinates employees, information, and business processes. As it is shown in Figure 38 SAP NetWeaver different parts, SAP WebAS (Web Application Server) center has embraced people integration, information integration, and process integration capabilities of NetWeaver. SAP WebAS is used for building and running applications. SAP CAF (Composite Application Framework) creates new applications by combining pieces of existing applications. Lifecycle Management works as a set of utilities which facilitate the process of installing software, running it, upgrading it, and fixing bugs. SAP WebAS and SAP CAF are placed on the right and left side of the figure to indicate the importance of their role in SAP NetWeaver.

To enable and manage changes, SAP NetWeaver works with existing IT infrastructure of the company. With SAP NetWeaver, design, build, implement, and execute new business strategies and processes are facilitate. NetWeaver platform is an industry standard and can be extended with commonly used development tools such as Java 2 Platform, Enterprise Edition (J2EE), Microsoft .NET, and IBM WebSphere.

According to manufacturer, SAP NetWeaver AS (Application Server), develops dynamic cross-company business applications. It provides the structure to bring business applications and Internet together. SAP NetWeaver AS supports determinate standards, such as HTTP(S), SMTP, HTML, SOAP, and XML (Kappauf, et al., 2011).

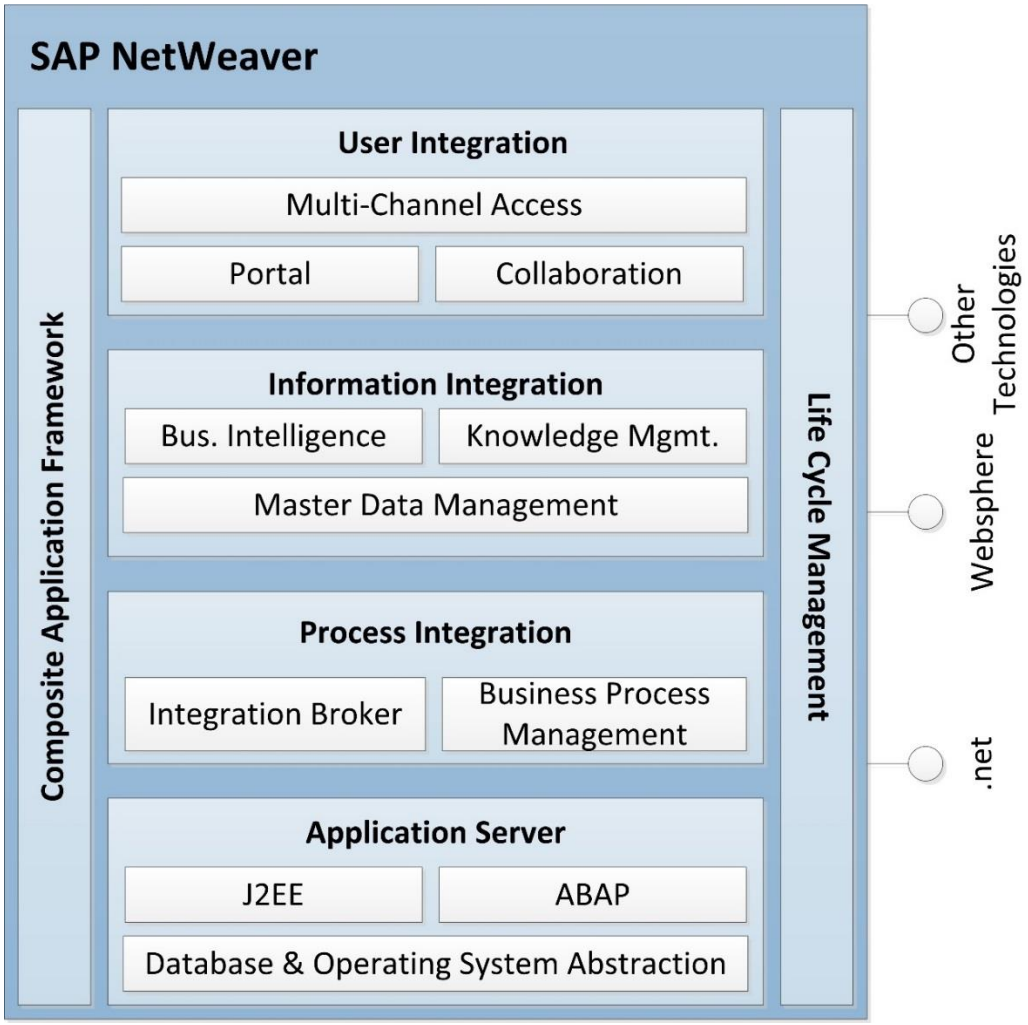

Figure 38 Functional view of SAP NetWeaver (Kappauf, et al., 2011)

SAP NetWeaver AS, with two stacks of J2EE and ABAP (Advanced Business Application Programming), along with database and operating system abstraction, provides a platform for the technical operation of the applications.

SAP NetWeaver PI (Process Integration), applies integration broker to facilitate individual applications integration as well as other external business partners' systems. The business process management component, indicates the integrated unit for complex business processes and communication procedures (Kappauf, et al., 2011).

Information integration is provided through SAP NetWeaver MDM (Master Data Management), which ensures consistently distribution of master data in an application and guarantee the uniform quality of the distributed data. Knowledge management

provides the evaluation of unstructured information from different data sources, with the help of central, role-specific access points.

SAP NetWeaver BW (Business Warehouse), serves as the data performance center gathered from all SAP applications and resources which can be used for statistical assessments.

User integration provides a central access point to the users of application components from various applications.

The supported standards on each layers of SAP NetWeaver are as follow:

- Application server: HTTP, XML, SMTP, J2EE, WSDL, SOAP, UDDI, XSLT
- Process integration: BPEL, CIDX, RosettaNet, CPPA
- Information integration: ICE, WebDAV, XML/A, JMI, XMI, CWM, ODBO
- User integration: JAAS, WSRP, Personal Java

From technical point of view, SAP NetWeaver can be illustrated as Figure 39. To harmonize the application server operation, SAP NetWeaver which is linked with the respective operating system, embraces a kernel similar to an operating system (Kappauf, et al., 2011).

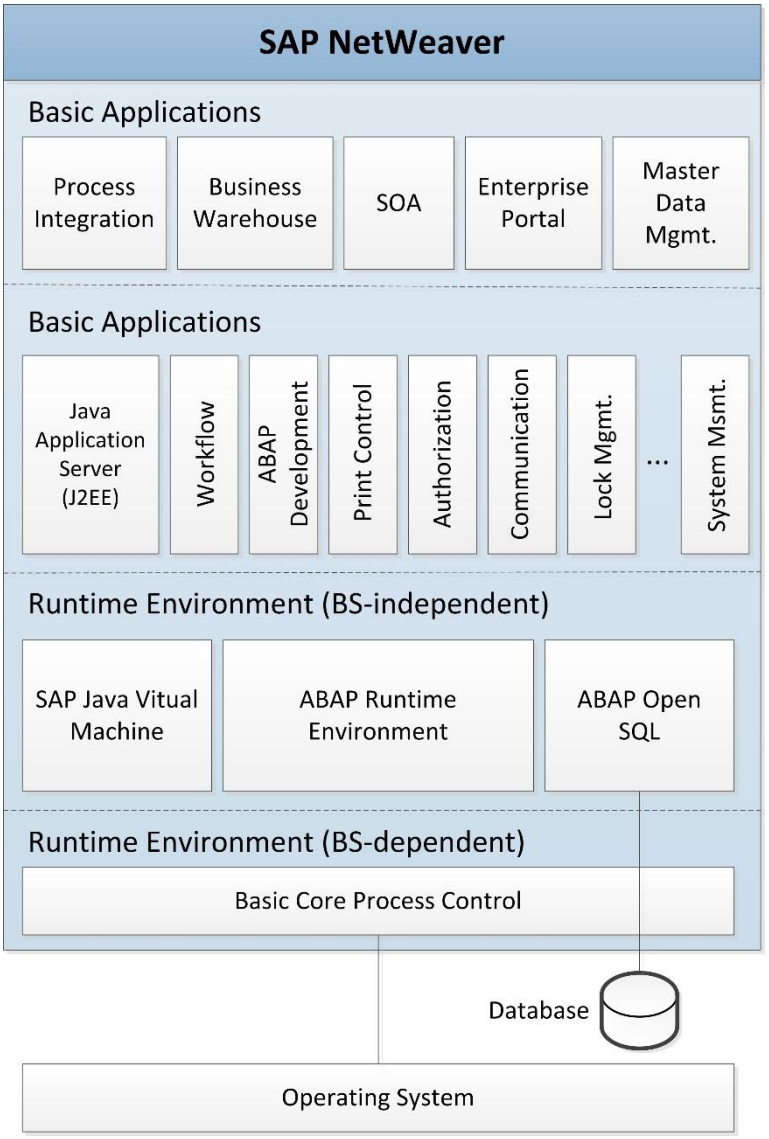

Figure 39 SAP NetWeaver technical view (Kappauf, et al., 2011)

ABAP and Java runtime environments provide a common platform for almost all the SAP applications that can be run in a homogeneous environment. ABAP, which is the SAP's programming language, initially is used as a reporting language like COBOL. During time, ABAP developed to be an object-oriented programming tool to develop business process applications (Kappauf, et al., 2011).

6.4.2 SAP business suite

According to SAP (2013), SAP Business Suite is a comprehensive family of applications designed to work together to help business performance. It provides fully integrated business software to support core business operations with market-leading applications, processes, and technologies.

SAP Business Suite performs end-to-end business processes with modular applications that are designed to work together. It also provides a technology environment to design, compose, and adapt business processes to address specific industry requirements and processes of industry (SAP, 2009). According to manufacturer (SAP, 2009) SAP Business Suite is supports SOA, to give greater flexibility to organizations in a wide range of industries.

As it is illustrated in Figure 40, SAP Business Suite consists of five core applications. The core applications are SAP ERP, SAP CRM, SAP SRM (Supplier Relationship Management), SAP SCM, and SAP PLM (Product Lifecycle Management). They support processes for finance, human resources, manufacturing, procurement, product development, marketing, sales, service, supply chain management, asset management, and IT management (SAP, 2009).

