Information Systems in Supply Chain Management - The case of Aegean Archipelago

Euripidis Loukis
Ass. Professor, University of the Aegean

Konstantinos Papalamprou
Graduate of Information Systems Engineering

Abstract

Today Information Systems (IS) are extensively used by enterprises, in order to increase both their internal efficiency and their cooperation with suppliers, partners and customers. Not only the extent, but also the maturity of IS usage is continuously increasing, resulting in higher level benefits and impact. This paper reviews the exploitation of IS for supporting the Supply Chain Management (SCM). The previous and the modern generations of IS for supporting the SCM are analysed, and their main characteristics, capabilities, benefits and impact on the SCM are examined. Special emphasis is put on the Internet-based e-business, and in general on the various new business models which are enabled by the Internet. Finally, it is emphasized that these opportunities offered by modern IS for supporting SCM concern not only the bigger enterprises, but also the small and medium enterprises (SMEs) ; also huge opportunities are offered to the enterprises of regions, which are remote from the big markets. Therefore the enterprises of the Aegean Archipelago islands, if they exploit these opportunities rationally, can get significant benefits, participate in bigger pan-hellenic or even pan-european Supply Chains and increase significantly their sales and profitability.

1. Introduction

There are several definitions of Supply Chain (SC) and Supply Chain Management (SCM). A SC is defined as '.. a network of organizations that are involved, through upstream and downstrean linkages, in the different processes and activities that produce a particular value in the form of a particular product and/or service for a consumer' [32] The SC consists of all stages involved, directly or indirectly, in fulfilling a customer request [1,5,14] ; in most industries it includes not only the manufacturer and the suppliers, but also transporters, warehouses, wholesalers, retailers and customers themselves. The objective of every SC is to maximize the overal value generated ; this value is equal to the value of the final products and services produced for the customer, minus the value of the resources spent in all the stages of the SC for producing them. The value generated by the SC is strongly correlated with the total SC profitability, which is then distributed in the various stages of the SC. Therefore the various stages of the SC are allies collaborating for maximizing this total SC profitability, while at the same time they are competing for the distribution of this total profitability ; in some cases predominant is the collaboration, while in others the competition [1,3,10]. The success of a SC is measured based on the total value and profitability generated by it. The only real source

4th International Conference on 'Analysis of Manufacturing

of revenue is the customer. However there are numerous and complicated fund exchanges within the SC between the various stages, given that they usually have different owners.

A SC is a complicated system, involving the constant flow of information, products, services and funds between its different stages. Each stage of the supply chain performs different processes and interacts with other stages of the supply chain. The coordination of all these stages and of all these numerous flows between them is of critical importance for the success of the SC. This coordination has become today very difficult, because supply chains are not actually linear models but complex networks [5,14,21] ; in each of the above stages usually are involved numerous players, and the interconnections between them are highly complicated, e.g. one manufacturer can receive materials from several suppliers, and can supply several distributors, etc. Also this coordination very often is inefficient because each stage, is usually an independent enterprise having a different ownership, therefore aims to maximize its own profits and not the total profitability of the SC. One of the most important problems, which are generated due to lack of coordination between SC stages, is the well known 'Bullwhip Effect' : even small variations in the demand from the customers increase significantly as the are transmitted upstream to the retailers, the wholesalers, the manufacturers and the suppliers [5,12,32]. This 'Bullwhip Effect' results in an increase of the manufacturing cost, the inventory cost, the transportation cost and the lead time, and therefore in an increase of the prices paid by the customers and in SC profitability reduction. In order to improve the coordination between SC stages it is necessary i) to build trust-based relationships between the stages, ii) to improve and support the information flows between them.

In general we can divide the required coordination between the various SC activities into three main levels: (1) Intracompany-Intrafunctional Coordination (coordination of the activities and processes within one of the functions of one of the enterprises participating in the SC), (2) Intracompany-Interfunctional Coordination (coordination of interfunctional activities, such as between logistics and finance, logistics and production, and logistics and marketing, within one of the enterprises participating in the SC), (3) Intercompany-Interfunctional Coordination (coordination of interorganizational activities that take place between legally separate enterprises participating in the SC). The goal of all this coordination is to link the marketplace, the distribution network, the manufacturing process, and the procurement process in such a way that customers are serviced at high levels and yet at a low cost [4, 6].

In modern globalized customer-focused marketplace, the successful Supply Chain Management (SCM) has become of critical importance to competitive advantage [2, 7]; it is not any more individual enterprises that compete for increased marketshare, but whole SCs. Therefore SCM can be defined as '.. the integration of key business processes from end user through original suppliers that provides products, services and information that add value for the customer' [32].

All these processes of the SC can be divided into two basic categories, depending on the timing of their execution relatively to the customer demand [5]. The first category are the 'Pull' processes (also referred to as 'reaction' processes), whose execution is initiated in response to customer order, while the second category are the 'Push' processes (also referred to as 'speculative' processes), which are executed in anticipation of customer orders. In 'Pull' processes at the time of execution demand is known with certainty ; in 'Push' processes at the time of execution demand in not known and must be forecast. One

of the most significant design decisions in a SC is the location of the 'Push/Pull Boundary' (that seperates the 'Pull' processes from the 'Push' processes).

In general the main decision in the design of a SC is to determine two basic characteristics : the level of Responsiveness (defined as the capability of the SC to respond to wide fluctuations of demand, to offer high level of service-availability, to meet short lead times, to produce a large variety of products, to innovate and offer new products) and the level of Efficiency (defined as the capability to produce and deliver to the customer products and services at a low cost). If we want to achieve a high level of Responsiveness, the cost will be high, resulting in low Effectiveness; also if we want to achieve low cost for the customer, and therefore a high level of Effectiveness, we must have low levels of Responsiveness. Therefore the design of a SC is a compromise between Responsiveness and Efficiency. This compromise has to be based on the needs and the priorities of the customers aimed at (referred to as 'Strategic Fit').

