Chapter 15

Cyber Transportation Logistics:
Architecting a Global Value-Chain for Services

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ABSTRACT

In today's global economy, products and services are provided across international borders. The sourcing of these products and services becomes an integral part of international businesses. Information, communication and transportation technologies (ICTT) have made this job significantly more streamlined. However, there is an advantage that big companies, such as Wal-Mart, have over small and medium size ones. While the big companies have the ICTT resources to source globally at will, small and medium enterprises (SME) are much less prepared to do so, resulting in a large competitive disadvantage. By contrasting SMEs with their more successful "big brothers," we highlight the salient ICTT features in a system architecture. This serves as a checklist for any assistance that might be rendered to SMEs and other entities in overcoming their competitive impediment. These findings are the result of numerous international workshops and conferences held in Hong Kong (the export city for a bulk of the Chinese consumer products) and in Arkansas (the headquarters of Wal-Mart).

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INTRODUCTION

In today's information and technology based global economy, the world experiences significant changes in the supply of goods and services. In the United States, call centers are not necessarily located domestically, but across the globe, including India. The biggest global retailer, Wal-Mart, imports a majority of its shelf items from China. In the last count, American Wal-Mart stores import approximately $15 billion in goods from China each year. Outside the US, Wal-Mart stores are currently located in nine countries. There is an unexpected connection between the former rice paddies in Southern China (now a major manufacturing region for consumer goods) and the remote Ozark Mountains (where Wal-Mart is headquartered). Supply chains are also critical to the public sector, as evidenced from recent experience with natural disasters such as Katrina in the US Gulf Coast and the disastrous earthquake in western China. In these instances, more can be done in delivering relief items to those dislocated in a timely and targeted fashion. The subject of *Cyber Transportation Logistics* aptly captures the interplay between e-commerce, shipments and services across the globe, robust and automatic systems of identification, and the complex worldwide supply chain for goods and services in general.

On an intellectual level, there is a mutual interest amongst selected industries in Arkansas (AR) and Hong Kong, where cyber-transportation-logistics industries are located. As mentioned, AR is the home state for Wal-Mart. Little Rock, AR is also the home for the Acxiom Corporation, a worldwide company specializing in data mining, data warehousing and consumer-market analysis. Memphis, Tennessee (TN), the international headquarters of Federal Express (FedEx), sits at the eastern border of AR. American Freightways, which provides ground operations for FedEx, is based in Harrison, AR. Among competing freight carriers—TNT, UPS—FedEx boasts the first exclusive right to serve within China, providing a direct air link to the US. Situated at the Pearl River Delta, Hong Kong is the main export hub for Chinese consumer products. While a majority is shipped by boat, high-end items are airlifted through Hong Kong, which is the air-cargo hub of Asia, and in particular, China—the fastest growing economy in the world. We contend that a cyber-transportation-logistics case-study based on this scenario covers the salient Information, Communication, and Transportation Technology (ICTT) factors to provide some useful insights.

On an academic level, research ideas were initiated first from reciprocal faculty visits between the City University of Hong Kong (CityU) and the University of Arkansas at Little Rock (UALR), between the School of Logistics (ISEL), Le Havre, France, and the Arkansas State University. This is followed by a series of workshops and conferences. This chapter summarizes research and instructional discussions and findings resulting from these joint workshops and conferences over the last five years. These discussions include those that took place in FedEx in Memphis, TN, a Wal-Mart Distribution Center in Bentonville, AR, Acxiom Corporation in Conway, AR, the International INFORMS Conference in Hong Kong, an Identity Solutions Symposium at Arkansas State University in Jonesboro, Arkansas, and an International Conference held in the Rockefeller Conference Center on top of Petit Jean Mountain, AR. While this paper focuses on the highlights, supplemental information can be found at the website: http://syen.ualr.edu/metalab/research/.

PRIORITIES

With the advent of information/communication technology and efficient transportation, it is an understatement that the world economy is now totally interdependent between even distant lands. For example, as the U. S. and Hong Kong transition from manufacturing-based to knowledge-based service economies, there are fundamental changes in organizational structures in similar places around the globe—including operational, decision and control, and behavioral changes. Under this scenario, the authors have the unique opportunity and responsibility to reexamine the important subject of *Cyber Transportation Logistics – Architecting a Global Value Chain for Services*. The classic supply chain problem has been researched by a number of authorities (Bowersox et al. 2007, Chopra & Meindl 2007, Coyle et al. 2009, Mangan et al. 2008). However, the core problem—namely identifying a more general paradigm on the technological factors for success—has yet to be overcome.

Two major paradigms of Supply Chain Management have been proposed (Li, 2008). The first is a traditional three-stage view, involving procurement, conversion, and distribution. The second is a three-flow view, which involves financial, information, and product flows (Ding et al., 2007; Lau et al., 2007). The basic structure of today's supply-chain/logistics (SC/L) typically includes three major components: operational (information flow), decision and control (planning, sourcing and procurement decisions), and behavioral (human-system interface, relationship management). Effective integration of these components will generate the product/service value flow between SC participants such as sellers and buyers (or suppliers, logistics providers, and customers) within the SC/L network (Bowersox et al. 2007).

The core issue can be simply phrased as a cost-benefit incidence problem, i.e., the person who pays for the costs may not be the only one that obtains the benefits. To the extent that goods and services change so many hands in a supply chain before it reaches the ultimate consumer, all participants in the chain share in the costs and the benefits. In other words, it is the *values* they gain that bring the willing partners to participate in this "chain." Pick the supply-chain security problem as an example, which has gathered full attention after the tragic event of 9/11. The participants in security assurance—whether they are the governmental bodies, the public, or the businesses—all benefit from the resulting safety and security. However, it is not so clear who should shoulder the blunt of solving this problem. It is not clear that the party that tends to the weakest point in the chain, the "Achilles heel," should be the only one responsible. A secure supply chain benefits and adds value to each party in the chain. This problem is compounded many times in a global market place involving many disparate economies, organizations, and in the lightning speed of e-commerce and supersonic travel.

Sprouting from this cost-benefit issue are many unresolved technical and technology-generated questions. For example, what are the different types of economies that participate in the supply chain (Martinez-Olvera, 2008)? Are the company's ICTT technologies robust enough to facilitate the e-commerce that results from such a supply chain? This is irrespective of whether the participant is a multinational corporation such as Wal-Mart, or a "mom-and-pop" manufacturer in Arkansas or China. In this case, technological components range from the streamlined brokerage between suppliers and consumers afforded by today's information and communication infrastructure to in-transit visibility as the shipment cross international borders. The authors contend that these questions can be answered by addressing the following research and educational thrusts. Each of these thrusts addresses a void in current research and educational activities—voids that, when filled, allow a system architecture for cyber transportation logistics (CTL) to be designed.

- E-commerce for Small and Medium Enterprises (SME),
- Seamless Enterprise Application Integration (EAI),
- In-transit visibility in the cyber space,
- Information quality and its relationship to Entity and Identity Resolution,

- Security assurance,
- Modeling and simulation technologies, and
- Educational implications (including Training and Technology Transfer).

