Czech University of Life Sciences in Prague

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Optimization in logistics based on accurate location data

Bachelor Thesis

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Prague, 2013

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE
Department of Information Engineering
Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

Lama Prabin

Informatics

Thesis title
Optimisation in logistics based on accurate location data

Objectives of thesis
The goal of the thesis is to analyse the current best-practices in logistics with the respect to accurate location data (GPS) and formulate some improvement possibilities for various specific environments and needs.

Methodology
- Literature review of logistics, GPS, data and information processing in enterprise.
- Formulation of the case-study.
- Case-study design and conclusions.

Schedule for processing
- Literature review of logistics, GPS, data and information processing in enterprise. 10/2012-12/2012
- Formulation of the case-study. 1/2013
- Case-study design 1/2013-2/2013
- Formulating the conclusions. 3/2013

The proposed extent of the thesis

50

Keywords

logistics, GPS, optimisation

Recommended information sources

Julien Bramel, David Simchi-Levi: The logic of logistics: theory, algorithms, and applications for logistics management, Springer 1997

André Langevin, Diane Riopel: Logistics systems: design and optimization, Springer 2005

Carlos Daganzo: Logistics systems analysis, Springer 2005

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Last date for the submission

March 2013

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Declaration

I declare that I have worked on my Bachelor thesis titled “Optimization in logistics based on accurate location data (GPS) “ by myself and I have used only the sources mentioned at the end of the thesis.

In Prague

Signature

Abstract

This thesis focuses on the findings of the fact how GPS is helping to shape better service in the field of logistic management. At present times, logistic techniques are becoming more sophisticated. With increasing demands of responsive, agile, global integration of complex dispersed multi-tiered suppliers, subcontractors and manufacturers, logistics is facing the challenge of moving from straightforward transaction oriented to open/ collaborative supply management. This challenge is visibly demonstrated in distributed supply-networks where multiple providers, as shipping carriers; dock management; hauliers; manufacturers, are involved in collaboratively fulfilling transactions and providing a service. The case study presented focuses on development of an integrated GPS/portal solution with an objective of enhancing control and visibility over inland transport thus improving customer service through the application of next generation information systems, utility computing and web-services.

Keywords: Logistics, Global position system (GPS), Supply chain management

Souhrn

Za posledních roky se Informační a komunikační technologie (ICT) staly dobře zavedenými v globálních dodavatelských řetězcech jako klíčový činitel integrace a sladění rozptýlených dodavatelů, výrobců a poskytovatelů logistických služeb. Spojení zakotvený v ICT je svědkem šíření mobilních technologií a nedávno se tak přidáva k sofistikovanosti technologických řešení poskytovaných komplexní, dodavatelským řetězcům. Mobilní technologie, jako je Global Positioning Systems (GPS), General Packet Radio Service (GPRS) a systémy Geography Information System (GIS), ve spojení s pokročilým internetovým řešením v zajištění transparentnosti a přísunu konkrétnější informace v rámci dodavatelského řetězce pokud jde o okamžitou lokalizaci a sledovatelnost zásilek nebo stav doručení. Několik studentů došlo k závěru, že sledování zboží v reálném čase výrazně zlepšuje logistickou výkonnost, efektivnost a spokojenost zákazníků.

Klíčová slova: Logistika, Globální polohový systém (GPS), Management dodavatelského řetězce

Acknowledgement

This thesis would not have been possible without the guidance and the help of several individuals who in one way or another contributed and extended their valuable assistance in the preparation and completion of this thesis. First and foremost, my utmost gratitude to Dr. Vlastimil Cerny, Head of International Relations Office, Faculty of Economics and Management through whose sincerity and guidance I was introduced to Faculty of Engineering. I am heartily thankful and owe my deepest gratitude to my supervisor, Dr .Ing .Robert Pergl whose encouragement, unselfish and unfailing guidance and support from the initial to the final level enabled me to develop an understanding of the subject. I would to like to count my Czech friend Petra Pospisilova for helping me in translating Czech to English whenever it was necessary. Thanks go to my all professors who taught me during my whole study period and also to my classmates and friends especially Anish Nepal, Suraj Ghimire, Sajjan Ghimire, Ujjwal AC , Deepa Manandhar, Srijana Karki for being always supportive to me in different ways directly or indirectly. Thanks go to last but not the least my family and relatives.