Based on the above mentioned fundamental concepts of SC and SCM, in the next sections we review the exploitation of IS for supporting SCM. The previous and the modern generations of IS for supporting the SCM are analysed, and their main characteristics, capabilities, benefits and impact on the SCM are examined. Special emphasis is put on the Internet-based e-business, and in general on the various new business models which are enabled by the Internet.

2. Information Systems for SCM : Past & Present

Information and Communication Technologies (ICTs) are critical factors to the performance of a SC, because they provide the tools to gather and analyze the necessary information in order to make all the required SCM decisions at the operational, at the planning and at the strategic level, for managing optimally all the resources of the SC (production and storage facilities, inventory, transportation means). Without appropriate Information Systems (IS) we can only make SCM decisions blindly ; for example without IS, we will not know what customers want, how much inventory is in stock and when more products should be produced and shipped. IS serve as the eyes and ears of SCM, capturing and delivering the information necessary to make good decisions [5,6,14].

In general, ICTs have changed the way that companies in all stages of the SC operate and cooperate. The information that is captured enable managers to make right decisions from the strategic phase (long-term decisions) to the planning phase (shorter term decisions) and to the operation phase (every day or week decisions). Information is basically needed for making decisions in order to manage optimally the SCM resources: Inventory, Transportation and Facilities (Production, Storage), and in particular :

- **Inventory** : Setting optimal inventory policies requires information that includes demand patterns, cost of carrying inventory, costs of stocking out, and costs of reordering.
- **Transportation** : Deciding on transportation networks, routing, modes, shipments, and vendors all requires information including costs, customer locations, and shipment sizes to make good decisions.

- **Production and Storage Facilities :** Determining the location, capacity, and schedules of a facility requires information on the trade-offs between efficiency and flexibility, demand, exchange rates, taxes and so on.

In the following subsections are analysed the previous and the modern generations of IS for supporting the SCM, in order to understand better the existing situation, which is highly mixed and complcated : in most SC there are both older IS belonging to previous generations, and also at the same time modern IS reflecting the state of the art. All these systems are categorised along two dimensions : the level of the SC decisions they support (strategic decisions concerning long time horizons of several years, planning decisions concerning several months up to one year, operational decisions concerning one week or less) and the stage(s) they cross (Supplier, Manufacturer, Wholesaler, Retailer, Customer).

2.1 The Past - Legacy Systems

The first generation of IS for supporting SCM were 'legacy' systems based on the mainframe technologies, that supported at the operational level one of the basic functions (e.g. manufacturing, warehouses), or a part of a basic function, in one of the SC stages [5,6,20]. Also they usually did not offer analytical capabilities for supporting decisions at the planning and the strategic level. These systems continue to exist today in many enterprises, having undergone many software modifications in order to support new requirements, and had a life much longer than initially intended. They can be very complex after all these continuous software modifications. The legacy systems focus on one specific function of one stage, therefore they offer a very narrow scope of visibility of the SC. Also they are based on proprietary technologies of some vendors, and therefore is very difficult the communication with other systems supporting other functions in the same enterprises (e.g. the systems monitoring the inventory level in the warehouse cannot easily communicate with the systems handling the transportation), or with systems of other SC enterprises (e.g. systems of the manufacturer cannot easily communicate with systems of the wholesaler). With such limited visibility, enterprises using legacy systems often make decisions that have very narrow scope and do not support the total SC profitability. So, these systems function efficiently only at the operational level and not at planning and strategic phase. Another disadvantage is that these systems are usually based on mainframe technology that is difficult to modify and takes a long time to modify them when situations change.

The main advantage of these legacy systems is that these systems run for many years, therefore, are less risky in some respects than installing a new untested system whose operational capabilities are unknown. Another advantage is that legacy systems sometimes require less incremental investment (e.g. for upgrades or modifications) than installing new systems.

2.2 The Present – ERP Systems

The legacy systems approach lead enterprises to a situation, where their different functions or departments often had different incompatible systems, therefore the communication between them was very difficult and the intra-enterprise coordination was

not supported. Much more difficult was the communication with the other SC stages and in general the SC coordination. For these reasons the IS which are used today by companies are the ERP systems [22,23,28]. The ERP systems are operational IS that gather and process information from all the functions of the enterprise, having a broader scope than the legacy systems. ERP systems systems monitor material, orders, production schedules, finished goods inventory, transportation schedules, procurement schedules and other information throughout the entire organization. They can support processes crossing more than one functions and departments of the enterprise. The ERP systems have many modules, each of them covering a different function within the enterprise, which are well integrated and can communicate (usually they have a common database). The main modules are :

- **Finance.** This module tracks financial information such as revenue and cost data through various areas within the company.
- **Logistics.** This module is often broken into several sub modules covering different logistics functions such as transportation, inventory management, and warehouse management.
- **Manufacturing.** This module tracks the flow of products through the manufacturing process, coordinating what is done to what part at what time.
- **Order fulfillment.** This module monitors the entire order fulfillment cycle keeping track of the progress the company has made in satisfying demand.
- **Human resources.** This module handles all sorts of human resources tasks, such as the scheduling of workers.
- **Supplier management.** This module monitors supplier performance and tracks the delivery of supplier's products.

ERP systems have historically resulted in significant redesigns and improvements of the internal processes, because the enterprise has to adopt one of the processes incorporated in and supported by the ERP systems ; these incorporated processes are based on a wide study of the best practices in many enterprises. But in some cases none of these incorporated processes is the optimal for the enterprise ; however the enterprise has to change its processes and adopt one of the incorporated processes in the ERP because the required modification of the ERP is quite difficult and expensive.

Therefore the main advantage of ERP systems is that they have a wider scope and offer a wider visibility than the legacy systems, but this scope and visibility is limited to one SC stage. Also another advantage is that ERP systems are based on on-line update of information, so they can immediately respond to changes, and also that they can be better integrated with the Internet, which resulted in the development 'outwards looking' systems (e.g. allowing the customer to enter orders over the Internet, to pay over the Internet, to track his/her orders over the Internet, etc), usually referred to as 'e-Business', as described in following sections.