Although the concept of Internet portals, trade exchanges, trading networks, and business-to-business (B2B) electronic marketplace is not new (Benjamin et al., 1995; Kaplan & Sawhney 2000; Pare 2003), and SC/L automation has been attempted for several years, e.g., e-SC portal (Boyson et al. 2003), electronically-enabled SCs (Yao et al. 2007), and inter-firm information systems in SCM (Karkkainen et al. 2007), concrete operational system that integrates e-marketplace with SC/L functions are still few in number (Trappey et al., 2007; Nucciarelli et al., 2008; Wang et al., 2007).

Cyber Transportation Logistics (CTL)—as envisaged here—goes beyond the traditional seller-operated or buyer-operated systems and the current generation of electronic marketplace. It integrates supply chain and logistics functions in an on-line trading infrastructure. By identifying this infrastructure, assistance can be rendered to serve SMEs to make them compete effectively in the global market place. Let us provide some examples on how this can be possible. To assist SME in their value-added competitive advantage, various automated SC/L capabilities can be incorporated into this framework, e.g., Collaborative Planning Forecasting and Replenishment, Vendor Managed Inventory, RFID, and SC Analytic software.

E-COMMERCE FOR SMALL AND MEDIUM ENTERPRISES

According to RSM McGladrey (2009), a leading national accounting, tax and business consulting firm, small- and medium-size manufacturers in the US are not enthusiastically responding to globalization. In a recent survey, only 25 percent said that globalization helped them lower cost. A little more than 40 percent said globalization forced them to lower the prices of their products. Less than 10 percent use state incentive programs to modernize their businesses, even though there are many that are available. This is different from multi-national large corporations (such as Wal-Mart), whose businesses are built explicitly upon globalization.

Setting aside companies like Wal-Mart, 95% of the Arkansas firms have less than 100 and 87% less than 20 employees (Table 1). These firms are facing at least three obstacles: the inability to acquire the necessary capital, the lack of leverage or relationship to bring other SMEs on board for creating a coordinated supply chain, and the lack of expertise and knowledge. This is by no means limited to Arkansas. Other states in the US have similar problems. The authors further suggest that the SMEs in China are not exempt from these problems. The question is asked: How can the SMEs be better served by providing them with a potentially improved cyber-enabled capability to compete with larger companies in the global marketplace (de Haan et al., 2007; Dehning et al., 2007).

In both the Arkansas and Chinese settings (and elsewhere), one recognizes the important role a sizable number of SMEs play in their respective economies. In Arkansas, many of these SMEs provide agricultural and manufactured products to a variety of customers, including Wal-Mart. Situated in the Pearl River Delta Region, Hong Kong‘s important manufacturing sector is moving increasingly toward a coordinating role for less expensive products made elsewhere in China, particularly by the SMEs in the Pearl River Delta. Chinese SMEs account for the majority of the “Made in China” labels found on the shelves of Wal-Mart, as there are no such giants as General Motors and General Foods in China (Wu & Olson, 2008).

Aquaculture is an important SME industry in Arkansas. The state of Arkansas leads the nation in production of baitfish, is third in catfish production and has a long history of commercial fish farming.

Table 1. Distribution of firm sizes in Arkansas(Source: 2005 statistics of U.S. businesses data, U.S. Census Bureau)

Size	Number	Percent	Cumulative
Firms with 0 to 4 employees	30,956	58%	58%
Firms with 5 to 9 employees	9,763	18%	76%
Firms with 10 to 19 employees	5,679	11%	87%
Firms with 20 to 99 employees	4,576	9%	96%
Firms with 100 to 499 employees	1,090	2%	98%
Firms with 500 employees or more	1,550	3%	101%
Total	53,614		

About 97% of baitfish farms and 90% of catfish farms are classified as small businesses by the US Small Business Administration. Markets and marketing issues are at the forefront of the aquaculture industry in Arkansas today (Engle et al., 1990; Engle et al., 1991; Hatch et al., 1991; House et al., 2003; Kinnucan & Miao, 1999; Kinnucan et al., 1988; Kinnucan & Venkateswaran, 1990; Olowolayemo et al., 1992; Raulerson & Trotter, 1973; Rauniya et al., 1997). In order to expand markets for catfish and baitfish, it is essential to design products that match consumer preferences and to encourage consumers' recognition and acceptance of new or different products.

Today, staying ahead of the competition means making the most of limited resources and planning effectively to identify and select new opportunities. This requires better planning using a web of facilities and activities enabling the flow of goods from raw materials to finished products and finally to the customers. Solutions from the supply chain analysis can help the industry to discover and exploit the hidden opportunities in the chain by leveraging enterprise data for tactical and strategic planning. Understanding and facilitating the chain of supply from farmers to consumers (buyers) is critical.

Identification of inefficiencies in the supply chain can lead to targeted solutions that match production and demand. Customer requirements and global competition have made supply chain design more challenging and complex than ever before. The increasing pace of change is driving a need for business flexibility to develop strategies and tactics to satisfy customer demand while balancing limitations on supply and the need for operational efficiency. There is a great interest in electronic marketing of catfish and baitfish in Arkansas, to expand the market and to maintain communication between farmers and their buyers. Though some aquaculture farmers use internet for marketing activities, e-marketing of aquaculture is in its infancy.

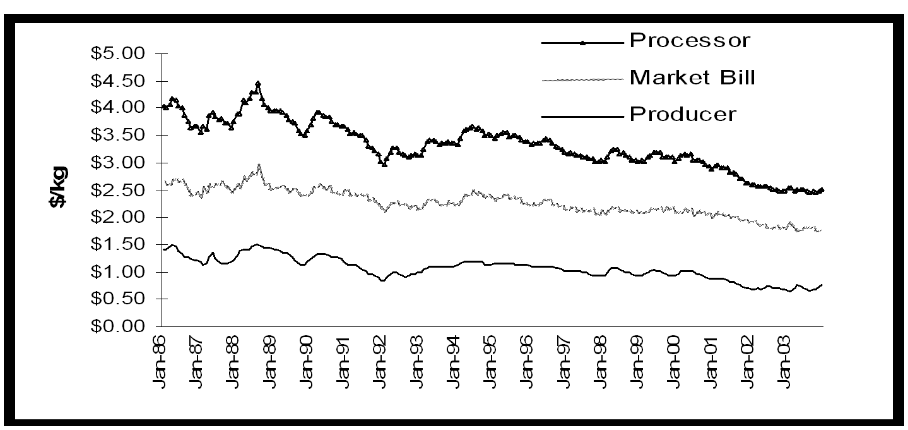
The catfish industry in the US is facing a variety of challenges, including low-price imports and a climate of increasing regulations. Three broad strategies exist for responding to these trends. First, US catfish farmers could focus their attention on becoming a low-cost producer of catfish and compete on the basis of price. Given the higher input (feed, land, labor) costs versus other producing countries (such as China and Vietnam), this strategy is not likely be effective. Second, non-business actions could be taken by the government to increase protectionism. Such a strategy is likely to have a low probability of success given the current global trade environment that emphasizes free trade and reducing barriers to trade. Third, catfish farmers in the US can become much more consumer responsive in their marketing strategies and responsiveness in reaching the consumers. This way, they compete on the high level of consumer benefit and value delivered. Given the inherent problems with the first two options, the third strategy appears to be more appropriate for the catfish industry in the US.