List of figures

Table of Contents

1 Introduction

1.1 Introduction

Over the past years Information and Communication Technologies (ICTs) have become well established in global supply chains as pivotal enablers of integration and alignment of dispersed suppliers, manufacturers and logistics providers Coupled with the maturity of embeddedness of ICTs, a proliferation of mobile technologies is witnessed recently thus adding to the sophistication of technology solutions provided to complex supply chains. Mobile technologies such as Global Positioning Systems (GPS), General Packet Radio Service (GPRS) and Geography Information Systems (GIS) coupled with advanced Internet solutions provide transparency and more specific information to supply chain collaborators in terms of instant localization and traceability of shipments and delivery status. Several scholars have concluded that tracking physical goods at real-time greatly improves logistics performance, cost efficiency and customer satisfaction.

1.2 Study background

GPS are space-based radio positioning systems that provide 24-hour, 3-dimensional position, velocity and time information to suitably equipped users anywhere on the surface of the Earth .The impact of these mobile technologies is more prevalent in contemporary sophisticated logistics which include multi-tiered suppliers, and manufacturers that are globally dispersed. It is apparent therefore that with an increase of global integration and complex business networks there is an imperative to develop network options beyond the boundaries of internal logistics. This brings new opportunities as risks inherent with implementing new logistics systems are lowered.

1.3 Goals and Methodology

The aim of the research is to develop an integrated GPS/portal solution with an objective of enhancing control and visibility over inland transport, thus improving customer service through the application of next generation information systems, utility computing and web-services.

Existing transport management systems have already adopted global positioning systems to track goods. This is prevalent in the transport and delivery of small, individual items such as parcels where the market leaders such as DHL and UPS have successfully used real-time goods tracking for many years. However when it comes to tracking an aggregated bulk consignment of goods/raw materials transported within a container, visibility between the shipping customer and haulier becomes elusive.

2 Methodology

2.1 Modern logistics tracking methods

2.1.1 GPS

GPS tracking offers potential to close the described gap: The actual position is defined continuously by the use of GPS signals. GPS modules calculate the distances to a number of satellites usually at least four satellites are necessary to determine the location accurately .The determined position can be transmitted in real-time with mobile data services like GPRS (general packet radio service) if the modules are equipped with such a mobile communication technology. For this reason the shipped goods can be localized anytime and with a satisfactory accuracy of a few meters. A GPS based track and trace solution can be categorized as continuous tracking. Further more the integration of GPS track and trace is independent from the IT infrastructure of the carrier. If the tracking modules are battery powered, the shipper can attach the GPS module to the shipment and can localize it on its own. Often this is possible with the help of a web application without special software. Even in big and open logistic networks the implementation of a GPS tracking is feasible if the tracking modules are mobile (requiring their own electricity supply e.g. via batteries) because no extra infrastructure is needed. [2]

2.1.2 GSM

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication, which has rapidly gained acceptance and market share worldwide. This technology is used to send and receive messages from vehicle and centralized monitoring sections in logistics management. GSM technology is very commonly used in any part of the world and it is economical to use. The powerful combination of information and intelligent technologies will advance the supply chain monitoring and management capabilities from the origin to final destination. *[4]*

2.1.3 RFID

In logistics RFID works by allowing authorized personnel to receive goods confidently without the need of opening the box and check for each item delivered. Instead of evaluating each item, RFID system, through its antenna, scans the box, confirms its content and delivers it to the stores. Through the use of RFID, operational efficiency is obtained. In fact, RFID enhances the speed of operation by as much as 22%.RFID technology has significantly improve logistics management by reducing the incidence of theft and damage of reusable assets which include gas containers, roll cages, bins, racks, totes and shipping containers. RFID technology actually helps in locating and tracking of reusable assets. It ensures that the assets are on its appropriate places and reduces the cost of procuring another set of reusable assets due to misplacement. In general, RFID technology positively affects Logistics management by improving the availability of reusable assets and enhancing operational efficiency in the industry.

This next generation technology proves to be effective in increasing productivity, maximizing accuracy and streamlining inventory in logistics. RFID Readers are capable of scanning multiple RFID Tags attached to each item in the box and pallets simultaneously. In fact, RFID readers can scan at least 400 RFID tags per second without human intervention. Nevertheless, logistics personnel are guaranteed with accurate inventory despite minimal human intervention.

Further RFID technology guarantees efficiency throughout the supply chain by increasing the level of accuracy during inventory. RFID tagging allows companies to determine the real time availability of their assets. In effect, companies are able to meet the demand of their customers immediately.