2.3 The Present - Internet

Without a doubt, the Internet has radically changed the way business is done, and in particular the SC is managed [8,9,11,13,25,26]. The growth of Internet in the 1990s and its wide acceptance by all businesses has created a technological base that can support the integration between SC stages (suppliers, manufacturers, wholesalers, retailers,

customers). Based on the Internet the cross SC integration between the IS of the various SC stages can be achieved at a lower cost and with minimal technical problems. This is very important because the problem of integration between SC stages has persisted for years for several reasons. First, the separate enterprises which own the various stages often do not have interoperable systems. Early efforts to reduce these interoperability difficulties resulted in the introduction of electronic data interchange (EDI) standards [16], which facilitated information sharing among key SC stages. However, a significant problem with EDI is that it has been used mainly by large enterprises because of its complexity and relatively high cost of implementation. Also, there have been problems with implementing EDI in many industries. For example, in the UK car industry suppliers have been frustrated by the implementations of EDI employed by the vehicle manufacturers [24]. For these reasons the EDI industry is now turning to the Internet, in combination with the usage of XML, in order to extend its reach and make it easier and cheaper for small firms to use it, despite the initial reaction among large enterprises with well-developed EDI systems that the Internet was unreliable and open to risk as databases could be accessed by hackers. The development of virtual private networks (VPNs), which only permit access to approved users, constitutes a good solution to the security issue.

Two basic technological advances contributed highly to the migration from EDI to Internet : the advances in the area of Internet security based on assymetric cryptography public key infrastructures (PKI), and digital signature, and also the advances in the area of Java language. Java software applications which have the attributes of portability and interoperability can benefit the SCM. The Java codes can be interpreted by Java Virtual Machines (JVMs) in practically any computing environment, enabling these applications not only to operate on a variety of machines, but also to be dynamically loaded into a running machine. This fact can turn a heterogenous network of computers into a homogenous collection of JVMs.

Therefore today the coordination between SC stages can be achieved via the secure communication of their ERPs over the Internet using predefined XML messages. This trend has started, and will take some years to expand and be established as the dominant model. However in many complicated SC the number of participant enterprises per stage is very big, therefore the communication among them based on such 'point-to-point' connections is inefficient and expensive. In such cases the development of portals, which act as central points for the communication between the various stages, is gradually becoming the dominant model [3,8,12,25], as described in following sections.

We should also emphasize that one the first step towards this direction was 'e-Commerce', defined as the capability to do business transactions with electronic means. This step had mainly the form of web-sites allowing the business or individual customer to enter orders over the Internet, to pay over the Internet, to track his/her orders over the Internet, etc. In such cases in order to exploit the rich capabilities offered by Internet, is required the seamless integration of the 'Front Office' (web site) and the 'Back-Office', e.g. if an web-based site that accepts orders from customers does not also automatically transmit them to the back office application or to the ERP module responsible for processing requests, the whole solution is largely unprofitable and inefficient. These e-Commerce web sites were initially used by the enterprises for creating a new electronic sales channel, accessible by customers from anywhere in the world and anytime (24

hours x 7 days accessibility), focused on their existing products ; however gradually they enabled an enrichment of the offering to the customer (new products and services were introduced), and also 'Mass Customization' [16,17]. Products such as PCs, cars, etc. are created, marketed and sold not based on forecasts of the demand, but on the wishes and preferences of the customer, who can enter a web site, configure and order his/her own specialized product, based on some predefined elements. If such a site in combined with appropriate back-end information systems (e.g. of ERP type) and with appropriate flexible manufacturing equipment, it can enable the production of customized specialized products at a low cost. In this way the Responsiveness – Efficiency frontier of the whole SC is pushed forward; also the 'Pull/Push Boundary' is changing in favour of 'Pull', leading to structural transformations of the SCs. Some claim that 'mass customization will be as important to business of the 21st century as mass production was in the 20th century' [17].

2.4 The Present - Analytical Systems

The SC Analytical Systems are focused mainly on the support of planning and strategic level SC decisions [5,6]. They analyze operational information (mainly historical) from the legacy systems and the ERPs, in order to support SC-related decisions. For example, based on ERP data concerning demand hostory, inventory levels, stock-outs, supply and manufacturing lead times, etc., are proposed the optimal inventory policies. Analytical Systems usually rely on sophisticated algorithms including linear programming, mixed integer programming, genetic algorithms, theory of constraints and many types of heuristics. Today the functionality of most ERP packages does not include analytical components, e.g the manufacturing component of most ERP systems lacks adequate operations research/management science (OR/MS) models to optimize manufacturing issues ; however most ERP vendors are working in order to enrich their products with such analytical components-modules.

The first category of Analytical Systems are the **Advanced Planning and Scheduling (APS) Systems**, produce schedules concerning what to make, where and when to make it, and how to make it, taking into account the business objectives, and the availabilities of materials, the capacities of the production and storage facilities and all other constraints. Their main capabilities concern :

- Allocation of production capacity in different production locations.
- Allocation of materials to different production locations
- Planning and optimization of intra-enterprise and inter-enterprise flows of products
- Integrated stock management.

Also APS systems usually offer longer horizon planning (up to the strategic level) functionality.

Other important categories of analytical systems which can be used to improve the performance of the SC are:

- **Procurement and Content Cataloging Applications.** These systems allow analytical comparisons of various suppliers, in order to help buyers make better sourcing decisions.
- **Transportation Planning and Content Systems.** These systems perform various kinds of analysis to determine how, when, and in what quantity materials should to be

transported. Comparisons of different carriers, modes, routes, and freight plans can be made using these systems.