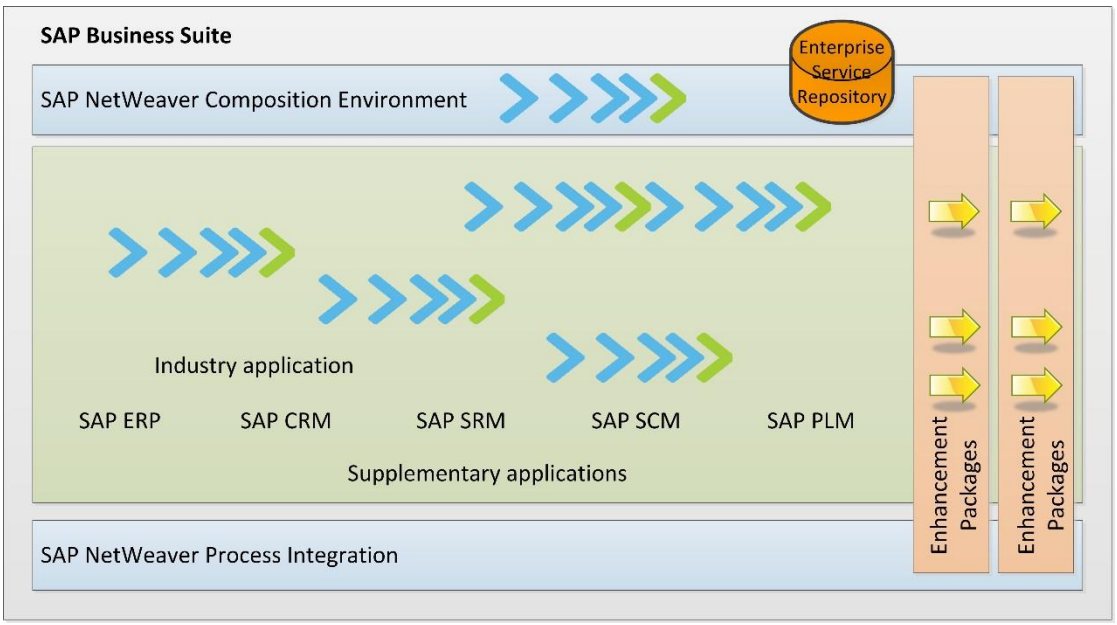

Figure 40 SAP business suite

Based on Kappauf, et al. (2011) business applications of SAP Business Suite are designed based on SAP NetWeaver to provide a solution for the entire company's standardized business processes. In general, complex business processes span several components of SAP Business Suite.

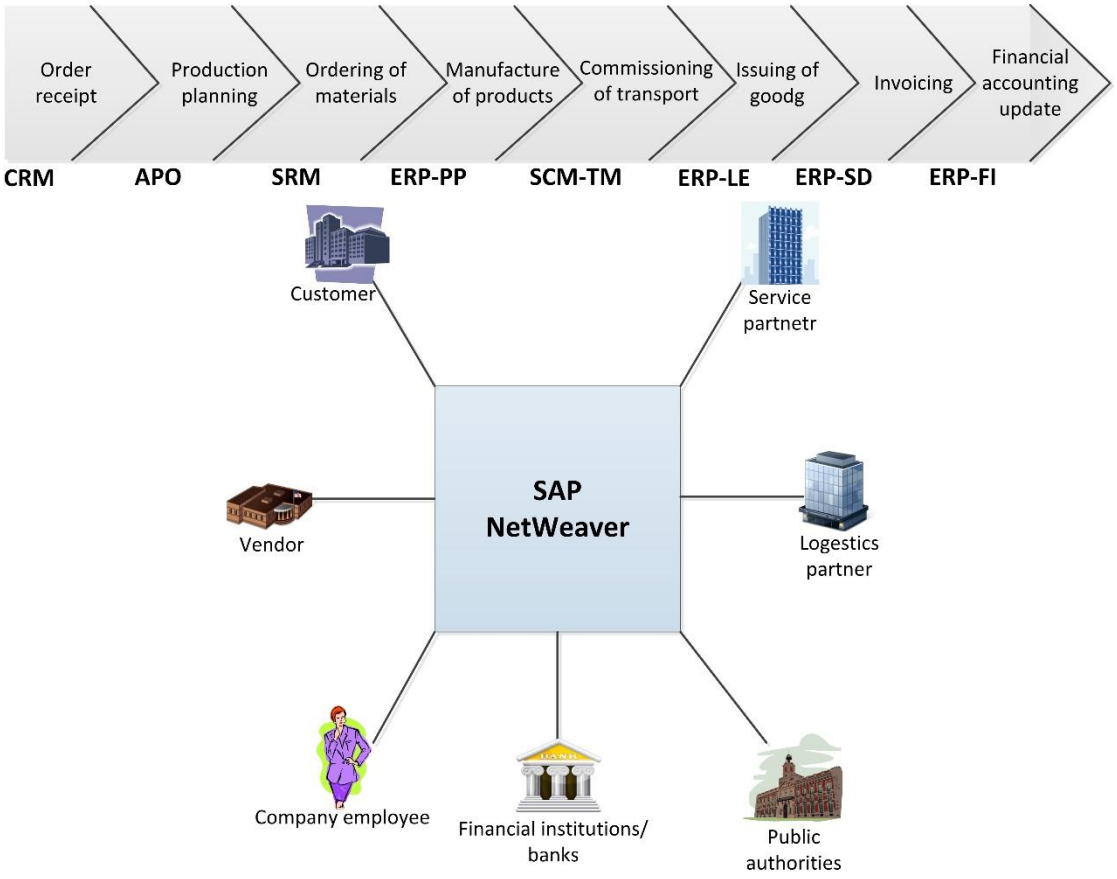

Figure 41 Business process in SAP business suite (Kappauf, et al., 2011)

Figure 41, illustrates an example of make-to-order business process in SAP Business Suite. SAP ERP consists of the components FI (Finance), CO (Controlling), MM (Materials Management), SD (Sales and Distribution), LES (Logistics Execution System), LO (Logistics), PP (Production Planning), and HCM (Human Capital Management). These components generally sketch the main functionality utilized by users (Kappauf, et al., 2011).

6.5 Summary

Giant software vendors, such as IBM, Oracle, Microsoft, and SAP provide various products to solve the enterprises integration difficulties. Each of these software solutions has a specific platform and technologies, but most of them are compatible with other platforms. For example, SAP NetWeaver as a middleware solution supports IBM, Microsoft, and many other platforms and can be integrated with their systems.

EC as a way of gaining competitive advantage can bring value to an enterprise. Therefore, not only large enterprises but also SMEs try to integrate and adopt their internal systems with EC system to automate business processes.

Collaborate tightly with business partners as considered as a valuable advantage for enterprises. Therefore, the integration of EC and enterprise systems is vital for organizations in order to have seamless inter and intra-organizational flow of products and transactions.

In this section, three Oracle's products were introduced in order to integrate EC and enterprise systems, these products are Oracle AIA, Oracle E-business Suite, and Oracle Fusion Middleware. Through IBM integration solutions, all the business processes from customer's demand to deliver goods and services are integrated across value chain. MQSeries and WebSphere application server are the two IBM products which were discussed in order to integrate EC and enterprise systems. Microsoft solutions, such as Commerce Server, BizTalk Server, and Windows Communication Foundation are the Microsoft's products that were explained earlier in this section. SAP NetWeaver and Business Suite are the two SAP's products that were investigated in this section.

Table 10 compares these products from different aspects.

Table 10 Products comparison

Company	Product	Integration Technology	Integration level	Platform	Description
Oracle	AIA	SOA, EBO, EBS	Application	Fusion Middleware	provides connection between applications and business partners
	E-business suite	EDI, XML, Web Services	Application Data	Application Server	manages customer interactions, deliver services, manufacture products, ship orders, and collect payments
	E-business Suite Adapter	SOA JCA XML Web Services	Application Data	Fusion Middleware	service provider for Oracle E-business Suite to enable a seamless integration through extended enterprise
	Fusion Middleware	RosettaNet EDI SOA	Process Application Data	Oracle E-business Suite	pace implementation and reduce costs of management and change
IBM	MQSeries	JMS MQI MQM	Application	Supports more than 30 platforms	provides programs with dissimilar components in a network to communicate with each other
	WebSphere	Web Services JMS JCA XML	Application Data	Java platform Enterprise Edition specification	provides a visual environment to create adapters to integrate with other applications in complex schemas
Microsoft	Commerce Server	Web Servers COM EAI	Application	SharePoint BizTalk Server ISS ASP.NET	provides a collection of EC functionalities to manage catalogs, users, orders, campaigns, and service integration
	BizTalk Server	ESB Web Services EAI	Application	.NET Framework Visual Studio .NET	provides solutions for message definition, transformation,

					exchange, and monitoring, and for deploying an enterprise-level integration system
	Windows Communication Foundation	SOA MSMQ XML COM	Application Data	Windows Server Windows Activation Service	offer a manageable approach to distributed computing, broad interoperability, and direct support for service orientation
SAP	NetWeaver	SOA XML JMI Web Services RosettaNet	Process Application Data	ABAP Java runtime environment	a middleware solution which coordinates employees, information, and business processes
	Business Suite	SOA Web Services XML JMI RosettaNet	Process Application Data	NetWeaver	a comprehensive family of applications designed to work together to help business performs efficiently and effectively

7 SUMMARY AND FUTURE WORKS

This thesis was based on the literature review to find out different methods, technologies, and architectures in order to integrate EC and enterprise systems. Therefore, a lot of literature was studied and the suitable integration technologies and approaches were extracted. In this study, the integration of EC and enterprise systems was investigated and studied at different layers of integration. Moreover, the adoption of EC by enterprises was discussed. Also, this thesis indicated that the integration of EC and enterprise systems can benefit the organizations technically and financially. This integration brings seamless flow of information within and across enterprises.

The benefit of this integration is not only for large enterprises, but also SMEs can gain competitive advantages by integrating EC and enterprise systems. This integration can also apply to different forms of EC, such as B2B and B2C in order to provide business advantages for the businesses.

Giachetti (2004), indicated that integration occur in four layers of physical, data, application, and process. Based on Giachetti (2004) study, network integration provides connectivity, data integration provides data sharing, application integration provides interoperability, and process integration provides coordination. Therefore, in this thesis the integration technologies of EC and enterprise systems investigated based on these layers.

Further, in this thesis EAI as one of the most popular integration techniques were studied and applied to integrate EC and enterprise systems. Integration technologies, such as Microsoft COM/DCOM, Java RMI, CORBA, .NET, J2EE, MOM, and JMS, Web Services, ESB, JBI, and JCA are discussed in detail in chapter five of this thesis. Furthermore, the mentioned technologies are categorized based on their communication style and their dependency to the platform.

Additionally, B2B integration was explained in order to form a unified business process between different organizations and individuals. RosettaNet and ebXML are the two standard integration technologies that provide common semantics for B2B EAI. These two technologies were explained in detail and compared based on their

business document, business process, managing issues, target industry, infrastructure, validation method, and process description.