Over the last several years, various studies have been conducted on catfish market and marketing (Dellenbarger et al., 2006; Drammeh et al., 2002; Quagrainie, 2006; Quagrainie & Engle, 2002a; Quagrainie & Engle, 2002b). However, the catfish industry has yet to develop pragmatic marketing strategies to meet the challenges ahead. So far, catfish marketing research has not been an integral part of catfish market development. There is a need for action research on e-marketing of catfish, where research activities will be implemented in partnership with the industry and research findings will be directly incorporated into market development efforts.

Marketing is the most important aspect of baitfish production. Retail price of baitfish is 10-15 times higher than the wholesale price. In other words, the consumer pays 10-15 times the money received by the farmer. One of the reasons is that baitfish are sold as a live product that requires extensive distribution system. The US baitfish industry has a very strong customer service orientation; the industry standard for customer service is to replace any fish losses incurred by the delivery intermediaries (Engle & Quagrainie, 2006). The live baitfish industry is also increasingly facing barriers to the interstate movement of the product. The Arkansas State Authority has recently launched a baitfish certification program to provide high quality and pathogen-free farm-raised baitfish. Based on the experience in e-marketing of other SMEs (Gilmore et al., 2007), it appears that Internet and e-marketing has a potential for marketing of Arkansas baitfish. At the same time, more can be done to streamline the distribution, delivery system.

Farm-retail price spread (calculated as the farm value share of the retail price) for farm-raised aquaculture products is around 15-20% (Engle & Quagrainie, 2006).). The marketing bill (or the difference between what the consumer pays and what the farmer receives) for US farm-raised catfish is very high. Figure 1 shows the monthly real farm-raised channel catfish prices at the producer and processor level, and the marketing bill cost for the period 1986-2003. Electronic marketing of aquaculture products and more streamlined delivery mechanism in general will help reducing intermediary cost, and thereby enhancing competitive advantage.

Figure 1 Monthly real farm-raised channel catfish prices (Source: adopted from Wiese, 2004; original data from USDA-NASS)



According to the University of Pennsylvania's Wharton School, Supply Chain Enterprise Systems—information, communication and management technologies that support supply chain functions—have become a central element of management strategy. Implementing these systems, however, is often a difficult undertaking with an uncertain outcome for different enterprises.

EVOLUTION OF E-COMMERCE

Here are some observations on e-commerce that is encouraging (Chu et al. 2007). The literature labels the period before 1990 as the pre-Web era. Then it was too soon to take advantage of the Internet and was a time of closed, pre-arranged, one-to-one, business-to-business commerce. In the early 1990s, e-commerce emerged with the following stages, as illustrated in Figure 2.

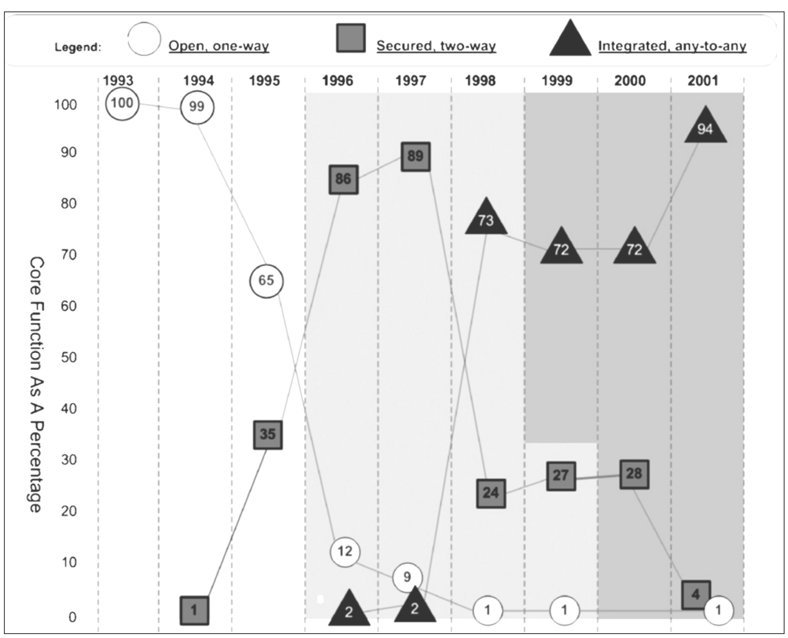
The initial stage is marked by the circle symbol ○: Although WWW communication had opened, a request for information was still one-way. Businesses could only react to requests. The second stage is marked by the square symbol □: Need arose for the interactive two-way negotiation of buy–sell transactions. By tracking the footprint of a participant, cookies allowed interactivity. The third stage is marked by the triangle symbol Δ: Web sites had become both marketplaces and management platforms. It became possible to improve collaboration, strategic alliances, and one-stop business services.

To summarize

- Early 1990s was the reactive Web era
- Mid 1990s was the Interactive Web era
- Start of the 21st century launched the integrative Web era

The numerical values in Figure 2 were the count of respective core functions that had occurred in the surveyed years, expressed in terms of percentages. The symbols (circle, square, and triangle) represented core functions of reactive, interactive, and integrative nature, respectively. It can be seen that the reactive era ended around 1995, the interactive era spanned between 1996 and 1998, and the integrative era began in 1999.

Figure 2. E-commerce core functions: 1993-2001 (Chu et al. 2007)



Low-cost country sourcing, outsourcing, customization and globalization are adding tremendous complexity to supply chains across the globe. Two key supply chain elements that are often taken for granted—coordination and collaboration—can mean the difference between the merely functioning and the profitable enterprises. The authors are referring to procuring goods and services from vendors around the world and delivering them to global consumers as fast and inexpensively as possible. Depending on the sourcing requirements, some responsibility for supply chain logistics may rest on the shoulder of the enterprise that places the order, not just the shippers. Our observation is that the SMEs, compared with larger enterprises, are ill prepared to take on this responsibility.

There are similarities and differences between the suppliers in the distribution of products. Again take the manufacturers from the Pearl River Delta, as well as the Arkansas suppliers. The former heavily cater for consumer products. The latter are more mixed, which includes agricultural products. According to Li (2008), low level of trust among supply-chain partners hampers information sharing in China. A win-lose perspective is prevalent between Chinese suppliers. Generally, there is a low level of visibility over inventory and demand, and a lack of process standardization and data transparency. By contrast, take the example of a cooperative industry such as Riceland in Arkansas, the largest rice-processor in the world. It is made up of many individual farmers (Ketchen & Hult, 2007), who work in a cooperative to supply the rice crop. Tyson at Springdale, AR, the largest meat processing in the world, is similarly made up of many constituent chicken farmers. These two sites—Arkansas and China—located at the opposite sides of the globe, create interesting parallels, contrasts, problems, opportunities and mutual relationships that deserve to be explored.