- **Demand Planning and Revenue Management.** These systems aim at supporting enterprises in forecasting their future demand. They take as inputs historical demand (sales) data and any existing information concerning future demand (e.g. scheduled promotions), and develop models to help explain past sales and forecast future demand.
- **Customer Relationship Management (CRM) and Sales Force Automation (SFA).** These systems assist enterprises to monitor and design the relations with their customers, and to monitor and optimally exploit their sales force.

2.5 New Supply Chain scenarios: E-shopping VMI, EPOS and Supplier Hubs

The ICTs not only support SCs, but also very often enable and give rise to their transformation. One of the most well-known transformation is 'Disintermediation' : using this term is meant the elimination of some SC stages, which play a role of simple intermediation between sellers and buyers (matching and information provision). At the same time new SC stages can be added, based on the ICTs and the Web, giving rise to 'Re-intermediation' [35]. In Fig. 1 [8] we can see the 'traditional' SC scenario, and four new SC scenarios, which are enabled by ICTs : e-shopping, EPOS enabled SC, Vendor Managed Inventory (VMI) and Reduced SC.

As 'e-shopping' is meant the SC model, where the manufacturer receives orders directly from the end consumers, mainly via the Internet, and then ships the product directly to them, without any intermediation (e.g. retailers, wholesalers, etc.). In the EPOS enabled SC scenario, the end consumer sales (CONS), which are made in Electronic Points of Sales (EPOS) are made visible to all stages of the SC. In the simpler version of this scenario, these electronic data are used by each stage independently for their own planning. In the more complex version of these scenario these electronic data are the basis of 'Collaborative Planning', where many stages are involved and contribute [8,19,25]. An efficient way to simplify the SC planning process is to use Vendor Management Inventory (VMI) : in this scenario the upsteam stage is responsible to handle the stock management of the downstream stage. The upstream stage must have electronic access to sales and inventory data of the downstrean stage, which requires not only appropriate ICTs, but also a trust-relationship between them. This makes it possible for the upstream stage to adjust production and distribution planning to changes in consumer demand. Of course, such a planning decreases the complexity in supplier relationships and by this system the suppliers are able to access the retailer's information system to view stock levels and future requirements. In the Reduced SC one or more stages have been eliminated.

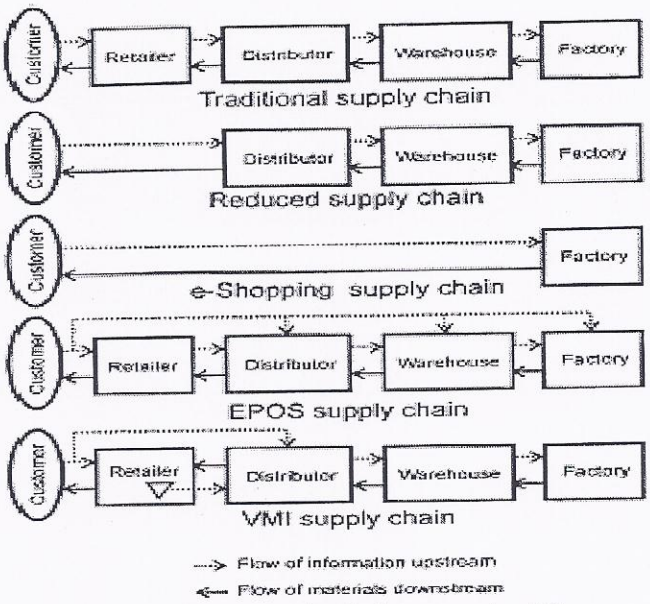

Fig.1. Five supply chain scenarios [8]

2.6 E-marketplaces - Supply Chain Portals

An e-Marketplace (EM) is defined as a web-site on the public Internet that allow large communications of buyers and suppliers to "meet" and trade with each other [2, 11, 18, 20, 35]. They present ideal structures for commercial exchange, achieving higher levels of market efficiency by tightening and automating the relationship between suppliers and buyers. The unique feature of an EM is that it brings multiple buyers and sellers together (in a virtual sense) in one central market. So, the meeting point is the cyberspace something which benefits the whole SC. Their services can be divided in two basic types: a) transaction based services, and b) strategic services. A transaction type service includes transactions that do not rely on a strong trust-relationship between the seller and the buyer, such as electronic catalogues, auctions, reverse auctions, exchange of public information, order tracking, etc. In contrast, strategic services rely on long-term trust-relationships, and include the exchange of strategic information among participant organizations (e.g. the exchange of sales and inventory information, promotion sales, etc., in order to support planning, or collaborative planning, and reduce the 'Bullwhip Effect' – mentioned in the Introduction – and its negative consequences).

As mentioned above the electronic exchange of information among SC stages is of great importance for the SC performance and total profitability : if one stage can use the information of other stages of the SC, the negative effects of uncertainty (i.e. higher inventory levels, inaccurate forecasts, and unfulfilled orders) can be significantly reduced, resulting in reduction of cost and increase of the service level to the customer. In practice, however, the exchange of information between companies is not as easy as it seems. Many different systems and standards are used, the number of peer-to-peer relationships with other companies in the network is usually too large to manage, and most systems are not open for easy exchange of information with other systems. A SC Portal represents a solution to overcome these problems [3]. Standardized interactions

with one Portal are easier to manage than are many interactions with many SC stages. The SC Portal provides an organization with a single, unified database, linked across all functional systems, both within the organization and between the organization and its major SC partners. The Portal described in [3] is a very interesting implementation of this concept for the US Department of Defense. The main idea was based in the fact that Internet provides the opportunity for demand data and supply capacity data to be visible to all companies within the SC. Consequently companies can be in a position to anticipate demand fluctuations and to respond accordingly. The design of this SC Portal is shown in Fig.2. Suppliers can be given access to the inventory levels of other portal users and tune their production according to this information. Customers can be given diverse information and services on a unified front-end via the Internet. For instance, a customer can log onto the Portal, enter an assigned security password, and gain access to real-time information about his/her order, to the availability of a specific product or production capacity, etc. In general a SC Portal will have a front-end display to promote products or services, an encryption system to allow secure trading, and a credit or payment authorization capability.