2.1.4 GPRS

The General Packet Radio Service (GPRS) is a new bearer service for GSM that improves and simplifies wireless access to packet data networks, e.g., to the Internet. It applies a packet radio principle to transfer user data packets in an efficient way between GSM mobile stations and external packet data networks. Packets can be directly routed from the GPRS mobile stations to packet switched networks. Networks based on the Internet Protocol (IP) (e.g.the global Internet or private/corporate intranets) and X.25

networks are supported in the current version of GPRS . (GPRS classes and coding schemes)

Users of GPRS benefit from shorter access times and higher data rates than they have now. In conventional GSM, the connection setup takes several seconds and rates for data transmission are restricted to 9.6 kbit/s. GPRS in practice offers session establishment times below one second and ISDN-like data rates up to several tens kbit/s

In addition, GPRS packet transmission offers a more user friendly billing than that offered by circuit switched services. In circuit switched services, billing is based on the duration of the connection. This is unsuitable for applications with bursty traffic. The user must pay for the entire airtime, even for idle periods when no packets are sent (e.g., when the user reads a Web page). In contrast to this, with packet switched services, billing can be based on the amount of transmitted data. The advantage for the user is that he or she can be “online” over a long period of time but will be billed based on the transmitted data volume.

To sum up, GPRS improves the utilization of the radio resources, offers volume-based billing, higher transfer rates, shorter access times, and simplifies the access to packet data networks. GPRS has been standardized by ETSI (the European Telecommunications Standards Institute) during the last five years. It finds great interest among many GSM network providers

3 Forms of logistics operation

3.1 Supply Chain Management

Supply Chain Management (SCM) is the concept for handling the production procedures in wide. A reliable SCM application could promote the industry to satisfy the demand of new business environment. Ross (1998) defined SCM as a continuously evolving management philosophy that seeks to unify the collective productive competencies and resources of the business functions found both internally and externally allied business partners located along intersecting supply channels into a highly competitive, customer enriching supply system focused on creating innovative solutions and synchronizing the flow of market products, services, and information to establish unique individualized sources of customer value.

SCM can be divided into three main activities purchase, manufacture and transport (Thomas et al., 1996). Cooper et al. (1997) analyzed the 3 elements of SCM supply chain business processes, supply chain management components, and supply chain network structure. Figure 1 shows the entire elements in SCM frame. It shows the entire details of the whole processes from purchasing, management, production, and distribution to customers. The information flow is like an individual system to link the whole supply chain from supplier and manufacturer to consumer. Unimpeded information flow could increase the operation accuracy for costs saving and enhance the competitiveness of organizations. The product flow proceeds through the entire production processes from goods supply via manufactories till giving the final products to consumers. The items in vertical direction show the various management activities within the supply chain. Particularly, the return flow, or reverse logistic, is one of the elements in the system but with converse direction from the others.

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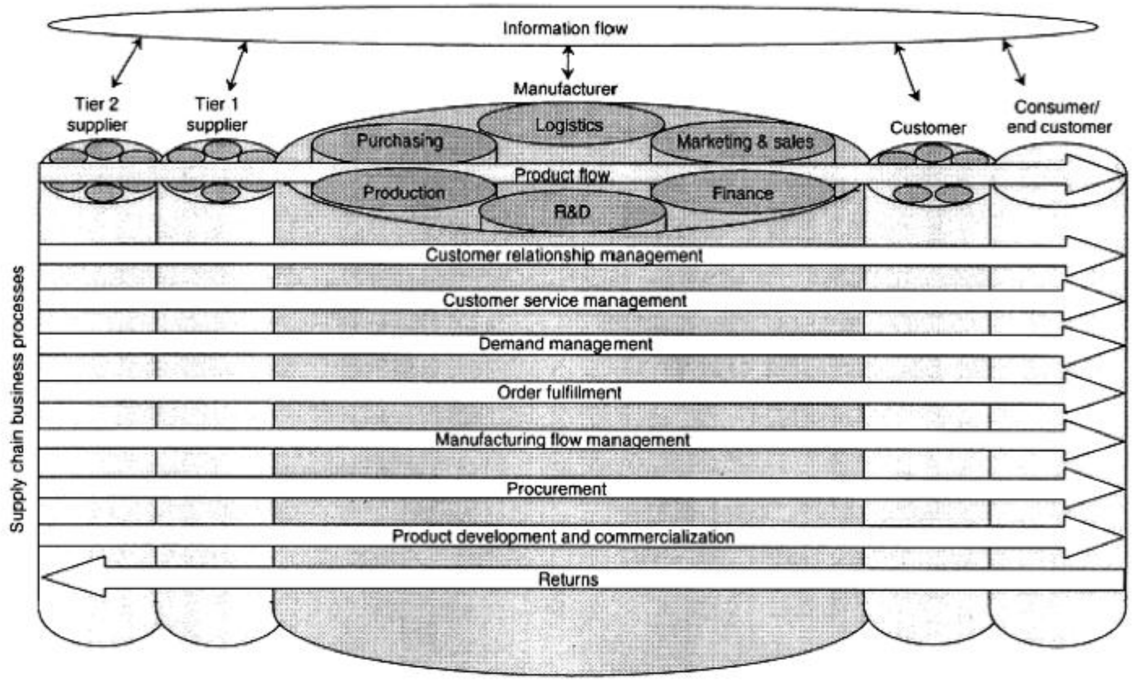