SEAMLESS ENTERPRISE APPLICATION INTEGRATION

To enhance the value-adding services to participating partners, the users of people-oriented e-SC/L system is a crucial factor in the efficient, effective and efficacious operation of the network. Human Factors Engineering can contribute to the design, development, and evaluation of this endeavor. Internet-based SC/L system has changed the traditional open-market negotiation in business relationship to one that facilitates dynamic coordination across the supply chain through information exchange and on-line collaboration (Barratt, 2004; Meroño-Cerdan et al., 2008). This enables not only cooperation among trading partners, information linkages can also be achieved through vendor managed inventory and EDI exchange (coordination) while supply chain integration among trading partners can be achieved through joint planning and shared gains/loss/investments (collaboration).

On-line coordination and collaboration in a distributed e-SC/L environment presents not only human factors design issues but also organizational issues of group or team interaction, and behavioral issues of cross-cultural collaborative commerce within a globally networked SC. In addition to the human elements of decision making and information processing, a significant value-chain area for the efficacious operation of the system is the relationship-based strategy of collaboration (Coyle et al., 2009). An e-SC/L platform can facilitate not only effective collaboration by enabling share use of information and mutual business benefits, it also has the potentials for establishing trusting relationship between participating trading partners in the network. Proper implementation of e-SC/L can help to remove suspicion on the part of SMEs about global commerce, and help to negate the win-lose perspective of competition among SMEs.

Going beyond human/systems interface issues, an equally important problem is Enterprise Application Integration (EAI). Enterprise applications usually consist of applications written in different programming languages, running on different platforms, and communicating to each other through different networks. In order to support daily business operations, these applications—including legacy software—need to be integrated. New applications also need to be integrated to provide efficient and reliable data exchanges among these enterprise applications. Software interoperability (Wegner, 1996) is a fundamental concern to the development of enterprise applications.

Several middleware technologies have been widely used for EAI including CORBA (CORBA, 2009), Microsoft COM/DCOM (DCOM, 2009), .NET (Microsoft .NET 2009), and Enterprise JavaBeans (Enterprise JavaBeans, 2009). The middleware technologies offer a potential solution to interoperability problems but also produce new issues such as interoperability of distinct middleware implementations (Chiang, 2001). The problems include different syntax and semantics of the interfaces. Nevertheless, the differences in the interfaces sometimes can be resolved by developing an interface adapter to convert one to another and vice versa. But very often, the fix usually leads to multiple versions of applications. Eventually, it will become difficult for software developers to maintain the consistency in the enterprise applications.

The web services technology (Webservices, 2009) has been proposed to solve the problems of EAI by connecting applications run by different companies in the supply chain. The technology provides a standard way of interfacing different applications in a seamless manner. Heterogeneous applications are exchanging messages in an XML document where a program sends a request to a Web service across the network, and receives a reply from another program. The reply is also in the form of an XML document. Thus, with Web services, companies are allowed to publish their services to their customers and suppliers and make their applications interoperable for e-commerce.

It is without a doubt that legacy applications should not be ignored when EAI is discussed. It is definitely not a good idea to suggest companies to rewrite their legacy applications for integration. One cost-effective way is to develop a wrapper around the legacy applications interfacing the Web services (Chiang, 2007). A wrapper is built to encapsulate a legacy system and provide access to the legacy system through the encapsulation layer. This layer exposes only the methods with parameter attributes to remote service requesters. In addition, the wrapper must resolve the incompatible communication issues between the legacy systems and the Web server using SOAP/XML messaging. The implementation details of the wrappers for web services integration can be found in Chiang (2007).

IN-TRANSIT VISIBILITY TECHNOLOGIES

In the first Gulf War in the early 1990's, the U.S. and her coalition partners poured an overwhelming amount of supplies to Kuwait before launching a swift war against Iraq. In spite of a lopsided technological advantage over the enemy, several lessons can be learned from the war. The most commonly known lesson is the lack of *in-transit visibility*. This refers to the unknown contents of tons and tons of supplies that were dropped off by ships, planes, and ground transport. The popular press labeled it "just in case" delivery, instead of "just in time" delivery, as supplies piled up unclaimed. Fortunately, the coalition had the luxury to begin the war at a time of its own choosing, which in effect mitigates this acute shortcoming.

In-transit visibility has progressed significantly since the first Gulf War. Prime examples are found in FedEx and UPS. Through a number of technologies, including GPS and fast communication, customers can easily find out the whereabouts of their shipment by clicking on the designated webpage. In-transit visibility is a sales advantage, highly touted by FedEx, which introduced the practice, and followed by many other just-in-time shippers (Chan & Ponder, 1979). In fact, it goes well beyond shippers, Riceland in Jonesboro AR handles its sales shipments in the same fashion.

While the global supply chain are adopting newer bar-code technologies such as two-dimensional and reduced-space codes, smart ID tags, or RFID, may gradually replace some or most bar code application for entity identification and product tracking. The process is gradual because there remain quite a few outstanding technical and non-technical issues (such as standards, security, privacy, and policy). Aside from RFID, there are quite a few competing identification-tracking technologies. UPS has watched RFID for 15 years but did not see it as an imminent solution to the problem of parcel tracking. In test runs, UPS found that RFID tags did not surpass the accuracy rate of bar code scanners. Moreover, an RFID rollout—including tags and a new technological infrastructure—would be quite costly. UPS decided that they could not simply replace optical scanners with an RFID reader and expect an improved return on investment. There have to be fundamental process changes to leverage the RFID technology, which are considerable at the present time (Ojala & Hallikas, 2006).

As a solution, 25,000 portable bar-code scanner/terminals—a competing technology to RFID—are in place at 400 UPS sites. In so doing, UPS has created one of the world's largest Wirelesses Local Area Network. Bluetooth and Wi-Fi connectivity are also being incorporated into the handheld computers carried by UPS drivers. The new electronic clipboards, first deployed in April 2005, allow a driver to receive last-minute delivery or route changes via a truck's receiver. Previously, updates came from putting the clipboard in a cradle inside the truck, which limits its portability.

When it comes to global supply chains, the potential for disruption comes in many forms, from large-scale natural disasters and terrorist attacks to plant manufacturing fires, electrical blackouts, and operational challenges such as bureaucratic requirements and red tape and shipping ports being too small to handle the flow of goods (Bogataj & Bogataj, 2007). In two representative site visits—to the Hongkong International Terminal (HIT) and the Memphis Airport operations of FedEx—it is clear that the security issue is paramount in the post-9/11 global trade. In HIT, the port capacity is also taxed to the limit, necessitating vertical stacking of container boxes.

To avoid choke points in the supply chain, containerization represents a transition in shipping technologies. Compared to the 40-ft containers, the U.S. standard of 53-foot containers is a more cost-effective way to ship freight. Sometime soon, an entrepreneur will invest billions of dollars to construct a fleet of vessels designed to handle only 53-foot equipment. China manufactures almost all of the 53-foot container units, and many are dispatched loaded with Chinese cargo. If China decides to adopt the 53-foot unit as the standard for its own internal transportation system, and to serve the commercial interests of trade between China and the US, the freight transportation map of the world will change. It appears that the days of the 40-foot container standard in international trade are coming to an end. This comes at a time that China is vying with others in the standardization of RFID technologies, often used in conjunction with containerized shipments.