In Table 1 is shown a comparison between these Portal systems and their predecessors.

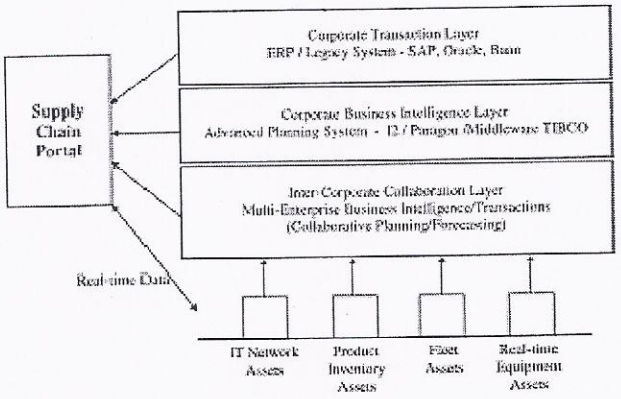

Fig.2. Design of e-supply chain portal as it is described in [3]

Table 2
Comparisons between pre-portal and portal systems on user experience, technology, workflow automation, and managerial implications

Pre-portal system characteristics	Portal system features
User experience	
Multiple screens and complex drill-down menus	Supply chain operations management views drastically reduced for ease of use
Widely distributed and varied databases/applications/ information sets, with little "Information Fusion" or integration into coherent user views	Role and personal preferences-based information delivery to user Single sign on to the Portal with easy to navigate user-interface and decision support tools
Logistics managers did not have "complete picture"	Top layer control panel that acts as real time management window on total operations, transactions and performance results
Critical technology infrastructure	
Fragmented online logistics services, with no clear overriding business logic/intelligence or automated rules	Integrated e-Portal services for logistics, a single scalable eBusiness platform with open standards and "plug and play" software interoperability capabilities
	Creation of an intelligent gateway using new mega-portal server that acts as a "Traffic Cop", channeling internet traffic associated with logistics
Key databases and applications migrated online, but remain separate islands of information that require multiple user logons and time-consuming online information searching	Portal routes data traffic into secure/non-secure communications tracks as appropriate Portal ties together diverse backend data systems and presents a unified display of data to the user
Wide geographic distribution of core actors and "black holes" in communications systems across user communities	Leverage new telephony switching services and build "follow me/find me" communications features across multiple devices (PCS, cell phones, PDAs, etc)
	Key Logistics team members can be automatically notified of an event/alert and be conferenced together in real time over diverse, multimedia channels
Intelligent workflow/business rule automation	
Frontline maintenance/repair operation	
Time-intensive, paper-based handoffs from maintenance engineers to local supply personnel; and lengthy escalation procedures to obtain system-wide inventory	Intelligent requirements management feature enables maintenance engineers' intake checklists to be automatically translated into complete parts-requirements and ordering forms
Supply management/demand forecasting	
Multi-site inventory positions are not visible, especially industry supplier inventory	Multi-site inventory positions are integrated/displayed at portal level, including those of OEM suppliers
Predictive demand forecasts are largely based on site-level observations of parts usage and replacement patterns	More complex, dynamic multi-factor analyses
	Real time sensor data from on wing engines is sent to portal, engine status is automatically diagnosed and needed parts are ordered in advanced of maintenance visits
Managerial implications	
Priority on building separate new logistics network infrastructure, databases/applications	Rapidly and effectively deploying existing infrastructure, databases/applications within a unifying Mega-Portal architecture
"Trying to Keep Up" with hungry users	
Proliferation of information islands with no overlying navigational or cognitive logic	Enabling users to personalize the site for themselves: aggregation and fusion of Web Services/Information based on User Rules and Preferences

Table 1. Comparisons between pre-portal and portal systems

3. The New Business Models enabled by ICTs

The ICTs, as mentioned above, not only support, but also transform the SCs and the economy in general ; this transformation is also influenced by other forces such as global competition, information availability, educated consumers, rapid innovations and increasingly complex products. In such an environment new business models emerge or old business models improve and experience a renaissance [33,34,35], resulting in huge transformations of existing SCs. In this section we will describe 8 new business models that are currently in use or being experimented, that are expected to have a significant impact on SCs, also shown in Figures 3 and 4.

I. e-shop: This is Web marketing of a company or a shop. In first instance this is done to promote the company and its goods or services. Increasingly added is the possibility to order and possibly to pay, often combined with traditional marketing channels. Benefits sought for the company are increased demand, a low-cost route to global presence, and

cost-reduction of promotion and sales. Benefits for the customers can be lower prices compared to the traditional offer, wider choice, better information, and convenience of selecting, buying and delivery, including 24-hour availability.

II. e-procurement: This is electronic tendering and procurement of goods and services. Large companies or public authorities implement some form of e-procurement on the web. Benefits sought are to have a wider choice of suppliers which is expected to lead to lower cost, better quality, improved delivery, reduced cost of procurement (e.g. tendering specs are downloaded by suppliers rather than mailed by post). Electronic negotiation and contracting and possibly collaborative work in specification can further enhance time- and cost saving and convenience. For suppliers the benefits are in more tendering opportunities, possibly on a global scale, lower cost of submitting a tender, and possibly tendering in parts which may be better suited for smaller enterprises, or collaborative tendering (if the e-procurement site supports forms of collaboration). The main source of income is reduction of cost (automated tender processing, more cost-effective offers).

III. e-auction: Electronic auctions (on the Internet) offer an electronic implementation of the bidding mechanism also known from traditional auctions. This can be accompanied by multimedia presentation of the goods. Usually they are not restricted to this single function. They may also offer integration of the bidding process with contracting, payments and delivery. The sources of income for the auction provider are in selling the technology platform, in transaction fees, and in advertising. Benefits for suppliers and buyers are increased efficiency and time-savings, no need for physical transport until the deal has been established, global sourcing. Because of the lower cost it becomes feasible to also offer for sale small quantities of low value, e.g. surplus goods. Sources of income for suppliers are in reduced surplus stock, better utilization of production capacity, lower sales overheads. Sources of income for buyers are in reduced purchasing overhead cost and reduced cost of goods or services purchased.