Figure 1 **Interaction of business processes and supply chain**

3.2 Reverse Logistics

The concept of reverse logistics has been applied in promoting customer service and resources recycling. Concerning quality control, the defective components and finished products will be returned to their producers through reverse logistics systems. Nowadays, reverse logistics has been developed rapidly for increasing industries' competitiveness, promoting customer service level, and recycling the reusable material. Meanwhile, the demand of reverse logistics brings out a new market for the third-party logistics industries.

Rogers et al. (1998) defined reverse logistics as 'the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. Figure 2 shows the structure of logistics systems, which includes forward logistics, backward logistics and information flow. The flow in black arrows presents the direction of reverse logistics, whose direction is counter to the ordinary logistics represented in hollow arrows.

The information flow connects between different stakeholders within the system. Each stakeholder can communicate with the other branches directly to maximize their profitability. Reverse logistics will be used in several modes and applications in the future due to its reliability, efficiency and benefits in environment protection.

The two core reasons behind the rise of reverse logistics are the globalization of markets and policies for environment protection. A successful reverse logistics could help to upgrade the service level of organizations and minimize the costs of manufacturing processes. More and more companies want to develop their reverse logistics system; however the system needs professional knowledge in logistics management and particular facilities. Thus the third-party logistics service provides another option for small to middle size companies to have their reverse logistics system. Figure 3 shows a system of reverse logistics service on how FedEx, a third party logistics provider, serves Acer computer, the customer company. At the very beginning of the system, the customer asks a request for returning the product through the Internet, and then FedEx develops the data of the products; meanwhile the system regulates the route of the delivery trips of the product. The customer can check the processing condition and wait for sending back at the right time.