One notable application of RFID in the supply chain is the tracking of assets and inventory items in real time within a facility. Such capability allows preparing efficient pick lists, efficient dispatching and routing of fork trucks and vehicles within warehouses and manufacturing facilities, efficient shelving of inventory items and much more. These solutions are known as real-time location-sensing or RTLS (Moeeni, 2008). RTLS may employ various RF tag types like passive, active, etc.

A study by Aberdeen Group (Aberdeen Group, 2009), shows that firms using RFID deliver complete and on time to 98% (against 81% for others), that traceability is made up in 2.5 hours (compared with 34 hours) and that manufacturers which use RFID make 99% in full compliance their products (compared with 86%).

However, in most of today's RFID implementations, there lacks an easy-to-use and cost-effective way to integrate a company's RFID equipment and its backend systems to enable it to enjoy the improvements in supply-chain management (SCM) that RFID technology can provide. Moreover, the cost of RFID implementation is much higher than in traditional automatic identification technology (Chen & Chen, 2007). The authors had identified three gaps:

1. An information gap exists due to the disparity of information models
2. A transaction gap exists due to the disparity in information transaction methods and
3. An authorization gap exists due to the disparity in authorization requirements.

To resolve the gaps, a middleware, RFID Application Enablement (RAE), is developed using an object-oriented approach. Object orientation enables encapsulation structured business objects that encompass RFID memberships, monitoring object conditions and defining object behaviors in terms of RFID operations and publishing RFID object information. The draft recommendation (ANEC BEUC, 2008) shows some promising measures focusing on privacy, data protection and security in the implementation of these RFID applications.

As seen in the case of Wal-Mart, SMEs may be pressured by large retailers and other players to implement RFID technology in order to comply with a prescribed information technology (IT) infrastructure and processes. Research can be employed to integrate RFID technologies with shop-floor control software for SMEs. When executed in conjunction with e-commerce portals, it would enable products to be tracked in real-time across the entire supply chain—all the way to the consumer (Niederman et al., 2007).

Chu et al. (2007) have proposed a "4th Party"—beyond the manufacturer, the consumer, and the regular third party broker—to use web-based e-commerce technology to coordinate activities throughout the supply chain. If the cost-benefit incidence problem is to be addressed, a "fourth" party broker can be employed for SMEs to minimize cost. This breakthrough will allow SMEs to compete effectively with larger enterprises in executing the various parts of the supply chain, which they can ill afford to do presently. In addition, a cost-benefit analysis of RFID implementation in SMEs operations may further help SMEs to gain competitive advantage in their particular markets (Leung et al., 2006).

INFORMATION QUALITY IN ENTITY AND IDENTITY RESOLUTION

Identification and tracking technologies can certainly play an important role for in-transit visibility, security assurance and storage retrieval. The real question, which is alluded to in the SME discussion above, is the respective role of the manufacturer, the shipper, the retailer, vis-à-vis the carrier in minimizing shipping "choke points" and ensuring security. This is not a simple question to answer when it comes to the incidence of costs and responsibilities. In other words, does a choke point at a port facility affect only port operations, or does it affect every party in the supply chain and, in turn, may determine the length of the queue of ships to be unloaded in Long Beach Harbor in California? Is it the sole responsibility of the port operator to address this problem, or the collective responsibility of all the parties?

HIT in Hong Kong is one of the largest transportation terminals in the world, being a terminal operated by the venerable Hutchison Port Holdings, Ltd. Strategically located in the Pearl River Delta, their shipment is destined globally from Long Beach to Rotterdam. Since 9/11, HIT has been visited numerous times by the U.S. Department of Homeland Security as part of a global war on terrorism. Since they all belong to the same company, the idea of developing a data network among the forty to fifty Hutchison terminals in the world is very appealing. Acxiom, a long established data-warehousing enterprise based in Little Rock, would definitely be able to contribute their knowledge and expertise in this area.

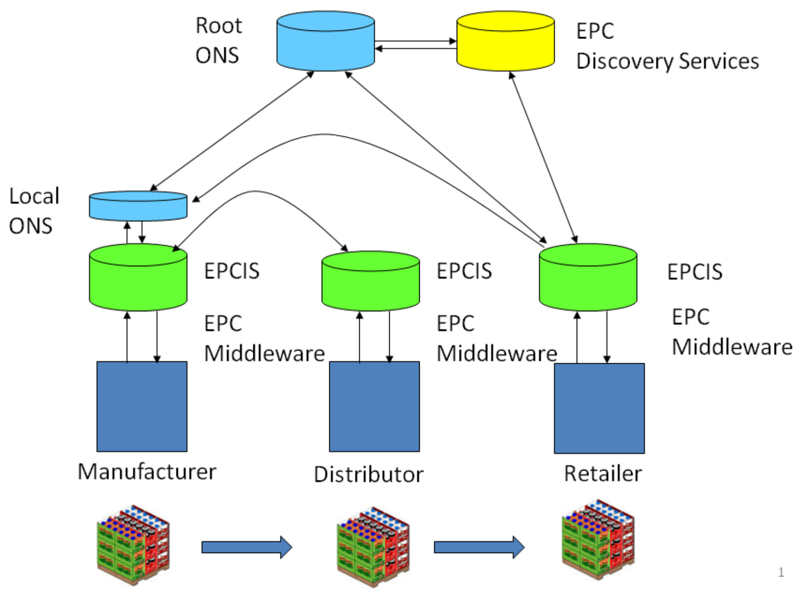
It is well documented that inaccurate, incomplete, inconsistent, and out-of-date information create operational errors, poor decisions, and damaged customer relations. This could cost government and industry billions of dollars a year, and transportation and logistics information is not immune from these thorny issues. For example, concerns for privacy conflict with accurate entity identification and tracking. The profusion of geographic subdivisions ranging from census tracts to traffic analysis zones often introduces inconsistencies in geo-spatial data coding, which lead toward errors in goods delivery and tracking. More precision can be achieved through geo-spatial technology based on GPS, GIS, relational database management systems and RFID principles.

The quality of information created, shared and the decisions made via the macro processes—including Internal Supply Chain Management, Customer Relationship Management and Supplier Relationship Management (Chopra & Meindl 2007)—is as good as the quality of the input data. Industry studies (GS1, 2009) show that two thirds of product information has data-quality problems. It has been long established that data entry through keyboard is extremely error prone. Bar-coding technology has substantially improved data quality. It also contributed to the efficiency of data-entry process. Bar-code standards, including the Global Trade Item Number (GTIN, a superset of the Universal Product Code or U.P.C.), Global Location Number (GLN), and several others have significantly contributed to the accurate and unique identification of various entities and objects during transaction-information exchange.