III. e-mall: An electronic mall, in its basic form, consists of a collection of e-shops, usually enhanced by a common umbrella, for example of a well-known brand. It might be enriched by a common - guaranteed - payment method. This is giving entry to individual e-shops. Benefits for the customer (real or hoped for) are the benefits for each individual e-shop (see above) with additional convenience of easy access to other e-shops and ease of use through a common user interface. When a brand name is used to host the e-mall, this should lead to more trust, and therefore increased readiness to buy. Benefits for the e-mall members (the e-shops) are lower cost and complexity to be on the Web, with sophisticated hosting facilities such as electronic payments, and additional traffic generated from other e-shops on the mall, or from the attraction of the hosting brand. Revenues are from membership fee (which can include a contribution to software/hardware and set-up cost as well as a service fee), advertising, and possibly a fee on transactions (if the mall provider processes payments).

III. Third-party marketplace: This is an emerging model that is suitable in case companies wish to leave the Web marketing to a 3rd party (possibly as an add-on to their other channels). They all have in common that they offer at least a user interface to the suppliers' product catalogues. Several additional features like branding, payment, logistics, ordering, and ultimately the full scale of secure transactions are added to 3rd party marketplaces.

VI. Virtual communities: The ultimate value of virtual communities is coming from the members (customers or partners), who add their information onto a basic environment provided by the virtual community company. The membership fees as well as advertising generate revenues. A virtual community can also be an important add-on to other marketing operations in order to build customer loyalty and receive customer feedback. Virtual communities are also becoming an additional function to enhance the attractiveness and opportunities for new services of several of the other business models listed here (e.g. e-malls, collaborative platforms, or 3rd party marketplaces).

V. Value-chain service providers: These specialize on a specific function for the value chain, such as electronic payments or logistics, with the intention to make that into their distinct competitive advantage. New approaches are also emerging in production/stock management where the specialized expertise needed to analyze and fine-tune production is offered by new intermediaries.

VI. Value-chain integrators: These focus on integrating multiple steps of the value chain, with the potential to exploit the information flow between those steps as further added value. Revenues are coming from consultancy fees or possibly transaction fees.

VII. Collaboration platforms: These provide a set of tools and an information environment for collaboration between enterprises. This can focus on specific functions, such as collaborative design and engineering, or in providing project support with a virtual team of consultants.

VIII. Information brokerage, trust and other services: A whole range of new information services are emerging, to add value to the huge amounts of data available on the open networks or coming from integrated business operations, such as information search, e.g. Yahoo (www.yahoo.com), customer profiling, business opportunities brokerage, investment advice, etc. Usually information and consultancy have to be directly paid for either through subscription or on a pay-per-use basis, although advertising schemes are also conceivable. A special category is trust services, as provided by certification authorities and electronic notaries and other trusted third parties. Subscription fees combined with one-off service fees as well as software sales and consultancy are the sources of revenue

In the following Fig. 6 [28] we give the qualitative mapping of the above business models along two dimensions. The first dimension gives the degree of innovation. The second dimension is the extent of integration of functions, ranging from single function business models (e.g. e-shop), to fully integrated functionality, e.g. value chain integration. Fig. 7 [28] gives a number of examples.