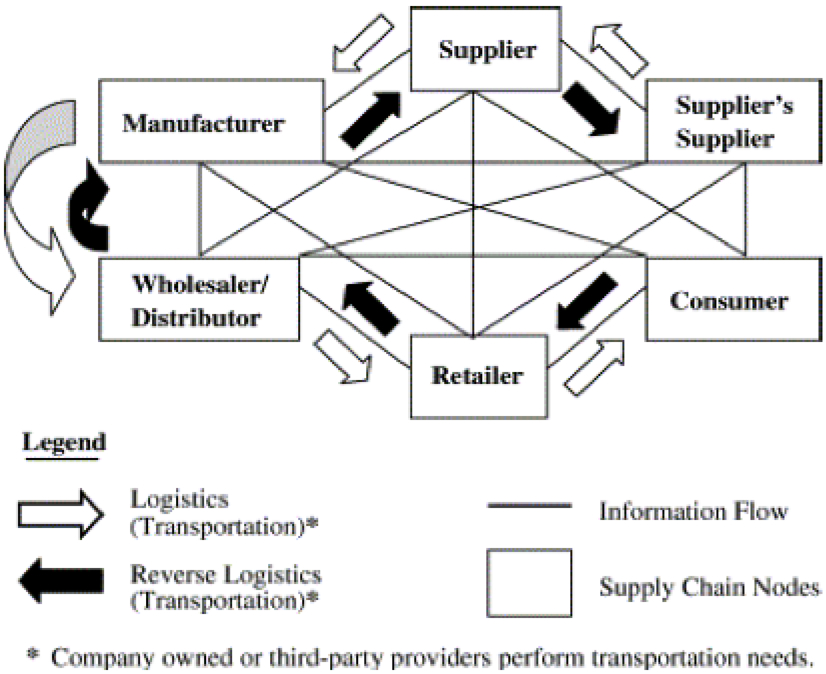

Figure 2 **Consumer supply chain (source: Krumwiede et al., 2002)**

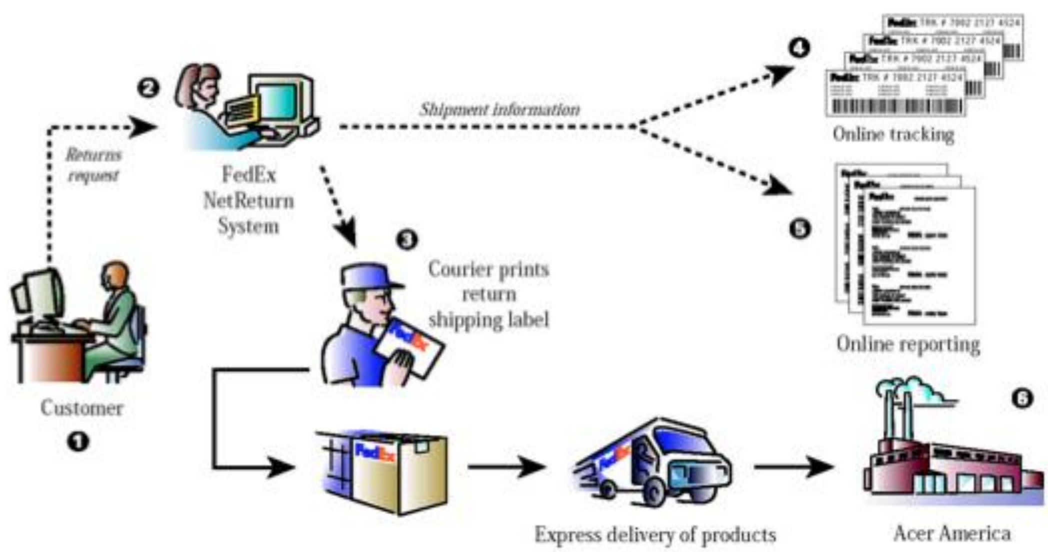

Figure 3. **Third party reverses logistics**

3.3 Maritime Logistics

Maritime industry plays an important role in international freight. It can provide a cheap and high carrying capacity conveyance for consumers. Therefore, it has a vital position in the transportation of particular goods, such as crude oil and grains. Its disadvantage is that it needs longer transport time and its schedule is strongly affected by the weather factors. To save costs and enhance competitiveness, current maritime logistics firms tend to use large scaled ships and cooperative operation techniques. Moreover, current maritime customers care about service quality more than the delivery price. Thus, it is necessary to build new logistics concepts in order to increase service satisfaction, e.g. real-time information, accurate time windows and goods tracking systems. The operation of maritime transport industry can be divided into three main types:

(1) Liner Shipping: The business is based on the same ships, routes, price, and regular voyages.
(2) Tramp Shipping: The characters of this kind of shipping are irregular transport price, unsteady transport routes, and schedule. It usually delivers particular goods, such as Dry Bulk Cargo and crude oil.
(3) Industry Shipping: The main purpose of industry shipping is to ensure the supply of raw materials. This sometimes needs specialized containers, such as the high-pressure containers for natural gas.

3.4 Air Freight Logistics

Air freight logistics is necessary for many industries and services to complete their supply chain and functions. It provides the delivery with speed, lower risk of damage, security, flexibility, accessibility and good frequency for regular destinations, yet the disadvantage is high delivery fee. (Reynolds-Feighan (2001) said air freight logistics is selected when the value per unit weight of shipments is relatively high and the speed of delivery is an important factor. The characteristics of air freight logistics are

- Airplanes and airports are separated. Therefore, the industries only need to prepare planes for operation.
- It allows speed delivery for far destinations.
- Air freight transport is not affected by landforms.

Research data show that the freight transport market keeps growing. Given the trend of global markets, air freight logistics also has to change their services. The future tendencies of air freight development are integration with other transport modes and internationalization and alliance and merger between air transports companies .The future pattern of air freight logistics is cooperative with other transport modes, such as maritime and land transport, to provide a service base on Just In Time, and door to door.

3.5 Land Logistics

Land logistics is a very valuable link in logistics activities. It extends the delivery services for air and maritime transport from airports and seaports. The most positive characteristic of land logistics is the high accessibility level in land areas. The main transport modes of land logistics are road freight transport railway transport and pipeline transport.