In addition, in this thesis different EC integration solutions provided by Oracle, IBM, Microsoft, and SAP were discusses in detail. Most of these solutions provide integration in different layers of physical, data, application, and process. Oracle's solutions for integrating EC and enterprise systems are Oracle AIA, Oracle E-business Suite, and Oracle Fusion Middleware. IBM solutions for EC and enterprise systems integration are IBM middleware, MQSeries, and WebSphere Application Server. Microsoft's Commerce Server, Microsoft BizTalk Server, and Windows Communication Foundation are the three solutions provided by Microsoft in order to provide integration of EC and enterprise systems. As for SAP, SAP NetWeaver and SAP Business Suite are the two major solutions to integrate EC and enterprise systems. This thesis categorized these solutions and provides a comparison based on integration technologies that each solution has employed, level of integration, and its operating platform. Through this information a system integrator can decides which solution is suitable for a specific situation. Besides this thesis also indicated that, SOA, Web Services, XML, RosettaNet, JMI, JMS, .NET, and J2EE are the most common integration technologies and platforms that are used by the mentioned products.

The goal of this thesis was to provide the technical details of EC and enterprise systems integration and to gather the common and suitable solutions used for this matter. Moreover, the factors that have effects on adoption of EC by an enterprise were studied and categorized to technical, social, managerial, financial, and human resource factors. More information about EC and enterprise systems adoption factors can be found in reference section.

All in all, the necessity of integration in different levels of an organization and the undeniable role of EC for enterprises led this thesis to provide a comprehensive source for the expertise to choose the most suitable approach and product for the organization to integrate EC and enterprise systems. Almost all of the previous studies discussed enterprise application integration in general, whilst in this thesis the integration of EC

and enterprise systems studied specifically. Lack of scientific research in the specific area of EC and enterprise integration was one of the barriers of this study.

This study can be continued to identify all the integration technologies and approaches and provide a complete list of integration technologies to the integration expertise. The novelty of this research is on its focus on the EC. Moreover, process integration which is one of the layers of application integration is recognized as the ultimate level of application integration until now. The integration of EC and enterprise systems can be investigated in future based on the business process integration.

REFERENCES

Al Mosawi, A., Zhao, L. & Macaulay, L., 2006. A Model Driven Architecture for Enterprise Application Integration. Hawaii, IEEE.

Alam, S. S. & Noor, M. K. M., 2009. ICT Adoption in Small and Medium Enterprises: An emprical evidence of services sectors in Malaysia. International Journal of Business and Management, 4(2), pp. 112-125.

Alsène, É., 1999. The Computer Integration of the Enterprise. Engineering Management, 46(1), pp. 26-35.

Anthony, H., 2010. Oracle iStore: Implementation and administration guide. [Online] Available at: http://docs.oracle.com/cd/E18727_01/doc.121/e13575.pdf [Accessed 1 July 2013].

Araujo, I., 2006. Critical Success Factors for ERP Deployment. In: A. M. Tjoa, L. Xu & S. S. Chaudhry, eds. Research and Practical Issues of Enterprise Information Systems. New York: Springer, pp. 319-324.

Armstrong, E. et al., 2004. The J2EE™ 1.4 Tutorial. Santa Clara, California, USA: Sun Microsystems, Inc..

Ash, C. G. & Burn, J. M., 2003. A Strategic Framework for the Management of ERP Enabled E-business Change. European Journal of Operational Research, 146(2), pp. 374-387.

Auger, P. & Callaugher, J., 1997. Factors Affecting the Adoption of an Internet-based Sales Presence for Small Businesses. The Information Society, 13(1), pp. 55-74.

Bakos, Y., 1998. The Emerging Role of Electronic Marketplaces on the Internet. Communications of the ACM, 41(8), pp. 35-42.

Batini, C., Lenzerini, M. & Navathe, S. B., 1986. A Comparative Analysis of Methodologies for Database Schema Integration. ACM Computing Surveys, 18(4), pp. 232-364.

Beimborn, D., Joachim, N. & Schlosser, F., 2011. The Role of SOA for BPO Intention – Proposing a Research Model . In: Exploring the Grand Challenges for Next Generation E-Business. s.l.:Springer Berlin Heidelberg, pp. 122-136.

Berbner, R., Grollius, T., Repp, N. & Hechmann, O., 2005. An approach for the Management of Service-oriented Architecture (SoA) based Application Systems. EMISA, pp. 208-221.

Bernard, S. A., 2012. Introduction to Enterprise Architecture. 3rd ed. s.l.:AuthorHouse.

Bernstein, P. A., 1996. Middleware: A model for distributed system services. Communications of the ACM, 39(2), pp. 86-98.

Bernus, P., Nemes, L. & Williams, T. J., 1996. Architectures for Enterprise Integration. Great Britain: Chapman & Hall.

Bidgoli, H., 2002. Electronic Commerce: Principles and Practice. San Diego: Academic Press.

Bih, J., 2006. Service Oriented Architecture (SOA) A New Paradigm to Implement Dynamic E-business Solutions, New York, USA: ACM.

Blair, G. S., Coulson, G., Robin, P. & Papathomas, M., 2009. An Architecture For Next Generation Middleware. s.l., Springer-Verlag, pp. 191-206.

Boeck, H., Bendavid, Y. & Lefebvre, E., 2009. Evolving B2B E-commerce Adoption for SME Suppliers. Journal of Business & Industrial Marketing, 24(8), pp. 561-574.

Boh, W. F., Soh, C. & Yeo, S., 2007. Standards Development and Diffusion: A case study of RosettaNet. Communication of the ACM, 50(12), pp. 57-62.

Bosch, J. & Bosch-Sijtsema, P., 2010. From Integration to Composition: On the impact of software product lines, global development and ecosystems. Journal of Systems and Software, 83(1), pp. 67-76.

Brodie, M. L., 2006. Integration in A Service-Oriented World: The Big Picture. s.l., s.n.

Brown, L., 2000. Integration Models: Templates for business transformation. IN,USA: SAMS.

Bruque, S. & Moyano, J., 2007. Organisational Determinants of Information Technology Adoption and Implementation in SMEs: The case of family and cooperative firms. Technovation, 27(5), pp. 241-253.

Bullinger, H. J., Faehnrich, K. P. & Linsamaier, T., 1998. Conceptual Approach for an Architecture of Distributed Objects for the Integration of Heterogeneous Data Process Systems in Manufacturing Companies. International Journal of Production Research, 36(11), pp. 2997-3011.

Bussler, C., 2003. B2B Integration: Concepts and architecture. Berlin Heidelberg: Springer.

Bussler, C., 2003. B2B Integration: Concepts and Architecture. Berlin, Heidelburg: Springer.

Bytheway, A. J. & Dhillon, G., 1996. Significance of Partnerships in the Management of Interorganisational Systems. International Journal of Information Management, 16(5), pp. 369-380.

Cagliano, R., Caniato, F. & Spina, G., 2003. E-business Strategy: How comapnies are shaping their supply chain through the internet. International Journal of Operations & Production Management, 23(10), pp. 1142-1162.

Caldeira, M. M. & Ward, J. M., 2003. Using Resource-based Theory to Interpret the Successful Adoption and Use of Information Systems and Technology in

Manufacturing Small and Medium-sized Enterprises. European Journal of Information Systems, 12(2), pp. 127-141.

Calì, A., Calvanese, D., De Giacomo, G. & Lenzerini, M., 2013. Data Integration under Integrity Constraints. In: Seminal Contributions to Information Systems Engineering. Berlin Heidelberg: Springer-Verlag Berlin Heidelberg, pp. 335-352.

Camarinha-Matos, L. M. & Pantoja-Lima, C., 2001. Cooperation Coordination in Virtual Enterprises. Journal of Intelligent Manufacturing, 12(2), pp. 133-150.

Chalmeta, R., Campos, C. & Grangel, R., 2001. Reference Architectures for Interprise Integration. Journal of Systems and Software , 57(3), pp. 175-191.

Chan, C. & Swatman, P. M., 2000. From EDI to Internet Commerce: The BHP Steel Experience. Internat Research, 10(1), pp. 72-83.

Chang, M. K. & Cheung, W., 2001. Determinants of the Intention to Use Internet/WWW at Work: A confirmatory study. Information & Management, 39(1), pp. 1-14.

Chan, Y. E., Huff, S. L. & Copeland, D. G., 1997. Assessing Realized Information Systems Strategy. Journal of Strategic Information Systems, 6(4), pp. 273-298.

Chapman, C. S. & Kihn, L.-A., 2009. Informtaion System Integration, Enabling Control and Performance. Accounting, Organiations and Society, 34(2), pp. 151-169.

Chappell, D. A., 2009. Enterprise Service Bus. s.l.:O'Reilly Media, Inc..

Chappell, D. & Jewell, T., 2002. Java Web Services. 1st ed. s.l.:O'Reilly.

Chauhan, N., 2009. Oracle E-Business Suite Adapter: Integration methodology, s.l.: Oracle.

Chau, P. Y., 1995. Factors Used in the Selection of Packaged Software in Small Businesses: Views of owners and managers. Information & Management, 29(2), pp. 71-78.

Chen, A., Sen, S. & Shao, B., 2006. Strategies for Effective Web Services Adoption for Dynamic E-business. Decision Support Systems , 42(2), pp. 789-809.

Chituc, C. M., Toscano, C. & Azevedo, A., 2008. Interoperability in Collaborative Networks: Independent and industry specific initiatives - The case of the footwear industry. Computers in Industry, 59(7), pp. 741-757.

Chong, A. Y.-L. & Ooi, K. B., 2008. Adoption of Interorganizational System Standards in Supply Chains: An empirical analysis of RosettaNet standards. Industrial Management & Data Systems, 108(4), pp. 529-547.

Chwelos, P., Benbasat, I. & Dexter, A. S., 2001. Research Report: Empirical Test of an EDI Adoption Model. Information System Research, 12(3), pp. 304-321.

Cooper, J. & Burgess, L., 2000. A Model of Internet Commerce Adoption (MICA). In: Electronic Commerce: Opportunity and Challenges. Hershey, PA, USA: IGI Publishing, pp. 189-201.

Cragg, P. B. & Zinatelli, N., 1995. The Evolution of Information Systems in Small Firms. Information & Management, 29(1), pp. 1-8.

Cranefield, S. & Ranathunga, S., 2013. Embedding Agents in Business Applications Using Enterprise Integration Patterns. Richland, ACM.