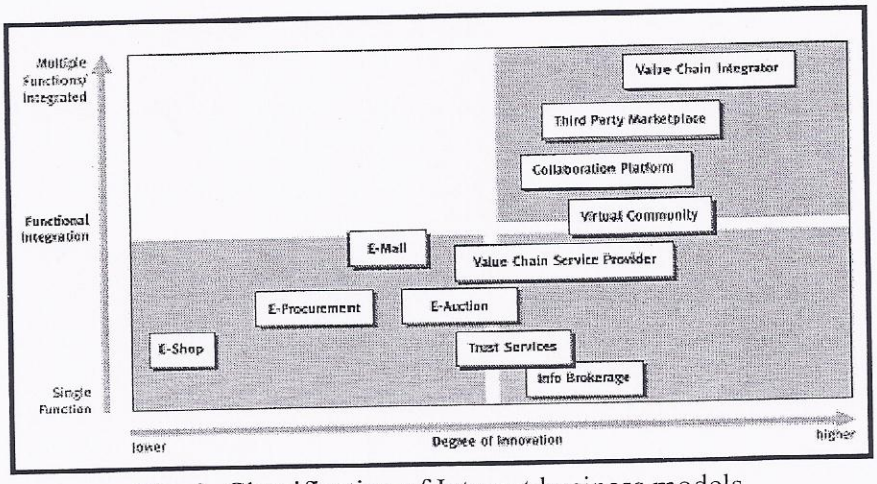

Fig. 3. Classification of Internet business models

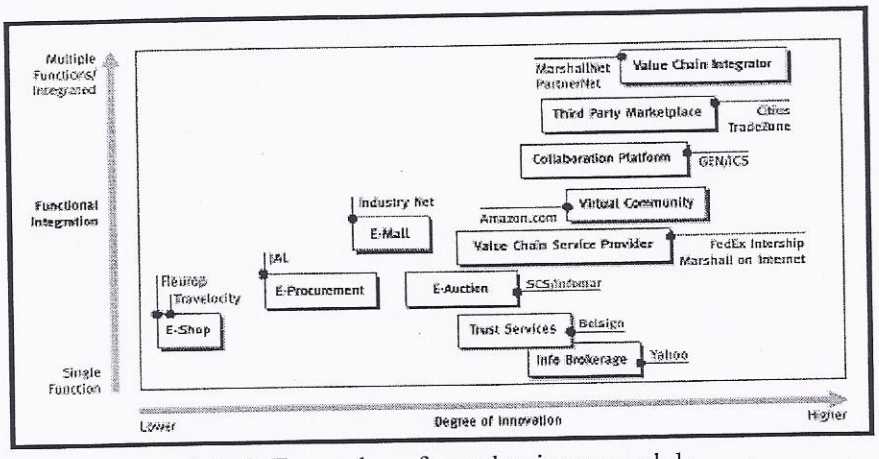

Fig.4. Examples of new business models

4. The Case of the Aegean Archipelago

The enterprises of the islands of Aegean Archipelago are small or medium sized enterprises (SMEs); most of them are family enterprises, belonging to traditional economic sectors (agriculture, fishing, tourism, small constructions, etc). Their main problem are : (1) they have very small markets (each enterprise located in one of the islands has mainly the market of this island : usually the people who live in this island and the tourists who visit the island in summer), so it cannot have many customers, therefore they cannot benefit from scale economies, (2) they are in a long distance from the big markets of Greece (located in the big cities, such as Athens, Thessaloniki, etc.), (3) they are in a long distance from the big suppliers (also located in the big cities, such as Athens, Thessaloniki, etc.), (4) there are not sufficient transport means (to/from the other Aegean islands and to/from the big cities of Greece). Also these SMEs of the Aegean Archipelago islands do not make extensive use of ICTs : they mainly have one or more PCs for accounting and administration purposes. The majority of these companies do not have complex information systems such as ERP or analytical systems, which are

very expensive for them, but many of them have access to the Internet ; the existing electronic Internet-based services (e.g. e-VAT, e-Taxation, e-Social Securities, e-banking, etc) have been their main motivation.

In many research papers [9,15,26] we can find that many types of products and services (among others discussed in this paper) are appropriate for SMEs to sell or promote over the Internet, such as : services of local interest that can be digitized, products and services that appeal to a community, such as ethnic foods' fans and hobbyists, services that rely on local knowledge and relationships, such as real estate, and products and services where there is an opportunity to sell directly to the consumer, such as fresh fish or agricultural products. All the above types of products and services and some unique products and services can be found in Aegean islands and in fact these are the majority of products or services that the SMEs sell in these islands. There are some key elements to foster the ICT-based solutions in small enterprises, which are derived from the practical experience of EU funded projects (ADAPT, SOLARE etc) that took place in SMEs in order to introduce ICT in these enterprises [32]. These key elements match with the Aegean enterprises' needs.

Developing a full awareness of the huge potentials of ICTs should be the starting point. Forcing the introduction of technology is one of the main reasons behind the failure of several attempts of the SMEs to become e-business organizations or simply to use ICT effectively for new services. The path to full awareness should be to introduce concrete and short-term benefits for the enterprises, in the form of some new electronic Internet-based services, so that they will be persuaded to proceed to a higher level of ICTs usage. Another important aspect is that ICT-based solutions should be introduced gradually: sudden transformations may fail due to unaware and unready business organizations. A further fundamental element concerns adequate training and support. The smaller the enterprise, the greater this problem becomes, since most small companies are not using information technology for their activities (apart from specific accounting services, and little more). Consequently, several problems must be solved to make ICT simpler to use, reliable and well integrated in the enterprises activities. The adoption of continuous training solutions can play an important role in increasing the awareness of the huge potentialities of ICT for concrete situations; in this way employees, managers, entrepreneurs, can acquire a learning culture, integrating the training in their work activities and understanding in depth the potentialities of communication and information tools.

Concerning the above mentioned required new electronic Internet-based services, the first should be an e-Marketplace of Aegean (with pages and product catalogues from all the local enterprises, strong search and compare facilities, auctions, etc.), that will unify all the small marketplaces of the islands into a bigger marketplace (that will be much more effective), and give a single point of access to the SMEs of Aegean islands (from the big cities of Greece, or even form Europe) ; it could also be organized in smaller sectoral e-Marketplaces (e.g. a touristic one, an agricultural one, etc.). Also this e-Marketplace should give electronic access to and booking of transportation, which as mentioned above is a major problem, and also access to e-banking. Also local SMEs having access to the Internet can participate in bigger remote SCs (e.g. in the bigger areas of Greece), and organize electronically their relevant transactions. This e-Marketplace can operate according to the Application Service Provider (ASP) model : one specialised

enterprise will operate it, and all the participating SMEs will pay for this service. Also the required internal IS functionality by most of these SMEs can be offered to them via the ASP model.

The successful exploitation of the ICTs and the effective use of the Internet will have numerous direct and indirect, internal and external effects on the SMEs of the Aegean Archipelagos. First of all, the Internet can provide small businesses with low cost worldwide visibility, that means the Internet presence gives cheap advertising and marketing exposure. In addition, the web can eliminate time and distance obstacles to business, that described above. A web page can take orders or answering questions originating at any time or place and search engines make it likely that a potential customer searching for a product or service will find an organization's well-indexed page [33]. The cost of internet transactions are independent to distance, thus, the advantage may be smaller for firms selling goods (e.g. local products) rather than services (e.g. hotel reservations). Moreover, the Internet (and cheaper phone calls and faxes) facilitates sharing information between companies, suppliers and customers, something that can increase bargaining power in myriad of ways e.g. a firm able to buy from many suppliers increases its bargaining power over individual suppliers. Especially, the SMEs can increase their bargaining power by forming bulk purchasing alliances. Consequently, the most important benefits for Aegean islands enterprises are: reach and access to new markets- chance to expand local markets, new modes of direct and indirect advertising, low cost communication (especially by e-mails), easy access to potential customers, company image enhancement, and formation and extensions of business networks.