Railway transport has advantages like lower influence by weather conditions, high carrying capacity, and lower energy consumption while disadvantages as difficult and expensive maintenance, high cost of essential facilities, difficult and expensive maintenance, lack of elasticity of urgent demands, and time consumption in organizing railway carriages. Road freight transport has advantages as high accessibility, cheaper investment funds, mobility and availability. Its disadvantages are lower safety, low capacity, and slow speed. The advantages of pipeline transport are less effect by weather conditions, high capacity, cheaper operation fee, and continuous conveyance; the disadvantages are harder supervision, expensive infrastructures, goods specialization, and regular maintenance needs.

The excessive usage of land transport also brings huge problems, such as traffic crashes traffic jams, and pollution. In the future, to improve the land transport in a revolution of transport policies, transport efficiency and reliability, and management is required, e.g. pricing.

3.6 Express delivery

As the increasing demand of decentralization of production and time accuracy, the need to reduce stock costs has led to the Just In Time (JIT) delivery principle, which involves more frequent delivery of materials at the right time and at the right place in the production process. The characteristics of express delivery are:

(1)Door to door service service

(2) Efficiency

(3) Traceability

(4) Just in time (JIT)

(5) Growing various delivery demands.

The trend toward rising compact products is expected to improve the cost-benefit ratio of express delivery by decreasing the transportation cost share. Smaller products will enlarge the market for express delivery services. Also, the increasing value of products requires rapid transportation, because companies want to reduce the interest costs bound up in stock and inventories. For future development, the industries should consider integrating the services with 24-hour stores so that customers could choose a certain shop as the pick-up station. Meanwhile, the services would become more efficient and controlled due to more regular routes to those shops instead of personal houses.

3.7 City logistics

City Logistics is a method trying to combine the existing resources to find solution or to solve problems caused by the impacts of increasing population and vehicle ownerships in the urban area. Many cities, such as London, Banking and Tokyo, have suffered from these problems due to low transport efficiency, traffic congestions, environment impact, and consequently the competitiveness of business decreased. This kind of situation not only reduces the standard of life in urban areas but also the future city development. City Logistics provides an important opportunity for innovative solutions to be developed for improving the standard of life in cities. (Taniguchi et al., 2001a) It contains various advanced methods or tools, such as logistics knowledge, Intelligent Transport System (ITS), Geographic Information System (GIS), Global Positioning System (GPS), and modeling, to optimize the city environment. Moreover, it helps to reduce both transport cost and negative environment impact.

City Logistics is the process for totally optimizing the logistics and transport activities by private companies with the support of advanced information systems in urban areas considering the traffic environment, its congestion, safety and energy savings within the framework of a market economy. (Taniguchi et al., 2001b)

Cities are the main locations of business activities. Hence they play an important role in economic development. However given the high concentrated development in urban areas, many cities have serious traffic problems and negative environmental impacts, such as noise and air pollution, this is the cost in both developing and developed countries. These negative factors reduce the economic competitiveness of a city and make its life quality declined. The residents become the victims in the highly developed cities. The way to solve and balance the condition became a demanding issue in the recent years. City Logistics is a new and innovative concept which aims to solve this complex problem.

Urban freight logistics can be broken down in many elements, such as storage, transport and handling. Conventional improvement of the logistics process is usually only focused on single element. However, from a macro-viewpoint, the improvement can help bring the best profit to the society. Figure 9 shows the principle of the cost matters with different transport modes. Airfreight might be more expensive than land transport but the storage cost might be less. Thus in terms of total cost, airfreight might be the most reasonable transport mode for a particular transport purpose, for example, transport of fresh seafood.

4 GPS an overview

The Navigation System with Timing And Ranging (NAVSTAR) Global Positioning System (GPS) was conceived as a ranging system from known positions of satellites in space to unknown positions on land, sea, in air and space. The GPS constellation consists of 24 satellites in 6 orbital planes with 4 satellites in each plane. The ascending nodes of the orbital planes are separated by 60 degrees and the planes are inclined 55 degrees. Each GPS satellite is in an approximately circular, semi-synchronous (20,200 km altitude) orbit. The orbits of the GPS satellites are available by broadcast - superimposed on the GPS pseudorandom noise codes (PRN), or after post-processing to get precise ephemerides, they are available from organizations such as the Jet Propulsion Lab (JPL) or the International Geodetic Service (IGS) among others. The GPS receivers convert the satellite's signals into position, velocity, and time estimates for navigation, positioning, time dissemination, or geodesy.