Crespi, G., Mahdi, S. & Patel, P., 2006. Adoption of E-commerce Technology: Do network and learning externalities matter?. s.l.:DTI.

Crow, L. & Shadbolt, N., 2001. Extracting Focused Knowledge from the Semantic Web. International Journal of Human-Computer Studies, 54(1), pp. 155-184.

Da Xu, L., 2011. Enterprise Systems: State-of-the-art and Future Trends. IEEE Transactions on Industrial Informatics, 7(4), pp. 630-640.

Damodaran, S., 2004. B2B Integration Over the Internet with XML: RosettaNet success and challenges. New York NY, ACM, pp. 188-195.

Danesh, M. R. & Jin, Y., 2001. An Agent-Based Decision Network for Concurret Engineering Design. Cocurrent Engineering, 9(1), pp. 37-47.

Daniel, E. & Wilson, H., 2002. Adoption Intentions and Benefits Realised: A study of e-commerce in UK SMEs. Journal of Small Business and Enterprise Development, 9(4), pp. 331-348.

Davenport, T. H., 1998. Putting the Enterprise into the Enterprise System, s.l.: Harvard Business Review.

Davenport, T. H., 2000. Mission Critical: Realizing the promise of enterprise systems. s.l.:Harvard Business School Press.

Davenport, T. H., 2000. The Future of Enterprise System-Enabled Organizations. Information Systems Frontier, 2(2), pp. 163-180.

Davenport, T. H. & Brooks, J. D., 2004. Enterprise Systems and the Supply Chain. Journal of Enterprise Information Management, 17(1), pp. 8-19.

Davis, F. D., 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly, pp. 319-340.

De Búrca, S., Fynes, . B. & Marshall, . D., 2005. Strategic Technology Adoption: Extending ERP across the supply chain. Journal of Enterprise Information Management, 18(4), pp. 427-440.

Dezdar, S. & Ainin, S., 2011. The Influence of Organizational Factors on Successful ERP Implementation. Management Decision, 49(6), pp. 911-926.

Diao, L. & Ma, Y., 2008. A Versatile SOA-based E-business Platform. s.l., IEEE, pp. 638-641.

Drew, S., 2003. Strategic Uses of E-Commerce by SMEs in the East of England. European Management Journal, 21(1), pp. 79-88.

Dutta, S. & Evrard, P., 1999. Information Technology and Organisation Within European Small Enterprises. European Management Journal, 17(3), pp. 239-251.

Eid, R. & Trueman, M., 2004. Factors Affecting the Success of Business-to-Business International Internet Marketing (B-toB IIM): An emprical study of UK companies. Industrial Management & Data Systems, 104(1), pp. 16-30.

Elalouf, A., Levner, E. & Cheng, T. E., 2011. Efficient Routing of Mobile Agents for Agent-based Integrated Enterprise Management: A general acceleration technique. Enterprise and Organizational Modeling and Simulation, Volume 88, pp. 1-20.

Elliot, S. & Fowell, S., 2000. Expectations versus Reality: A snapshot of consumer experiences with Internet retailing. International Journal of Information Management, 20(5), pp. 323-336.

Erasala, N., Yen, D. C. & Rajkumar, T. M., 2003. Enterprise Application Integration in the Electronic Commerce World. Computer Standards & Interfaces, 25(2), pp. 69-82.

Erl, T., 2005. Service-Oriented Architecture. Crawfordsville, Indiana, USA: Pearson Education Inc.

Ernst, H., Hoyer, W. D., Krafft, M. & Krieger, K., 2011. Customer Relationship Management and Company Performance - The mediating of new product performance. Journal of the Academy of Marketing Science, 39(2), pp. 290-306.

Esteves, J. & Pastor, J., 2000. Towards the Unification of Critical Success Factors for ERP Implementations. Manchester, 10th Annual Business Information Technology 2000 Conference.

Evgeniou, T., 2002. Information Integration and Information Strategies for Adaptive Enterprises. European Management Journal, 20(5), pp. 486-494.

Fan, J. C. & Fang, K., 2006. ERP Implementation and Information Systems Success: A Test of DeLone and McLean's Model. Technology Management for the Global Future, Volume 3, pp. 1272-1278.

Fathian, M., Akhavan, . P. & Hoorali, . M., 2008. E-readiness Assessment of Non-profit ICT SMEs in a Developing Country: The case of Iran. Technovation, 28(9), pp. 578-590.

Fensel, D. & Bussler, C., 2002. The Web Service Modeling Framework WSMF. Electronic Commerce Research and Applications, 1(2), pp. 113-137.

Fillis, I., Johannson, U. & Wagner, B., 2004. Factors Impacting on E-business Adoption and Development in the Smaller Firm. International Journal of Enterpreneurial Behaviour & Research, 10(3), pp. 178-191.

Finin, T., Fritzson, R., McKay, D. & McEntire, R., 1994. KQML as an Agent Communication Language. s.l., ACM, pp. 456-463.

Fink, D., 1998. Guidelines for the Successful Adoption of Information Technology in Small and Medium Enterprises. International Journal of Information Management, 18(4), pp. 243-253.

Forlenza, M. & Cavallero, D., 2003. Break Through the Complexity of Integration with IBM's Total Integration Advantage. [Online] Available at: ftp://ftp.software.ibm.com/software/websphere/integration/pdf/G325-2190-00_4.pdf
[Accessed 1 July 2013].

Friedman, T. L., 2007. The Wrold Is Flat: a brife history of the twenty-first century. New York: Picador.

García-Jiménez, F., Martínez-Carreras, M. & Gómez-Skarmeta, A., 2010. Evaluating Open Source Enterprise Service Bus. s.l., IEEE, pp. 284-291.

Ghobakhloo, M., Sabouri, M. S., Hong, T. S. & Zulkifi, N., 2011. Information Technology Adoption in Small and Medium-sized Enterprises; An Appraisal of Two Decades Literature. Interdisciplinary Journal of Research in Business, 1(7), pp. 53-80.

Giachetti, R. E., 2004. A Framework to Review the Information Integration of the Enterprise. International Journal of Production Research, 42(6), pp. 1147-1166.

Giachetti, R. E., 2011. Design of Enterprise Systems: Theory, architecture, and methods. Boca Raton, Florida: CRC Press.

Gibbs, J., Kraemer, K. L. & Dedrick, J., 2003. Environment and Policy Factors Shaping Global E-commerce Diffusion: A cross-country comparison. The International Society, 19(1), pp. 5-18.

Goel, R., 2008. E-commerce. 1st ed. s.l.:New Age International Pvt Ltd Publishers.

Grandon, E. E. & Pearson, M., 2004. Electronic Commerce Adoption: An emprical study of small and mediume US businesses. Information & Management, 42(1), pp. 197-216.

Grandon, E., Nasco, S. A. & Mykytyn jr., P. P., 2011. Comparing Theories to Explain E-commerce Adoption. Journal of Business Research, Volume 64, pp. 292-298.

Grewal, D., Lyer, G. R. & Levy, M., 2004. Internet Retailing: Enablers, limiters and market consequences. Journal of Business Research, 57(7), pp. 703-713.

Gu, J., Xie, J. & Li, G., 2011. Study on Vitual Enterprise Information Integration Based on Multi-Agent Web Services Platform. XianNing, IEEE.

Gulledge, T., 2006. What is Integration?. Industrial Management and Data Systems, 106(1), pp. 5-20.

Hasselbring, W., 2000. Information System Integration. Communications of the ACM, 43(6), pp. 32-38.

Hatamirad, A. & Mehrjerdi, H., 2010. Deployment of ERP System at Automotive Industries, Security Inspection (Case Study: IRAN KHODRO Atomotive Company). In: S. Tenreiro de Magalhães, H. Jahankhani & A. G. Hessami, eds. Global Security, Safety, and Sustainability. Berlin: Springer, pp. 160-169.

Helo, P. & Szekely, B., 2005. Logistics Information Systems: An analysis of software solutions for supply chain co-ordination. Industrial Management & Data Systems, 105(1), pp. 5-18.

Henderson, J. C. & Venkatraman, N., 1993. Strategic Alignment: Leveraging Information Technology Transforming Organizations. IBM Systems Journal, 32(1), pp. 4-16.

He, W. & Xu, L., 2012. Integration of Distributed Enterprise Applications: A survey. IEEE Transaction on Idustrial Informatics, PP(99), pp. 1-8.

Hohpe, G. & Woolf, B., 2004. Enterprise Integration Patterns: Designing, Building, and Deploying Messaging Solutions. Boston, USA: Addison-Wesley Professional.

Holland, C. P. & Light, B., 1999a. A Critical Success Facors Model for ERP Implemention. IEEE Software, 16(3), pp. 30-36.

Holland, C. P. & Light, B., 1999. Global Enterprise Resource Planning Implementation. Hawaii, IEEE.

Hong, W. & Zhu, K., 2006. Migrating to Internet-based E-commerce: Factors affecting e-commerce adoption in migration at the firm level. Information & Management, 43(2), pp. 204-221.

Ho, S.-C., Kauffman, . R. J. & Liang, T.-P., 2007. A Growth Theory Perspective on B2C E-commerce Growth in Europe: An exploratory study. Electronic Commerce Research and Applications, 6(3), pp. 237-259.

Hossain, L., Patrick, J. D. & Rashid, M. A., 2002. Enterprise Resource Planning: Global Opportunities & Challenges. Hershey: Idea Group Publishig.

Hui, P. C., Tse, K., Choi, T.-M. & Lui, N., 2010. Enterprise Resource Planning Systems for the Textiles and Clothing Industry. In: T. E. Cheng & T. Choi, eds. Innovative Quick Response Programs in Logistics and Supply Chain Management. Berlin: Springer, pp. 279-295.

Hurwitz, J., Bloor, R., Kaufman, M. & Halper, F., 2009. Service Oriented Architecture (SOA) for Dummies. 2nd ed. Indianapolis, Indiana, USA: Wiley Publishing.

Iacovou, C. L., Benbasat, I. & Dexter, A. S., 1995. Electronic Data Interchange and Small Organizations: adoption and impact of technology. MIS Quarterly, 19(4), pp. 465-485.

Iddris, F., 2012. Adoption of E-Commerce Solutions in Small and Medium-Sized Enterprises in Ghana. European Journal of Business and Management, 4(10), pp. 48-57.

Igbaria, M., Zinatelli, N., Cragg, P. & Cavaye, A. L., 1997. Personal Computing Acceptance Factors in Small Firms: A structural equation model. MIS Quarterly, pp. 279-305.