The EPCglobal organization (EPCglobal 2009) is currently overseeing various standards and protocols for the supply-chain implementation of RFID. Passive, backscatter RF tags, referred to as class 1, generation 2 (C1G2), functioning at the ultra high frequency (UHF) is currently supported by the standards. Passive tags are by far less expensive than semi-passive or active tags. UHF passive tags also offer the highest read range compared to other frequencies such as high frequency or microwave for the same level of allowable output power. The vision is to create an RFID-based network that acts as the nervous system of the supply chain for linking the physical world directly to the decision-making process. In Figure 3, Object Naming Service (ONS) is a database and look up service based on Domain Name System (DNS), which is a hierarchical naming system for computers, services, or any resource participating in the Internet. EPC Information Services (EPCIS) is an EPCglobal standard designed to enable EPC-related data sharing within and across enterprises. Together with EPC middleware, the system allows a streamline operation between manufacturers, distributors, and retailers. The automatic identification, transaction recording and tracking of trade items contributes to the quality of data and better supply-chain decisions by eliminating many intermediate agents and manual processes.

Future EPCglobal network, which encompasses ubiquitous low-powered, sensor-equipped, RFID networks that are connected through the Internet, will create new capabilities for managing the supply chain with potential strategic implications. It will provide unprecedented quality information in real time, including:

Figure 3. EPCglobal network architecture for track and trace



- expiration date of a given bottle of milk in the refrigerator,
- a recalled batch of hotdogs,
- the contaminated shipment of spinach,
- variation in the temperature of individual boxes of ice cream during transit
- air quality at a particular road intersection,
- traffic-flow data of an Interstate,
- the imminent failure of a pacemaker
- the location of the nearest ambulance, fire truck or police patrol vehicle.

However, current research in customer-centric information-quality management suggests that most organizations still practice "tactical data-quality management." Tactical data-quality management implies that an organization reacts to adverse data-quality events as they are discovered, in many cases by its customers. On the other hand, "strategic data-quality management" attempts to define data-quality requirements across the entire information system from data contributors and collectors, through key processes, to the delivery of the final data product. Moreover, the attainment of these requirements is assessed through periodic measurements of data quality in order to facilitate continuous quality improvement and to detect problems before data is released to customers. Data-quality/information-quality will soon be an important issue for most organizations, whether large enterprises such as Hutchison Port Holdings or SMEs. Meanwhile, interested universities could participate in this emerging topic in terms of both research and teaching (Wang, 1998).

To overcome the challenges faced by SMEs in adopting and implementing e-commerce, the CTL framework—with its on-line trading platform that includes a fourth-party logistics services—can facilitate electronic transaction by bringing together not only sellers and buyers but also shippers and carriers to collaborate on their supply chain and logistics planning. It applies information, communication and e-commerce technologies in supporting a range of SC/L activities such as e-procurement, multiple sourcing, supplier selection, collaborative planning, disruption management, and supply chain visibility (Chu et al., 2007; Pare, 2003).

The system environment not only improves connectivity among trading partners but also allows companies to communicate and collaborate in a globally networked supply chain within a single streamlined trading platform with a common user interface. By leveraging on Internet and other information and communication technologies, users of this system (e.g., logistics managers or SME owners) can access multiple sub-systems (modules) within and across the particular enterprise. This neutral and secure web-enabled trading platform adds values to the participant parties in areas such as information exchange, product visibility, and process optimization which in turn reduce inventory, decrease delivery times, and improve inventory turnarounds.

SECURITY ASSURANCE

Since the 9/11 tragedy, the supply chain security risk has been gaining fast-growing interest: global supply chain managers have started to fear that the logistics networks might be used as targets of, and/or vectors for, further terrorist attacks, leading to deep and long-lasting disruptions in the supply chains that would add to those already caused by ill-operated procurement processes, capacity constraints, and/or quality issues in factories. Therefore, global supply chain vulnerability has become a capital issue for all of the logistics networks' partners, and security is now an unavoidable high-performance factor for supply chains.

In such a context, with the growing pressure from national and international regulation bodies to enhance security, Supply Chain Management has to address an end-to-end issue: achieve a cost-effective and lead-time efficient design of the complete SC, while at the same time including relevant security requirements, and leveraging real-world information to both assess the security level and enforce the security requirements.

A large variety and great quantity of products are in transit from diverse origins to numerous destinations. Increasingly, these products are shipped in containers, and maritime container transportation has become the premier transportation mode for the manufacturing industry. In 2002, the International Container Bureau (BIC) estimated the number of containers world-wide number as 15,000,000. Each day, those millions of containers, each carrying more than 20 tons of products, are conveyed to and from seaports on trucks, rail carriages, barges and ships. Efficient and reliable such flows may be, this huge volume of container movements, besides significantly increasing the complexity of the global maritime transportation system (Robinson 1998), poses formidable security challenges to freight and people.

Containers have for a long time been used for clandestine immigration, illegal weapons smuggling and drug smuggling. However, the associated risks (Tsai, 2006) and possible consequences are incomparable to those associated with weapons of mass destruction. A solution is to design and implement an expert system dedicated to maritime container security risk management. The approach encompasses the three core elements of (1) risk modeling, (2) risk assessment and (3) risk management (Bechini et al. 2007, GOST 2009). Risk modelling is process-based. It is an "activity-resource" model well suited for logistics systems analysis and the associated security-centric performance monitoring. The data-collection methodology followed at this stage is case-based, within a set of typical SCs involving internal (e.g., Port of Le Havre) and also external logistics actors. The processes taken into account go from the origination port to point of destination (for imports) and from point of origin to the destination port (for exports).

Risk assessment is addressed with reference to such security-dedicated standards as food industry Hazard Analysis and Critical Control Points. Associated with it is the military-born Failure Mode and Effects Analysis, which is a risk assessment of reliability widely practiced in the aerospace and automotive industries. Risk management is taken care of through the implementation of an expert-system coupling a database to a knowledge base. The database is fed with real-time and automatically collected information from the monitored logistics operations. The knowledge base is fed with the expertise of, among others, customs / police / immigration agents, lawyers, and port authorities. To optimize container transit security and facilities, the expert-system inference engine first interprets information on the incoming (from sea or from land) container and then presents a solution for dealing with each cargo, on the basis of available expert knowledge.

The expected impacts of the project at the technical and scientific levels are numerous.

- development of a service for securing the transport of cargo (better monitoring of sensitive materials and protection against malicious acts)
- Integrating sensors such as RFID, from different origins, embedded in a system of traceability and complete protection
- Development of an electronic platform with shared interfaces to the platforms of existing owners and
- Implementation of an innovative solution.

For all users, the platform offers productivity gains by optimizing the links in the transport chain. The prototype offers the potential for global service traceability and security of the transport chain. Ultimately, it offers the potential for the development of an "information system port," transferable to other port communities, either locally or globally.

As the World Customs Organization (WCO) progresses with the implementation of the WCO SAFE Framework of Standards to secure and facilitate global trade, parameters of the Authorized Economic Operator (AEO) programs are developed. Supply-chain compliance-software provides electronic collection, standardization and organization of supplier information, allowing the user to efficiently collect information required for AEO certification. Such a system may bring the cost down for SMEs who are inevitably part of the security picture.