5. Conclusions

The present paper reviews the previous and the modern generations of IS for supporting the SCM, and describes their main characteristics, capabilities, benefits and impact on the SCM. It is described how the ICTs and the Internet can not only support multidimensionally the SCs and support all the decision levels (operational, planning and strategic), but also can transform them and give rise to new business models ; the ICTs give rise to new business models. or the improvement of the existing models. The most important and promising new business models that are expected to have big impact on SCM are presented. Finally, it is emphasized that these opportunities offered by modern ICTs for supporting SCM concern not only the bigger enterprises, but also the small and medium enterprises (SMEs) ; also huge opportunities are offered to the enterprises of regions, which are remote from the big markets. Therefore the enterprises of the Aegean Archipelago islands, if they exploit these opportunities rationally, can get significant benefits, participate in bigger pan-hellenic or even pan-european Supply Chains and increase significantly their sales and profitability. The companies of the Aegean islands can be benefited in many ways if these ICT capabilities can be exploited, in combination with continuous training on both technological aspects as well as on the socio-relational and cultural changes that must occur inside these enterprises.

References

1. AMR, (1998). Are we moving from buyer to seller to collaborators?. SCM Report, American Manufacturing Research Inc.
2. Ballou, R. H., Gilbert, S. M., & Mukherjee, A. (2000). New managerial challenges from supply chain opportunities. Industrial Marketing Management, 29, pp. 7 –18.
3. Boyson, S., Corsi, T., Verbraeck, A., (2003), The e-supply chain portal: a core business model. Transportation Research Part E , pp.175 - 192
4. Chaston, I., (2001), E-marketing strategy. London: McGraw-Hill
5. Chopra, S., Meindl P. (2000), Supply Chain Management: Strategic, Planning and Operation. Prentice Hall Editions
6. Christopher, M. (1998). Logistics and supply chain management (2nd ed.) London: Prentice-Hall Editions
7. Coppel, J., (2000). E-commerce: Impacts and policy challenges. OECD Economics Department, Working Paper 252
8. Disney, S. M., Naim, M. M., Potter, A., (2003). Assessing the impact of e-business on supply chain dynamics. International Journal of Production Economics
9. Drew, S., (2003). Strategic uses of e-commerce by SMEs in the East England, European Management Journal, Vol. 21/1, pp. 79-88
10. Dyer, J.H., Ouchi, W.G., (1993), Japanese-style partnerships: giving companies a competitive edge. Sloan Management Review 35, pp. 51 –63
11. Edwards, N., Hancock, S., Mullen, J., (1998). Electronic commerce: reality bytes. Supply Management 9, pp. 32-38
12. Eng Teck-Yong, (2003), The role of e-marketplaces in supply chain management. Industrial Marketing Management, 5567, pp. 1-9.
13. Fraser, J., Fraser, N., Mc Donald, F., (2000), The strategic challenge of electronic commerce. Supply Chain Management: An International Journal, No 5
14. Fredenhall, L., Hill, E., (2001). Basics of supply chain management. St. Lucie Press, New York
15. Fulantelli, G., Allegra, M., (2003). Small company attitude towards ICT based solutions: some key-elements to improve it. Educational Technology & Society 6(1), pp. 43-49
16. Ghiassi, M., Spera, C., (2003). Defining the Internet-based supply chain system for mass customized markets. Computers & Industrial Engineering, pp. 1-25
17. Gilmore, J.H., Pine, B. J., (2000). Markets of one: creating customer-unique value through mass customization. Harvard Business Review
18. Grieger, M., (2003). Electronic marketplaces: A literature review and a call for supply management research. European Journal of Operational Research 144, pp. 280-294
19. Helms, M. M., Ettkin, L. P., Chapman, S. (2000). Supply chain forecasting – Collaborative forecasting supports supply chain management. Business Process Management Journal, Vol. 6/5, pp. 392-407.
20. Humphreys, P. K., Lai, M.K., Sculli, D., (2001). An inter-organizational information system for supply chain management. International Journal of Production Economics, pp. 245-255
21. Hvolby, H. H., Trienekens, J., (2002), Supply chain planning for small and medium sized companies. Computers in Industry, 49, pp. 3-8.

22. Kennerly, M., Neely, A., (2001) Enterprise resource planning: analyzing the impact. Integrated Manufacturing System, 12 (2)
23. Lambert, M.D., Cooper, M.C., (2000), Issues in supply chain management. Industrial Marketing Management, 29
24. McIvor, R., Humphreys, P., Huang, G., (2000). Electronic commerce: reengineering the buyer supplier interface. Bus. Process Manage. J. 6 (2), pp. 122-138
25. McIvor, R., Humphreys, P., McCurry, L. (2003), Electronic commerce: supporting collaboration in the supply chain? Journal of Materials Processing Technology, 6736
26. Mustaffa, S., Beaumont, N., (2002). The effect of electronic commerce on small Australian enterprises. Technovation
27. New, S. J., & Payne, P. (1995). Research frameworks in logistics: three models, seven dinners and a survey. International Journal of Physical Distribution and Logistics Management, 25(10), pp. 60–77.
28. Paterson, K. A., Grimm, C. M., Corsi, T. M., (2003). Adopting new technologies for supply chain management.Transportation research Part E, pp. 95-121.
29. Poon, S., Swatman, P., (1996). Small business alliances: internet-enabled strategic advantage. Paper presented at the 29th Hawai International Conference on Systems and Software, Hawai, January
30. Porter, M., (2001). Strategy and the Internet. Harvard Business Review 79, pp. 62-78
31. Roberts, B., Mackay, M., (1997). IT supporting supplier relationships: the role of electronic commerce. European Journal of Purchasing Supply Management 4, pp. 175-184
32. Rudberg, M., Klingenberg, N., Kronhamm, K. (2002). Collaborative Supply Chain Planning. Integrated Manufacturing Systems 13/8, pp. 596-610.
33. Tapscott, D., (2001). Rethinking strategy in a networked world. Strategy + Business Issue No 24. downloadable: www.strategy-business.com/ideaexchange
34. Timmers, P., (1998). Business Models for Electronic Markets. In: Gadient, Y., Beat, F.; Selz, D: EM–Electronic Commerce in Europe EM–Electronic Markets, Vol.8, No2
35. Turban, Efr., et al, (2002). Electronic Commerce –A Managerial Perspective. Prentice-Hall