Irani, Z., Themistocleous, M. & Love, P. E., 2003. The Impact of Enterprise Application Integration on Information Systems Lifecycles. Information & Management, 41(2), pp. 177-187.

Jeffcoate, J., Chappell, C. & Feindt, S., 2002. Best Practice in SME Adoption of E-commerce. Benchmarking: An international journal, 9(2), pp. 122-132.

Jennex, M. E., Amoroso, D. & Adelakun, O., 2004. E-Commerce Infrastructure Success Factors for Small Companies in Developing Economies. Electronic Commerce Research, Volume 4, pp. 263-286.

Johannesson, P. & Perjons, E., 2000. Design Principles for Application Integration. Advanced Information Systems Engineering, Volume 1789, pp. 212-231.

Johnson, M., 2010. Barriers to Innovation Adoption: A study of e-markets. Industrial Management & Data Systems, 110(2), pp. 157-174.

Johnson, P., 2002. Enterprise Software System Integration an Architectural Perspective, Stockholm, Sweden: Industrial Information and Control Systems KTH, Royal Institute of Technology.

Josuttis, N., 2007. SOA in Practice. Sebastopol, CA, USA: O'Reilly Media.

Kachru, S. & Gehringer, E. F., 2004. On The Relative Advantages of Teaching Web Services in J2EE vs. .NET. s.l., s.n., pp. 24-28.

Kalakota, R. & Whinston, A. B., 1997. Electronic Commerce, A Manager's Guide. s.l.:Addison-Wesley.

Kappauf, J., Lauterbach, B. & Koch, M., 2011. Logistics Core Operations with SAP. Berlin Heidelberg: Springer.

Kauremaa, J., Nurmilaakso, J.-M. & Tanskanen, K., 2010. E-business Enabled Operational Linkages: The role of RosettaNet in integrating the telecommunications Supply chain. International Journal of Production Economics, 127(2), pp. 343-357.

Kendall, J. D. et al., 2001. Receptivity of Singapore's SMEs to Electronic Commerce Adoption. The Journal of Strategic Information Systems, 10(3), pp. 223-242.

Khalifa, M. & Limayem, M., 2003. Drivers of Internet Shopping. Communications of the ACM, 46(12), pp. 233-239.

Kim, C. & Galliers, R. D., 2004. Toward a Diffusion Model for Internet Systems. Internet Research, 14(2), pp. 155-166.

Kim, H.-W., 2000. Business Process Versus Coordination Process in Organizational Change. International Journal of Flexible Manufacturing Systems, 12(4), pp. 275-290.

Kim, H., 2002. Conceptual Modeling and Specification Generation for B2B Business Processes Based on ebXML. ACM SIGMOD Record, 31(1), pp. 37-42.

Kosanke, K. F., Vernadat, F. & Zelm, M., 1999. CIMOSA: Enterprise engineering and integration. Computers in Industry, 40(2), pp. 83-97.

Kotinurmi, P., Haller, A. & Oren, E., 2009. Ontologically Enhanced RosettaNet B2B Integration. Semantic Web for Business: Cases and Applications.

Kuan, K. K. & Chau, P. Y., 2001. A Perception-Based Model for EDI Adoption in Small Businesses Using a Technology–Organization–Environment Framework. Information & Management, 38(8), pp. 507-521.

Kumar, V., Maheshwari , B. & Kumar, U., 2003. An Investigation of Critical Management Issues in ERP Implementation: Empirical evidence from Canadian organizations. Technovation, 23(10), pp. 793-807.

Kurnia, S. & Ali, m., 2012. B2B E-commerce Adopting by Grocery Industry in Developing Countries: Indonesia versus Bahrain. Hawaii, IEEE.

Labiche, Y., 2011. Integration Testing Object-oriented Software Systems: An experiment-driven research approach. Canada, IEEE, pp. 652-655.

Lambert, D. M. & Cooper, M. C., 2000. Issues in Supply Chain Management. Industrial Marketing Management, 29(1), pp. 65-83.

Lam, W., 2005. Investigating Success Factors in Enterprise Application Integration: A case-driven analysis. European Journal of Information Systems, 14(2), pp. 175-187.

Lawson, R., Alcock, C. & Cooper, J., 2007. Diffusion of Electronic Commerce in Small and Mediune Enterprises. Australian Journal of Information Systems, 9(2), pp. 123-134.

Lawson, R., Alcock, C., Cooper, J. & Burgess, L., 2003. Factors Affecting Adoption of Electronic Commerce Technologies by SMEs: An Australian Study. Journal of Small Business and Enterprise Development, 10(3), pp. 265-276.

Lee, H.-G., 1998. Do Electronic Marketplaces Lower the Price of Goods?. Communications of the ACM, 41(1), pp. 73-80.

Lee, J., Siau, K. & Hong, S., 2003. Enterprise Integration with ERP and EAI. Communications of the ACM, 46(2), pp. 54-60.

Lee, Z. & Lee, J., 2000. An ERP Implementation Case Study from a Knowledge Transfer Perspective. Journal of Inforamtion Technology, 15(4), pp. 281-288.

Lim, B. B. & Wen, J., 2002. The Impact of Next Generation XML. Information Management & Computer Security, 10(1), pp. 33-40.

Lim, H., Juster, N. & Pennington, A. d., 1997. Enterprise Modelling and Integration: A taxonomy of seven key aspects. Computers in Industry, 34(3), pp. 339-359.

Ling, C. Y., 2001. Model of Factors Influences on Electronic Commerce Adoption and Diffusion in Small and Medium Sized Enterprises. Bled, Slovenia, s.n.

Lin, S.-P., Lo, S.-H. & Yang, H.-L., 2010. Information System Integration After Merger and Aquisition in the Banking Industry. World Academy of Science, Engineering and Technology, Volume 72, pp. 189-193.

Linthicum, D., 2001. B2B Application Integration. Boston, USA: Addison-Wesley.

Linthicum, D. S., 2000. Enterprise Application Integration. New Jersy, USA: Addison-Wesley.

Linthicum, D. S., 2004. Next Generation Application Integration: from simple information to web services. Boston,USA: Addison-Wesley .

Li, P. & Xie, W., 2012. A Strategic Framework for Determining E-Commerce Adoption. Journal of Technology Management in China, 7(1), pp. 22-35.

Liu, Z.-F., Lu, Z.-Y. & Zhang, C.-L., 2010. Application Research on Manufacture E-commerce and ERP Integration. s.l., IEEE, pp. 3204-3207.

Lohse, L. G. & Spiller, P., 1998. Electronic Shopping. Communications of the ACM, 41(7), pp. 81-87.

Longenecker, J. G., Moore, C. W., Petty, J. W. & Palich, L. E., 2006. Small Business Management: Entrepreneurial Emphasis. 13th ed. Mason, Ohio, USA: South-Western Pub.

Love, P. E. et al., 2001. An Emperical Analysis of the Barriers to Implementing E-commerce in Small-Medium Sized Construction Contactors in the State of Victoria, Australia. Construction Innovation: Information, Process, Management, 1(1), pp. 31-41.

Lybaert, N., 1998. The Information Use in a SME: Its importance and some elements of influence. Small Business Economics, 10(2), pp. 171-191.

Maassen, J. et al., 2001. Efficient Java RMI for Parallel Programming. ACM Transaction on Programming Languages and Systems, 23(6), pp. 747-775.

Mabert, V. A., Soni, A. & Venkataramanan, M., 2001. Enterprise Resource Planning: Common myths versus evolving reality. Business Horizons, 44(3), pp. 69-76.

MacGregor, R. C. & Vrazalic, L., 2006. E-Commerce Adoption Barriers in Small Business and the Differential Effects of Gender. Journal of Electronic Commerce in Organizations (JECO), 4(2), pp. 1-24.

Malone, T. & Crowston, K., 1994. The Interdisciplinary Study of Coordination. ACM Computing Survey, 26(1), pp. 87-119.

Maréchaux, J.-L., 2006. Combining Service-Oriented Architecture and Event-Driven Architecture using an Enterprise Service Bus, s.l.: IBM Developer Works.

Markus, L. M., 2000. Paradigm shifts-E-business and Business/Systems Integration. Communications of the ACM, 4(10), pp. 1-44.

Markus, M. L., Axline, S., Petrie, D. & Tanis, C., 2000. Learning from Adopters' experiences with ERP: Problem encountered and success achieved. Journal of Information Technology, 15(4), pp. 245-265.

Medjahed, B. et al., 2003. Business-to-Business Interactions: Issues and enabling technologies. The International Journal of Very Larg Data Bases, 12(1), pp. 59-85.

Mehrtens, J., Cragg, P. B. & Mills, A. M., 2001. A Model of Internet Adoption by SMEs. Information & Management, 39(3), pp. 165-176.

Menge, F., 2007. Enterprise Service Bus. s.l., s.n., pp. 1-6.

Mereddy, R., 2011. SAP Basis Administration Handbook:NetWeaver edition. 1st ed. s.l.:McGraw-Hill Osborne Media.

Microsoft, 2004. Understanding BizTalk Server 2004. [Online] Available at: http://msdn.microsoft.com/en-US/library/ms942195(v=bts.10).aspx [Accessed 1 July 2013].

Microsoft, 2011. What Is Windows Communication Foundation?. [Online] Available at: http://msdn.microsoft.com/en-us/library/vstudio/ms731082(v=vs.90).aspx [Accessed 1 July 2013].

Microsoft, 2013. Windows Communication Foundation Architecture. [Online] Available at: http://msdn.microsoft.com/en-us/library/vstudio/ms733128(v=vs.90).aspx [Accessed 1 July 2013].

Middleton, M., 2007. A Framework for Information Management: Using case studies to test application. International Journal of Information Management, 27(1), pp. 9-21.

Mole, K. F., Ghobadian, A., O'Regan, N. & Liu, J., 2004. The Use and Deployment of Soft Process Technologies within UK Manufacturing SMEs: An empirical assessment using logit models. Journal of Small Business Management, 42(3), pp. 303-324.

Monk, E. F. & Wagner, B. J., 2009. Concepts in Enterprise Resource Planning. 3rd ed. Massachusetts: Course Technology Cengage Learning.

Moradi, H. & Bahreininejad, A., 2013. Toward a Comprehensive Framework for Evaluating the Core Integration Features of Enterprise Integration Middleware Technologies. Journal of Systems Integration, 4(1), pp. 13-29.

Motiwalla, L. F. & Thompson, J., 2009. Enterprise Systems for Management. New Jersey: Pearson Education.

Myerson, J. M., 2002. Enterprise Systems Integration. 2nd ed. Boca Raton, Florida, USA: CRC Press.