MODELING AND SIMULATION TECHNOLOGIES

This chapter proposes IT solutions for Cyber Transportation Logistics (CTL). These include the existing IT enterprise business applications and information sharing among organizations. Enterprise Resource Planning (ERP)—broadly defined here as the science of enterprise planning, management and execution—has progressed significantly over the last two decades or so. The "curse of dimensionality" in solving these business problems has been tempered by a number of advancing techniques, including the use of asymptotic error bounds (Bramel & Simchi-Levi 1997), and a priori/robust optimization (Bertsimas & Simchi–Levi 1996, Laporte et al. 1994). Capitalizing on grid computing and the semantic web concept, today's knowledge base and E-platform allow step-by-step procedures to perform the following functions: (a) site location, (b) location-routing, (c) competitive allocation of products/services, and (d) spatial economic forecasting. They are some of the key analytic ingredients in CTL.

Chan (2005) showed that there is an emerging science in capturing most of these analysis functions. For example, many of these procedures can be captured in the judicious use of a *weight* *matrix* for location and allocation. Such a framework can be used to analyze *spatial equilibrium*, or the resulting trade patterns among participating enterprises. This is accomplished through competition and gaming in spatial dynamics, analyzing market share and geographic coverage. User vs. system optimization, as illustrated in the Braess' Paradox, can be generalized to other contexts, showing the results of competition vs. collaboration among SMEs. These results include Cournot–Nash equilibrium for user optimization and monopolistic-market equilibrium for system optimization respectively. Furthermore, regional and international input-output economic-development implications can be ascertained within this analytical framework. This is particularly important for venture capitalists and governments that are considering investing in a public e-trading platform. In view of the significant advances in this field, other management-science contributions toward analyzing this subject can be found in the list of references in Chan (2005).

Meanwhile, three-dimensional (3D) virtual worlds, like Second Life (SL), provide a simulation platform to investigate smart-world domains like CTL. TagCentric was first developed, which is an agent-based RFID middleware available on SourceForge. A project at the University of Arkansas (http://vw.ddns.uark.edu) is investigating ubiquitous computing, location-aware systems, virtual RFID, massive use of sensors, smart devices, workflows, ways of merging reality and virtual reality, and means of talking to devices using natural language. The potential impact of testing these technologies in a simulated world before deployment could lower costs and accelerate the pace of technological change.

EDUCATIONAL AND TRAINING IMPLICATIONS

A focus of this chapter is to show how information, communication, and transportation technologies (ICTT) play a role in global commerce. Using ICTT, we envision a CTL system architecture for global commerce. While large enterprises are well positioned to be a prominent member of CTL, SMEs are much less prepared to do so at the present time. While we paint an encouraging picture, it is clear from the above discussions that the CTL has many technical and non-technical components that discourage SME participations. One such component is education and training for the SME work force. Today's CTL work-force requires these educational and training support:

- Logistics work-force development to endow workers with familiarity and appreciation for today's ICTT
- Science, Technology, Engineering and Mathematics related enhancement for under-represented groups
- Logistics education/training on modeling-and-simulation, including virtual-reality technologies.

To show the cogency of this issue, FedEx, JB Hunt, Wal-Mart and the National Science Foundation has funded the Mid-America Transportation Center (MATC) in Arkansas to train the work force required for today's logistics industries. MATC educates and trains students in all of the three support functions for e-SCL. While the first two of the three functions are self explanatory, the third needs some explanation.

As explained, there are two major paradigms for SCM:

- Three-stage view, which consists of procurement, conversion, and distribution
- Three-flow view, consisting of financial, information, and product flows

Furthermore, it was suggested that a departure from the traditional three-stage view of supply chain management to embrace the three-flow view. Financial derivatives such as options and future contracts can help SC partners to mitigate the risk in raw materials and capacity shortage.

Furthermore, the authors provide information-based research and data-quality management best practices to the majority of CTL enterprises, including SMEs, IT-intensive industries, nonprofit and governmental bodies.

Educational institutions are starting to embrace this interpretation of SCM. Online simulation games now are used to introduce the financial-flow implications to students. For example, the Responsive.Net Simulator combines cash-flow position with lot size and lead time, with some analysis regarding the optimal ordering policy. It considers adding production capacity at different points in the simulation.

Harvard Business Publishing's SCM simulation combines cash flow with product design, vendor selection and procumbent management strategies. It also includes justification for contingency actions, such as change of contracts or an interim marketing survey.

SOME COGENT THOUGHTS

Cyber transportation logistics is a realization of the shipment of goods or the delivery of services in cyber space. It includes the IT process of planning logistics services and its subsequent integrative management. These services are implemented to facilitate the pervasive accessibility of logistic information online (Li et al., 2007). Key logistics functions such as shipping, inventory management, customer-relationship management utilize interdependent information and can be managed more effectively with integrative data service. On top of these traditional functions is the outreach to consumers who are the ultimate decision-makers that drive the entire supply chain. As mentioned, Chu et al. (2007) proposed Web-based services to replace the third party service provider, called the 4th party, that directly serving the seller and buyer in a supply chain. Another worthwhile activity may be advancing related identification-tracking technologies to go beyond the current stalemate that surround RFID implementation. These efforts will have monumental impacts on information-based manufacturing, logistics and security assurance. While large retailers such as Wal-Mart already have this service in place, the less well-endowed SMEs do not. Apparently, the Department of Defense also needs such a service, as evidenced from the delivery of materiel and supplies during the first Gulf War.

To successfully implement a workflow in an organization, there are four fundamental elements (Karmarkar & Apte, 2007):

- Data Base Management System
- Work Flow Management System
- Administration and Monitoring (access control mechanisms, especially those that are related to other organizations)
- Applications (providing services, such as ERP)

On top of these is a partners' coordination tool, which shares the data between different administrative and monitoring elements of the organizations in a collaborative relationship. Such coordination is necessary in such partnership as Riceland, and to some extent Tyson, both of which are based in Arkansas (as mentioned). The higher the degree of coordination, the better the SC performance, which is manifested in a lessened bullwhip effect, lower inventory levels, less transportation overheads, a lower manufacturing capacity requirement, and other considerations. However, it also makes keeping the information secret more difficult, and privilege-propagation conflicts are also an issue.

In the design, development, and implementation of the CTL system, human factors research will need to be carried out to ensure human-users/CTL system equilibrium. Two areas of focused research are proposed, which are consistent with the modeling-and-simulation focus under CTL:

1. Design of Natural Human-Agent Interaction – The main goal is to evaluate appropriate forms of interaction for CTL system users. These users work closely with intelligent agents, which are used to support the delegated information processing on behalf of the human users (Nam et al., 2009; Scholtz, 2002).
2. Modeling Team Decision-Making in Multi-Cultural Contexts – Cultural background significantly influences the way humans select, interpret, process, and use information (Marks et al., 2001). Common cognitions among team members and their effective communication process are closely associated with team effectiveness (Cannon-Bowers & Salas 2001). Human Factors research can investigate the effects of cultural differences on team performance, behaviors, and team cognition (e.g., communication, shared mental model, etc.). In a global marketplace, any step to facilitate decision-making in a multi-cultural SC is mandatory.