4.1 Signals

Each GPS satellite transmits data on two frequencies, L1 (1575.42 Mhz) and L2 (1227.60 MHz). The atomic clocks aboard the satellite produces the fundamental L-band frequency, 10.23 Mhz. The L1and L2 carrier frequencies are generated by multiplying the fundamental frequency by 154 and 120, respectively. Two pseudorandom noise (PRN) codes, along with satellite ephemerides (Broadcast Ephemerides), ionospheric modeling coefficients, status information, system time, and satellite clock corrections, are superimposed onto the carrier frequencies, L1 and L2. The measured travel times of the signals from the satellites to the receivers are used to compute the pseudoranges.

The Course-Acquisition (C/A) code, sometimes called the Standard Positioning Service (SPS), is a pseudorandom noise code that is modulated onto the L1 carrier. Because initial point positioning tests using the C/A code resulted in better than expected positions, the DoD directed "Selective Availability" (SA) in order to deny full system accuracy to unauthorized users. SA is the intentional corruption of the GPS satellite clocks and the Broadcast Ephemerides. Errors are introduced into the fundamental frequency of the GPS clocks. This clock "dithering" affects the satellite clock corrections, as well as the pseudorange observables. Errors are introduced into the Broadcast Ephemerides by truncating the orbital information in the navigation message.

The Precision (P) code, sometimes called the Precise Positioning Service (PPS), is modulated onto the L1 and L2 carriers allowing for the removal of the first order effects of the ionosphere. The P code is referred to as the Y code if encrypted. Y code is actually the combination of the P code and a W encryption code and requires a DoD authorized receiver to use it. Originally the encryption was intended as a means to safe-guard the signal from being corrupted by interference, jamming, or falsified signals with the GPS signature. Because of the intent to protect against "spoofing," the encryption is referred to as "Anti-spoofing" (A-S). A-S is either "on" or it's "off;" there is no variable effect of A-S as there is with SA.

4.2 Observables

4.2.1 Code Pseudorange

The pseudorange is the distance between the GPS satellite at some transmit time and the receiver at some receive time because the transmit time and the receive time are different, it is impossible to measure the true range between the satellite and the receiver. The basic definition of the pseudorange observable is,

$$\rho = \rho_{TRUE} + c(\Delta t_R - \Delta t_T)$$

where rho is the observed pseudorange calculated from the light time equation, rhotrue is the difference of the position of the receiver at the true receive time minus the position of the satellite at the true transmit time and the rest of the equation represents the biases created by the errors in the clocks.

4.2.2 Phase Pseudorange

Another observable based on the carrier phase of the signal, does not require the actual information being transmitted. The basic definition of the phase observable is:

$$\rho_{\phi} = \rho_{TRUE} + c(\delta t_S - \delta t_R) + N\lambda$$

where

$$\rho_{\phi} = -\lambda \cdot \Delta\phi_S^R \Big|_{t} = \lambda\Phi$$

where the fractional beat phase of the signal is converted into a pseudorange by scaling with the wavelength. rhotrue and the clock corrections remain the same as for the code pseudorange definition.

The integer number of cycles N is typically not known and varies for every receiver-satellite combination. As long as the connection between the receiver and the satellite is not broken, N remains constant while the fractional beat phase changes over time. Because of the ambiguous nature of N, it is referred to as the ambiguity and can either be solved for by using the code pseudoranges, or estimated. The loss of signal lock between a GPS satellite and the receiver is referred to as "cycle slip." If the signal lock is re-established, a new ambiguity will exist and must be solved for separately from the original ambiguity.

4.3 Atmospheric Effects

The GPS signals passing through the atmosphere encounter refraction effects including ray bending and propagation delays. These include the atmospheric effects of the troposphere and ionosphere.

4.3.1 Troposphere

The largest effects of the troposphere can be avoided by prescribing an elevation mask for your receiver, thereby avoiding signals from low elevation satellites. With a 15 degree elevation mask, 4-8 satellites will be simultaneously observable from a location on the Earth at any time. The troposphere is composed of the "hydrostatic (dry)" portion and the wet portion accounting for water vapor. The dry portion constitutes 90% of the tropospheric refraction, whereas the wet portion constitutes 10%. However, the models for the dry troposphere are more accurate than the models for the wet troposphere. Therefore, the errors in the wet troposphere have a larger effect on the pseudorange bias than the errors in the dry troposphere.