Nah, F. F., Lau, J. L. & Kuang, J., 2001. Critical Factors for Successful Implementation of Enterprise systems. Business Process Management Journal, 7(3), pp. 285-296.

Naick, I., Berkhoff, M. & Bosnich, D. V., 2000. Business-to-Business Integration Using MQSeriese and MQSI: Patterns for e-business series. Austin, Texas, USA: International Business Machines Corporation.

Napier, H., Rivers, O. N., Wagner, S. W. & Napier, J., 2006. Creating a Winning E-business. 2nd ed. Boston: Thomson Course Technology.

Nasco, S. A., Toledo, E. G. & Mykytyn Jr, P. P., 2008. Predicting Electronic Commerce Adoption in Chilean SMEs. Journal of Business Research, 61(6), pp. 697-705.

Ngai, E., 2005. Customer Relationship Management Research (1992-2002): An academic literature review and classification. Marketing Intelligence & Planning, 23(6), pp. 582-605.

Ngai, E., Xiu, L. & Chau, D., 2009. Application of Data Mining Techniques in Customer Relationship Management: A literature review and classification. Expert Systems with Applications, 36(2-2), pp. 2592-2602.

Nightingale, D. J. & Rhodes, D. H., 2004. Enterprise System Architecting: Emerging art and science within engineering systems, Cambridge: MIT Engineering Systems Symposium.

Nugent, E. J. & Hamblin, D. J., 1996. Improved Methodologies for Vertical Integration Research. Integrated Manufacturing Systems, 7(1), pp. 16-28.

Nurmilaakso, J.-M., 2008. Adoption of E-business Functions and Migration from EDI-based to XML-based E-business Framework in Supply chain Integration. International Journal of Production Economics, 113(2), pp. 721-733.

O'Keefe, R., O'Connor, G. & Kung, H.-J., 1998. Earli Adoption of the Web as a Retail Medium: Small Company Winners and Losers. European Journal of Marketing, 32(7), pp. 629-643.

O'Leary, D. E., 2000. Enterprise Resource Planning System: Systems, Life cycle, Electronic Commerce, and Risk. Cambridge: Press Syndicate of the University of Cambridge.

OMG, 2013. CORBA® BASICS. [Online] Available at: http://www.omg.org/gettingstarted/corbafaq.htm#TotallyNew [Accessed 07 07 2013].

Ooi, S. L. & Su, M. T., 2006. Integrating Enterprise Application Using Message-Oriented Middleware and J2EE Technologies. s.l., IEEE, pp. 1-5.

Oracle, 2007. Oracle Business-to-Business Integration. [Online] Available at: http://www.oracle.com/us/products/consulting/resource-library/business-to-business-integration-069301.pdf [Accessed 1 July 2013].

Oracle, 2008. Oracle's Complete Sell-Side: E-commerce solution. [Online] Available at: http://www.oracle.com/us/products/applications/siebel/self-service-ebilling/038547.pdf [Accessed 1 July 2013].

Oracle, 2009. Oracle Application Integration Architecture Enterprise Business Objects (EBO) Concepts –Concepts, Structure, Terminologies and Design Rules. [Online] Available at: http://www.oracle.com/us/products/applications/057277.pdf [Accessed 1 July 2013].

Oracle, 2009. Oracle Application Integration Architecture Foundation Pack Extension for Communications. [Online] Available at: http://www.oracle.com/us/products/applications/047082.pdf [Accessed 1 July 2013].

Oracle, 2010. Oracle E-Business Suite and Oracle Fusion Middleware. [Online] Available at: http://www.oracle.com/technetwork/apps-tech/ebusiness/whyfmwisbestmiddlewareforebs-167718.pdf [Accessed 1 July 2013].

Papazoglou, M. P., Ribbers, P. & Tsalgatidou, A., 2000. Integrated Value Chains and their Implications from a Business and Technology Standpoint. Decision Support Systems, 29(4), pp. 323-342.

Parent, C. & Spaccapietra, S., 1998. Issues and Approaches of Database Integration. Communications of the ACM, 41(5es), pp. 166-178.

Patil, S. & Newcomer, E., 2033. ebXML and Web Services. Internet Computing, IEEE, 7(3), pp. 74-82.

Petrie, C. J., 1992. Enterprise Integration Modeling. Proceedings of the first international conference ed. s.l.:MIT Press.

Poon, S. & Swatman, P. M., 1999. An Exploratory Study of Small Business Internet Commerce Issues. Information & Management, 35(1), pp. 9-18.

Preist, C. et al., 2005. Automated Business-to-Business Integration of a Logistics Supply Chain using Semantic Web Services Technology. Galway, Ireland, s.n., pp. 987-1001.

Premkumar, G. & Roberts, M., 1999. Adoption of New Information Technologies in Rural Small Businesses. Omega, 27(4), pp. 467-484.

Psiuk, M. & Bujok, T., 2012. Enterprise Service Bus Monitoring Framework for SOA Systems. IEEE Transactions on Services Computing, 5(3), pp. 450-466.

Puschmann, T. & Alt, R., 2001. Enterprise Application Integration-the case of the Robert Bosch Group. Hawaii, IEEE.

Qin, Z., 2009. Introduction to E-commerce. s.l.:Springer.

Qureshi, S. & York, S., 2008. Information Technology Adoption by Small Businesses in Minority and Ethnic Communities. Hawaii, IEEE.

Radovilsky, Z., 2004. Enterprise Resource Planning (ERP). In: H. Bidgoli, ed. The Internet Encyclopedia . New Jersey: John Wiley & Sons, pp. 707-717.

Raghavan, N., 2005. Data mining in e-commerce: A survey. Sadhana, 30(2-3), pp. 275-289.

Rao, S. S., Metts, G. & Mora Monge, C. A., 2003. Electronic Commerce Development in Small and Mediume Sized Enterprises. Business Process Management Journal , 9(1), pp. 11-32.

Rau, H., Chen, T. & Chen, C., 2009. Develop a Negotiation Framework for Automating B2B Processes in RosettaNet Environment Using Fuzzy Technology. Computers & Industrial Engineering, 56(2), pp. 736-753.

Rebovich, G. & White, B. E., 2011. Enterprise System Engineering : advances in the theory and prictice. Boca Raton: Taylor and Francis Group.

RedHat, 2013. Apache CXF JCA Connector Overview. [Online] Available at: http://fusesource.com/docs/framework/2.4/j2ee/JavaEEJAXWSIntroFUSE.html#JavaEEJAXWSArchitecture
[Accessed 08 July 2013].

Reimers, K., 2001. Standardizing the New E-business Platform: Learning from the EDI Experience. Electronic Markets, 11(4), pp. 231-237.

Reser, J., 2002. Principles of Dynamic Business: Build-to-integrate, New York, USA: IBM.

Richards, M., Haefel, R. M. & Chappell, D. A., 2009. Java Message Service. 2nd ed. Sebastopol, California, USA: O'Reilly.

Riemenschneider, C. K., Harrison, . D. A. & Mykytyn Jr., P. P., 2003. Understanding It Adoption Decisions in Small Business: integrating current theories. Information & Management, 40(4), pp. 269-285.

Riggins, F. J. & Rhee, H.-S. S., 1998. Toward a Unified View of Electronic Commerce. Communications of the ACM, 41(10), pp. 88-95.

Rizescu, G., 2006. The Role of Enterprise Portals in Enterprise Integration. Economics and Applied Informatics, Volume 1, pp. 117-122.

Roshen, W., 2009. SOA-Based Enterprise Integration: A step-by-step giude to services-based application integration. s.l.:The McGraw Hill Companies.

Ruh, W. A., Maginnis, F. X. & Brown, W. J., 2001. Enterprise Application Integration: A Wiley Tech Brief. s.l.:John Wiely & Sons, Inc..

Russell, D. J., Looker, N. & Xu, J., 2006. SOA Dependability, and Measures and Metrics for Network Enabled Capability. IET, Forum on Capability Engineering, London, UK, pp. 131-135.

Sait, S., Al-Tawil, K. & Hussain, S., 2007. E-commerce in Saudi Arabia: Adoption and perspectives. Australasian Journal of Information Systems, 12(1), pp. 54-74.

Salmeron, J. L. & Bueno, S., 2006. An Information Technologies and Information Systems Industry-based Classification in Small and Medium-sized Enterprises: An institutional view. European Journal of Operational Research, 173(3), pp. 1012-1025.

SAP HANA, 2013. SAP Integration and Certification Center: Integration Guide, s.l.: SAP.

SAP, 2009. Adopting SAP Business Suite 7 Software and Enhancement Packages. [Online]
Available at: http://www.b4-consulting.com/documentation/SAP-Business-Suite-7.pdf
[Accessed 05 August 2013].

SAP, 2009. SAP Business Suite. [Online]
Available at: http://www.b4-consulting.com/documentation/SAP-Business-Suite-Overview.pdf
[Accessed 05 August 2013].

SAP, 2013. SAP Business Suite Powered by SAP HANA: Delivering real-time business value. [Online]
Available at: http://www.saphana.com/servlet/JiveServlet/previewBody/2946-102-4-7609/SoH_OverviewBrochure.pdf
[Accessed 05 August 2013].

Schantz, R. E. & Schmidt, D. C., 2002. Middleware for Distributed Systems: Evolving the Common Structure for Network-Centric Applications. Encylopedia of Software Engineering, Volume 1.

Schelp, J. & Schwinn, A., 2005. Extending the Business Anegineering Framework for Application Integration Purposes. Proceeding of the 2005 ACM Symposium on Applied Computing, pp. 1333-1337.

Schneider, G. P., 2010. Electronic Commerce. 9th ed. Massachusetts(Boston): Course Technology, Cengage Learning.

Scupola, A., 2009. SMEs' E-commerce Adoption: Perspectives from Denmark and Australia. Journal of Enterprise Information Management, 22(1/2), pp. 152-166.

Seligman, L., Mork, P., Halevy, A. & Smith, K., 2010. OpenII: An open source information integration toolkit. New York, USA, ACM.

Seyal, A., Rahim, M. M. & Rahman, M. N. A., 2000. An Emprical Investigation of Use of Information Technology Among Small and Medium Business Organizations: A Bruneian scenario. The Electronic Journal of Information Systems in Developing Countries, 2(7), pp. 1-17.

Shanks, G., Seddon, P. B. & Willcocks, L. P., 2003. Second-Wave Enterprise Resourse Planning Systems: Implementing for effectiveness. Cambridge: Cambridge University Press.