While the state-of-the-art has progressed in the subject of CTL, SMEs have not taken advantage of the technology. This is particularly so in China (Li, 2008). SMEs in China have almost non-existing e-Commerce capability. Subpar transportation networks are prevalent, where distribution channels are inefficient, fragmented, and costly. There are no national distributors but a plethora of small and medium-sized local wholesalers. There are simply too many "nodes" in supply networks. For the Chinese labor force, there is weak professional identity among those who work in this field. There is only low awareness of the benefits of scientific SC planning and execution. Financially, the Chinese currency is not freely convertible. Department of Foreign Currency regulation encourages underground banks. Payment process hampers financial flows, eventually slowing down product flows. There is an increasing demand for better payment solutions and supplier/buyer certification agents.

Entry of international companies into Chinese markets maybe one solution. Carrefour, with 4.3 billion dollars in sales, ranked sixth among all retailers in China in 2007. Its sales were up 24% over the previous year. At a sales volume of 3.1 billion dollars, Wal-Mart has increased its store sales in China by 42% in the same period. Hong Kong, serving as the Chinese window to the developed countries, has a unique role to play in technology, business practices and manpower development for China.

LOOKING AHEAD

Globalization, technology and an ever-changing world create significant challenges and opportunities for SC management and logistics execution. To succeed, change and innovation are necessary, as painfully evident in the US "rust belt" associated with automobile manufacturing. Operating in the emerging global market, SMEs are increasingly required to effectively coordinate and cooperate with potential trading partners. E-marketplace approach can be an enabler for SC and serve to facilitate collaboration between SC partners through information, communication and transportation technologies (ICTT). Unlike a generation ago, knowledge-based technology drives today's supply and demand market. The opportunities for educating/training the work force and in advanced research are there waiting to be harnessed.

The world is converging toward the development of robust and automatic systems of in-transit visibility. Just as computers on the Internet are uniquely identified by IP addresses, objects, locations, transactions would be uniquely identified through GPS, smart cards and wireless information and other systems. The movement is stimulated by the ever-increasing need for operational streamlining, as well as accuracy, security, quality in capturing data and in the authentication process. One objective is to improve shipment efficiency, to prevent fraud, save lives, and protect properties. Another objective is found in location-based services, where telecom companies are vying to provide travelers with information ranging gas-station locations to where to eat lunch, not to say ascertaining the whereabouts of individuals or objects of interest.

With today's communication network, E-commerce has been gradually evolving into Mobile Commerce (Ngai et al., 2007). Examples include location-based services, mobile financial applications, and product locating and searching. It is clear that more research is warranted for these constituent enabling technologies: wireless network infrastructure, mobile middleware, including data stream management, database management, and wireless user infrastructure (such as mobile handheld devices). (Ngai & Gunasekaran, 2007)

As the World Customs Organization (WCO) progresses with the implementation of the WCO SAFE Framework of Standards to secure and facilitate global trade, parameters of the Authorized Economic Operator (AEO) programs are developed. Supply-chain compliance-software provides electronic collection, standardization and organization of supplier information, allowing the user to efficiently collect information required for AEO certification. Here are some issues raised by Wigand (2006):

- How to develop an AEO program for SME businesses, which do not have an advanced ERP system?
- AEO redesign process only works if legislation is changed at an international and national level.

For Chinese SMEs, for example, intellectual property protection is weak. There is a proliferation of forged brands. However, Hong Kong has restrictive laws and regulations on Intellectual Property protection. As a gateway to the outside world, again it can serve as a knowledge hub to address this problem on behalf of China, including the provision of ERP services for AEO (Pibernik & Sucky, 2007).

A large number of case studies on e-commerce in SME conducted over the last few years (e.g., Poon & Swatman, 1997; Henderson, 2001; Baourakis et al., 2002; Vlosky & Westbrook, 2002; Abate & Moser, 2003; Alexander et al. 2003; Chau, 2003; Cordeiro, 2003; Galloway et al. 2004; Grandon et al. 2004; Henderson et al., 2004; Holmes et al., 2004; Yasin et al. 2006) show that e-commerce offers SMEs significant operational and strategies opportunities. But, the implementation of effective e-commerce based business model in SMEs is not without serious organizational and technological challenges. For catfish and baitfish industries in Arkansas, various university campuses are keen to provide leadership and guidance to develop strategies for electronic marketing and physical distribution of these aquaculture products, which will keep these industries competitive and improve the welfare of the stakeholders concerned.

The rapidly evolving global SC is creating a historic demand for a technological workforce to support all components of this system. The educational and training implications of this revolution are profound. To achieve this goal requires workers who have skills not only in transportation, distribution, and logistics but also in GPS, GIS, identification technologies, Database Management Systems, and financial flow.

It is clear that sound solutions to the CTL problem require a holistic, multinational and multi-disciplinary approach that engages the talents of universities, industries and governments around the globe. The authors' goal is to marshal the interests not only of the university community, but also the industries and governmental bodies that can benefit from the results of a cooperative, entrepreneurial, educational and research activity.

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KEY TERMS AND DEFINITIONS

Aquaculture: Aquaculture is defined as farming of fish and other aquatic organisms under controlled condition.

Collaborative Commerce (CC): is the use of a web server hub to facilitate collaboration among suppliers, customers, and business partners in the integration of supply chain functions through information exchange, joint decision and planning across various enterprises.

Electronic Product Code (EPC): EPC is an object identification coding structure for supply chain RFID systems that currently encompasses 96 bits.

Enterprise: An enterprise is considered as a business organization.

Enterprise Application Integration (EAI): EAI is a process enables an enterprise to integrate a set of enterprise applications together.

Enterprise Resource Planning (ERP): ERP is a software application used to manage and coordinate all the information, resources, and business functions from a data store.

Fourth-Party Logistics Provider (4PL): 4PL is a provider of logistics services and solutions who operates as the sole conduit and systems integrator by managing the supply chain/logistics functions and activities of a client through the use of information technology.

Geospatial: Geospatial is used in this chapter to describe the combination of analytical and geographic attributes.

Global Location Number (GLN): GLN is a global supply chain numbering system for the identification of physical locations and legal entities.

Global Positioning System (GPS): GPS can be used to determine the geographic location.

Global Trade Item Number (GTIN): GTIN is a new 14-digit global numbering system for item class identification in the supply chain that will coexist with the 12-digit U.P.C. and 13-digit EAN codes. A serialized version of GTIN (SGTIN) allows the current bar code numbering structure be used with supply chain implementation of RFID.

Human Factors: HF is the research and systematic application of knowledge of human capabilities (e.g., sensory/perceptual, cognitive, behavioral) to the design and development of systems, services, and products to ensure effective people-systems interaction, and the safe and ease of use of technological systems.

Middleware: The software serves as the glue to connect different applications to work together.

Online Trading Platform/Infrastructure: An e-commerce model, that aside from providing information about sellers (e.g., electronic catalogs), allows multiple sellers/suppliers/vendors and buyers/customers to conduct business transactions through a web server.

Radio Frequency Identification (RFID): RFID is a technology that reads data from electronic tags to identify items.

Real Time Location Sensing (RTLS): RTLS is an RFID-based technology for asset tracking and location identification.