Sharif, A. M., Irani, Z. & Love, P. E., 2005. Integrating ERP Using EAI: A model for hoc evaluation. European Journal of Information Systems, 14(2), pp. 162-174.

Sharma, R., Stearns, B. & Ng, T., 2001. J2ee(tm) Connector Architecture and Enterprise Application Integration. Palo Alto, California, USA: Addison-Wesley Professional.

Sharma, S. K., Gupta, J. N. & Wickramasinghe, N. '., 2006. A framework for Designing the Enterprise-Wide E-commerce Portal for Evolving Organizations. Electron Commerce Research, Volume 6, pp. 141-154.

Sharpanskykh, A., 2010. Authority and Its Implementation in Enterprise Information Systems. In: N. Bajgoric, ed. Always-On Enterprise Information Systems for Business Continuance: Technologies for reliable and scalable operations. Hersby,PA, USA: IGI Global, pp. 265-276.

Shatet, A. S. & Udin, Z. M., 2012. The Relationship Between ERP Systems and Supply Chain Management Performance in Malaysian Manufacturing Companies. Journal of Enterprise Information Management, 25(6), pp. 576-604.

Shim, S. S., Pendyala, V. S., Sundaram, M. & Gao, J. Z., 2000. Business-to-Business E-commerce Framework. IEEE Computer, 33(10), pp. 40-47.

Sikander , J. & Sarma, V., 2010. A Prescriptive Architecture for Electronic Commerce and Digital Marketing. 2nd ed. s.l.:Microsoft Corporation.

Sikander, J. & Sarma, V., 2010. A Prescriptive Architecture for Electronic Commerce and Digital Marketing , s.l.: Microsoft .

Sila, I., 2013. Factors Affecting the Adoption of B2B E-commerce Technologies. Electronic Commerce Research, 13(2), pp. 199-236.

Singh, N., 1998. Unifying Heterogeneous Information Models. Communications of the ACM, 41(5), pp. 37-44.

Skok, W. & Legge, M., 2002. Evaluating Enterprise Resource Planning (ERP) Systms Using Interpretive Approach. Knowledge and Process Management, 9(2), pp. 72-82.

Słowiński, R. & Stefanowski, J., 1989. Rough Classification in Incomplete Information Systems. Mathematical and Computer Modelling, 12(10-11), pp. 1347-1357.

Southern, A. & Tilley, F., 2002. Small Firms and Information and Communication Technologies (ICTs): Toward a typology of ICTs usage. New Technology, Work and Employment, 15(2), pp. 138-154.

Stadtler, H., 2008. Supply Chain Management - An. In: H. Stadtler & C. Kilger, eds. Supply Chain Management and Advanced Planning. Berlin Heidelberg: Springer Berlin Heidelberg, pp. 9-36.

Stair, R. M. & Reynolds, G. W., 2010. Principles of Information Systems: A Managerial Approach. 9th ed. Boston: Course Technology, Cengage Learning.

Steinfield, C., 2004. Electronic Commerce and Electronic Business. In: H. Bidgoli, ed. The Internet Encyclopedia : Volume 1. New Jersey: John Wiley & Sons, pp. 601-612.

Stockdale, R. & Standing, C., 2006. A Classification Model to Support SME E-Commerce Adoption Initiatives. Journal of Small Business and Enterprise Development, 13(3), pp. 381-394.

Stohr, E. A. & Nickerson, J. V., 2003. Intra Enterprise Integration: Methods and directions. In: J. N. Luftman, ed. Competing in the Information Age: Align in the sand. 2nd ed. New York,USA: Oxford University Press, pp. 227-251.

Stone, M., 2003. SME E-business and Supplier-Customer Relations. Journal of Small Business and Enterprise Development, 10(3), pp. 345-353.

Subramoniam, S., Tounsi, M. & Krishnankutty, K., 2009. The Role of BPR in the Implementation of ERP Systems. Business Process Management Journal, 15(5), pp. 653-668.

Sulong, M. S., Koronios, A., Gao, J. & Abdul-Aziz, A., 2012. Driving the Initiative of Service-Oriented Architecture Implementation. Journal of Software & Systems Development, Volume 2012.

Sundaram, M. & Shim, S., 2001. Infrastructure for B2B Exchanges with RosettaNet. San Juan, CA, IEEE.

Sutanonpaiboon, J. & Pearson, A. M., 2006. E-commerce Adoption: Perceptions of managers/owners of small-and-medium-sized enterprises (SMEs) in Thailand. Journal of Internet Commerce, 5(3), pp. 53-82.

Sutherland, J. & van den Heuvel, W. J., 2002. Enterprise Application Integration and Complex Adaptive Systems. Communications of the ACM, 45(10), pp. 59-64.

Su, Y. F. & Yang, C., 2010. Why Are Enterprise Resource Planning Systems Indispensable to Supply Chain Management?. European Journal of Operational Research, 203(1), pp. 81-94.

Swarz, R. S. & DeRose, J. K., 2006. A Framework for Enterprise Systems Engineering Processes. Paris, International Conference on Software & Systems Engineering and their Applications.

Tan, K. S., Chong, S. C. & Eze, U. C., 2009. Internet-based ICT Adoption: Evidence from Malaysian SMEs. Industrial Management & Data Systems, 109(2), pp. 224-244.

Themifstocleous, M. & Irani, Z., 2002. Novel taxonomy for Application Integration. Benchmarking: An International Journal, 9(2), pp. 154-165.

Themistocleous, M., 2004. Justifying the Decisions for EAI Implementations: A validated proposition of influential factors. The Journal of Enterprise Information Management, 17(2), pp. 85-104.

Themistocleous, M. & Irani, Z., 2003. Toward a Novel Framework for the Assessment of Enterprise Application Integration Packages. Hawaii, IEEE.

Themistocleous, M., Irani, Z., Kuljis, J. & Love, P. E., 2004. Extending the Information System Lifecycle through Enterprise Application Integration: A case study experience. Hawaii, IEEE, pp. 1-8.

Themistocleous, M., Irani, Z. & Love, P. E., 2004. Evaluating the Integration of Supply Chain Information Systems: A case study. European Journal of Operational Research, 159(2), pp. 393-405.

Themistocleous, M., Irani, Z. & O'Keefe, R. M., 2001. ERP and Application Integration: Exploratory Survey. Busniss Process Management Journal, 7(3), pp. 195-204.

Thong, J. Y., 1999. An Integrated Model of Information Systems Adoption in Small Businesses. Journal of Management Information Systems, 15(4), pp. 187-214.

Thong, J. Y., 2001. Resource Constraints and Information Systems Implementation in Singaporean Small Businesses. Omega, 29(2), pp. 143-156.

Thong, J. Y. & Yap, C.-S., 1995. CEO Characteristics, Organizational Characteristics and Information Technology Adoption in Small Businesses. Omega, 23(4), pp. 429-442.

Tkacz, E. & Kapczynski, A., 2009. Internet – Technical Development and Applications. Berlin: Springer.

To, M. L. & Nagi, E. W., 2006. Predicting the Organizational Adoption of B2C E-commerce: An empirical study. Industrial Management Study, 106(8), pp. 1133-1147.

Toral, S. L., Barrero, F., Cortes, F. & Gregor, D., 2013. Analysis of Embedded CORBA Middleware Performance on Urban Distributed Transportation Equipments. Computer Standards & Interfaces, 35(1), pp. 150-157.

Tsur, S., Abiteboul, S., Agrawal, R. & Dayal , U., 2001. Are Web Services the Next Revolution in E-commerce?(Panel). Rome, Italy, s.n., pp. 614-617.

Turban, E. & King, D., 2003. Introduction to E-commerce. New Jersy: Pearson Education.

Turban, E., Leidner, D., McLean, E. & Wetherbe, J., 2008. Information Technology fot Management: Transforming Organizations in the Digital Economy. 6th ed. s.l.:John Wiley & Sons.

Vandersluis, K., 2004. XML-Based Integration Using Wa-Suite:Unifying applications and data in today's e-business worl. s.l.:Maximum Press.

Vernadat, F., 2002. Enterprise Modelling and Integration. Proceeding of the IFIP TC5/WG5, Volume 12, pp. 25-33.

Vicens, E., Alemany, M., AndreHs, C. & Guarch, J., 2001. A Design and Application Methodology for Hierarchical Production Planning Decision Support Systems in an Enterprise Integration Context. International Journal of Production Economics, 74(1), pp. 5-20.

Wiederhold, G. & Genesereth, M., 1997. The Conceptual Basis for Mediation Services. IEEE Expert, 12(5), pp. 38-47.

Wigard, R. T., 1997. Electronic commerce: definition, theory, and context. The Information Society, 13(1), pp. 1-16.

Vilaseca-Requena, J., Torrent-Sellens, J., Meseguer-Artola, A. & Rodriguez-Ardura, I., 2007. An Integrated Model of the Adoption and Extent of E-commerce in Firms. International Advances in Economic Research, 13(2), pp. 222-241.

Xin, S., Yunlong, Z. & Lin, N., 2009. An Architecture Design of a JBI-Based Enterprise Service Bus. s.l., IEEE, pp. 343-347.

Zhang, P. & Chen, J., 2010. Research and Application of Asynchronous Message Transmission on JMS. s.l., IEEE, pp. V6-355.

Zhu, K., Kraemer, K. & Xu, S., 2003. Electronic Business Adoption by European Firms: A cross-country assessment of the facilitators and inhibitors. European Journal of Information systems, 12(4), pp. 251-268.

Zimmermann, O., Doubrovski, V., Grundler, J. & Hogg, K., 2005. Service-Oriented Architecture and Business Process Choreography in an Order Management Scenario: Rationale, concepts, lessons learned. s.l., ACM, pp. 301-312.

APPENDICES

Appendix I: Factors influenced the adoption of EC in enterprises

T: Technical

S: Social

M: Managerial

F: Financial

H: Human resource

Resource	Factor	T	S	M	F	H
(Cragg & Zinatelli, 1995)	Inadequate hardware and software	●				
	Lack of internal technical expertise					●
	Insufficient attention by management			●		
(Thong & Yap, 1995)	Benefits and costs financial				●	
	IT knowledge and experiences					●
	CEO innovativeness			●		
	Turn over				●	
	Number of employee					●
	Information intense	●				
	Competitiveness of environment		●			
(Chau, 1995)	In-house IT experts					●
	Users' training					●
	Users‟ attitudes and opinions toward IT					●
	The costs of Its				●	
	User-friendliness		●			
	Complexity	●				
	Popularity		●			
	External expertise and					●
	Services availability and support	●				
(Auger & Callaugher, 1997)	Low-development and maintenance costs				●	
	An interest in experimenting with a new marketing tool		●			
	The desire to promote products and build the company's image		●			
	Financial considerations				●	
	Benefits in obtaining and disseminating information	●				
	Competitive considerations		●			
(Lybaert, 1998)	IT knowledge and experiences					●
	CEOs desire for growth			●		

	Familiarity with administration			●		
	Financial resources availability				●	
	Business maturity	●				
	Family intervention on management			●		
	Users‟ participation and involvement		●			
	SME‟s strategic context	●				
(Fink, 1998)	Organizational culture		●			
	Sufficient internal resources are available and appropriate procedures exist	●				
	External environment	●				
(O'Keefe, et al., 1998)	International scope		●			
	Access to target public		●			
	Low cost				●	
(Poon & Swatman, 1999)	Relative advantage of using EC	●				
(Dutta & Evrard, 1999)	Level of IT investment				●	
	Users' training					●
	Business size		●			
	Government policies		●			
	Customers and supplier pressure		●			
(Premkumar & Roberts, 1999)	Relative advantage		●			
	Top management support			●		
	Organizational size		●			
	External pressure and competitive pressure		●			
(Poon & Swatman, 1999)	Perceived impacts and benefits of IS/ITs on organization	●				
	Larger counterpart demand		●			
	Industry sector and product nature	●				
(Chan & Swatman, 2000)	Technology issues	●				
	Managerial issues			●		
	Business issues				●	
(Seyal, et al., 2000)	IT knowledge and experiences					●
	Turn over				●	
	Number of employee					●
	Information intensity	●				
	Government policies		●			
(Cooper & Burgess, 2000)	Promotion		●			
	Technical information	●				
	Links warehouse and links distributors	●				
(Thong, 2001)	User information satisfaction		●			
	Organizational impact	●				
	CEO support			●		
	User involvement		●			
	IS planning	●				
	IS investment				●	

	Users' IS knowledge		●			
	Consultant effectiveness		●			
	Vendor support	●				
(Kendall, et al., 2001)	Relative advantage of using EC	●				
(Jeffcoate, et al., 2002)	Presentation of supply	●				
	Usability of Web site	●				
	Process control	●				
	Relationship with customers		●			
	Relationship with other interest groups.		●			
	Price sensitivity				●	
	Brand image		●			
	Commitment to Internet	●				
	Partnerships with members of value chain	●				
	Ease of changing and improving		●			
	Processes	●				
	Integration	●				
(Daniel & Wilson, 2002)	Improved internal knowledge sharing		●			
	Improved competitive position		●			
	Enhanced and efficient service	●				
	Attract new customers		●			
	Improved supply	●				
	Recruited staff online					●
(Southern & Tilley, 2002)	In-house IT experts		●			
	Technological change and business expansion	●				
	Capturing new markets				●	
	Government policies		●			
	Customers and supplier pressure		●			
	Strategies of private technology suppliers	●				
(Drew, 2003)	CEO support and commitment			●		
	IT knowledge and experiences		●			
	Perceived impacts and benefits of IS/ITs on Organization	●				
	Business growth and expansion				●	
	Business maturity	●				
	Competitiveness of environment		●			
(Caldeira & Ward, 2003)	Type of IS/IT	●				
	IS/IT objectives and assumptions	●				
	Evaluation of IS/IT	●				
	Time of adoption	●				
	Resource availability	●				
	Management perspectives and attitudes			●		
	IS/IT competencies	●				
	Organizational structure		●			
	Power relationships and user attitudes		●			

	Stages in the process of IS/IT development	●				
	Planning and Evaluation	●				
	Construction / Acquisition	●				
	Implementation	●				
	Benefits Management			●		
	Vendors support		●			
	Consultant effectiveness		●			
	Quality of IS/IT products and services available in the market				●	
	Clients and suppliers pressure to adopt IS/IT		●			
(Zhu, et al., 2003)	Firms' size	●				
	Slack resources	●				
	Economies of scale				●	
	Risk of investment	●				
	Pressure on their trading partners to adopt the same technologies		●			
(Rao, et al., 2003)	Technology	●				
(Stone, 2003)	Technology	●				
(Lawson, et al., 2003)	Promotion of products and services	●				
	Online enquiry	●				
	Technical information	●				
	FAQ and value-added links	●				
	Online sales	●				
	Online ordering and payments	●				
	Order status enquiry	●				
	Links warehouse and links distributors	●				
(Cagliano, et al., 2003)	E-business tools	●				
	Close collaboration relationships		●			
	Information sharing effectiveness	●				
(Gibbs, et al., 2003)	International competitive pressure due to globalization		●			
	Pressure for cost reduction				●	
	Government procurement				●	
	Opening of economy				●	
	market liberalization				●	
	Government promotion and investment		●			
	Business environment and culture		●			
	National culture		●			
	Limited scope of EC	●				
	Education and tax system	●				
	Political concerns and instability		●			
(Riemenschneider, et al., 2003)	Financial resource availability				●	
	social contact improvement with customers, vendors		●			

	Perceived impacts and benefits of IS/ITs on organization		●			
	Business, social, and market pressure		●			
	Customers and supplier pressure		●			
(Eid & Trueman, 2004)	Marketing strategy	●				
	Web site	●				
	Global dimension		●			
	Internal and external related factors		●			
(Mole, et al., 2004)	Financial resources availability				●	
	Turn over				●	
	Number of employee					●
	Technological change and business expansion	●				
(Fillis, et al., 2004)	Macro-environment factors		●			
	Characteristics of industry or sector	●				
	Characteristics of firm or management			●		
	How internal and external factors		●			
(Kim & Galliers, 2004)	Characteristics of market				●	
	Technical characteristics	●				
	Organizational characteristics		●			
	Internal systems	●				
(Grandon & Pearson, 2004)	Organizational readiness	●				
	External pressure		●			
	Perceived ease of use		●			
	Perceived usefulness		●			
(Grewal, et al., 2004)	Organization e-readiness	●				
	Type of product	●				
	Lack of trust due to security/privacy concerns		●			
	Good quality of EC Websites	●				
	Logistics infrastructures	●				
(De Búrca, et al., 2005)	Process compatibility	●				
	Organization culture		●			
	Integration of internal processes	●				
	Customer demand to adopt technology		●			
	Larger counterpart demand		●			
(Salmeron & Bueno, 2006)	Type and age of implemented IS/ITs	●				
	Type of industry	●				
	Competitiveness of environment		●			
(To & Nagi, 2006)	Organization e-readiness	●				
	Competitive pressure		●			
	Relative advantage of using EC	●				
(Sutanonpaiboon & Pearson, 2006)	Entrepreneurial integration	●				
	Environment		●			
	EC ease of use for customers		●			

	EC usefulness for customers		●			
	Organizational readiness	●				
(Stockdale & Standing, 2006)	Environment		●			
	Stakeholder lack of awareness of needed technology		●			
(Hong & Zhu, 2006)	Influencing factors: technology integration	●				
	Web functionalities	●				
	Web spending	●				
	Partner usage	●				
	Differentiate non-adopters from adopters	●				
(Bruque & Moyano, 2007)	Various systems for the socialization of the workers		●			
	The rotation of personnel for exemplary purposes		●			
	The simultaneous implementation of information technology and quality systems	●				
	Professionalization in the case of family firms	●				
	Modification of the firm's hierarchy and power structures		●			
	Absence of qualified personnel					●
(Ho, et al., 2007)	ICT infrastructure	●				
	Degree of credit cards penetration	●				
	education and awareness		●			
(Lawson, et al., 2007)	Promotion of products and services	●				
	Online enquiry	●				
	Technical information	●				
	FAQ and value-added links	●				
	Online sales	●				
	Online ordering and payments	●				
	order status enquiry	●				
	Links warehouse and links distributors	●				
(Sait, et al., 2007)	Existing infrastructure	●				
	Internet awareness		●			
	Social and Islamic traditions		●			
(Vilaseca-Requena, et al., 2007)	Characteristics of the competitive environment		●			
	Organizational characteristics of the firm		●			
	Strategic orientation	●				
	Innovative capacity	●				
	Managers ' characteristics			●		
	IT equipment possessed and the uses the firm makes of it	●				
(Fathian, et al., 2008)	Organizational features		●			

	ICT infrastructures	●				
	ICT availability and security and legal environment		●			
(Nurmilaakso, 2008)	Organizational factors		●			
	Technological factors	●				
(Nasco, et al., 2008)	Behavior of the organization		●			
	Subjective norm and attitude constructs		●			
(Qureshi & York, 2008)	Perception of and attitude toward IT adoption		●			
	Benefits and costs				●	
	Perceived behavioral control over IT		●			
(Tan, et al., 2009)	Relative advantage	●				
	Compatibility	●				
	Complexity	●				
	Observability	●				
	Security	●				
(Alam & Noor, 2009)	Perceived Benefits		●			
	Perceived Cost				●	
	ICT Knowledge and Skill					●
	External Pressure		●			
	Government Support		●			
(Scupola, 2009)	Role of government		●			
	Technology support infrastructure	●				
	CEOs characteristics and top management support			●		
	Employees' IS knowledge and attitude					●
	Resource constraints	●				
(Boeck, et al., 2009)	Specific EC processes and tools	●				
(Johnson, 2010)	Firms' size	●				
	Slack resources	●				
	Economies of scale				●	
	Able to handle the risk of investment	●				
	Pressure on their trading partners to adopt the same technologies		●			
(Ghobakhloo, et al., 2011)	Top management			●		
	Resource	●				
	End user		●			
	IT solution computer applications	●				
	Organizational behavior and characteristics		●			
	Competitive environment		●			
	Government		●			
	Customers and suppliers		●			
	External IT consultant and vendors		●			
(Grandon, et al., 2011)	Behavior		●			

(Kurnia & Ali, 2012)	Social condition		●			
	Economic condition				●	
	Political condition and		●			
	Technological condition	●				
(Iddris, 2012)	E-payment infrastructures	●				
	Insufficient developed legal and regulatory system	●				
	Required high initial investments of EC				●	
	EC security	●				
	Insufficient EC technology knowledge		●			
	Managers' lack of interests			●		
	Lack of technical skills					●
	Cultural resistance		●			
	Internet security concerns	●				
	Expansion and growth	●				
	Competitive advantages		●			
	Customer service improvement		●			
	Attracting new customers		●			
(Li & Xie, 2012)	Environment		●			
	Firm	●				
	Technology	●				
(Sila, 2013)	Scalability	●				
	Firm size	●				
	Firm type	●				
	Management level			●		
	Pressure from competitors		●			
	Data security	●				
	Trust		●			