4.3.2 Ionosphere

Some models try to account for all effects of the ionosphere, but require much effort in modeling the highly time dependent total electron count of the atmosphere. A technique to remove the first order effects of the ionosphere linearly combines the L1 and L2 observables to form a new signal that is free of ionospheric effects. Alternatively, a correction to one of the two signals can be solved for. The first order contribution of the ionosphere to the pseudorange bias is related to the inverse of the frequency squared. Thus for the two pseudoranges:

$$\rho_{L1} = \rho_{TRUE} + c(\delta_S - \delta_R) + \frac{a}{f_{L1}^2} \qquad \rho_{L2} = \rho_{TRUE} + c(\delta_S - \delta_R) + \frac{a}{f_{L2}^2}$$

We can form an ionosphere free pseudorange by taking a linear combination to cancel the effects which results in an ionospheric free pseudorange observable of:

$$\rho_{IONO} = \rho_{L1} - \frac{f_{L2}^2}{f_{L1}^2}\rho_{L2}$$

A similar development exists for the carrier phase observable. The expressions for the phase derived pseudoranges with first order ionosphere corrections are:

$$\Phi_{IONO} = \Phi_{L1} - \frac{f_{L2}}{f_{L1}}\Phi_{L2}$$

To actually use this new observable, it is necessary to compute the wavelength of the ionosphere free signal. Substituting values in yields a wavelength of about 48.5 cm for the ionosphere free signal or a frequency of 618.8 Mhz (60.5*f.0). Because the ratio between the L1 and L2 frequencies is not an integer value, the ambiguity term is no longer an integer. Alternatively, the ionospheric correction, a, could have been solved for.

4.4 Non-Clock Related Pseudorange Biases

There are other corrections besides the clock offsets and atmospheric effects which would appear as pseudorange biases. Receiver specific biases due to antenna phase center offset should be considered as well. The phase center of an antenna is where the signal is essentially received at and where the measurement refers to. Therefore, the distance between the antenna phase center and the point of interest needs to be known in order to correct the results to the point of interest.

When satellite signals reflect off of another surface and then arrive at the receiver simultaneously with non-reflected signals, this is known as multipath. The effect of multipath is greater on code based pseudoranges than phase based pseudoranges. Mathematical models to account for the multipath effect are impractical because the multipath effect is so highly dependent upon the specific geometry of the situation. Instead of accounting for multipath, it is recommended that multipath be avoided by placing the antenna as far from reflective objects as possible. In instances where multipath can not be avoided, the bias can be estimated from the ionospheric free combination pseudoranges; or the effects can be removed through digital filtering, wideband antennas, or radio absorbent antenna ground planes.

Because the reference frames fixed with the GPS satellite and the receiver are accelerated compared to the reference frame fixed in the Earth, special and general relativistic effects must be considered. The gravitational field of the Earth causes perturbations in the satellite orbits and space-time curvature of the satellite signal. The acceleration of the reference frames cause perturbations in the fundamental frequency of the satellite and receiver clocks.

4.5 Differential Techniques

4.5.1 Differential GPS

As the saying goes, necessity is the mother of invention. The DoD envisioned the civilian community using the GPS network and thus constrained them to the C/A code. The combination of the less accurate code and selective availability degraded the possible accuracy the civilian community could obtain. The solution came in the form of differential GPS (DGPS). The basic concept of DGPS is the use of 2 receivers, one at a known location and one at an unknown position, that see GPS satellites in common. By fixing the location of one of the receivers, the other location may be found either by computing corrections to the position of the unknown receiver or by computing corrections to the pseudoranges.

By using DGPS, effects of selective availability can be removed. For short baseline distances between receivers, some of the biases from the atmosphere can be removed as well. This cancellation effect is the result of both receivers seeing the same things. If one receiver location is known, then the bias in the pseudorange to the known receiver can be calculated and used to correct the solution of the unknown receiver location. The DGPS system designed by the US Coast Guard calculates the biases at a known receiver location, and then broadcasts them on a radio frequency.

4.5.2 Double Difference Processing

Using double differenced observables can eliminate selective availability effects as well as other biases. Double differences are primarily used for surveying and geodetic research using phases; however, they are not limited to those applications. First, single differences are formed by subtracting observation equations from two separate receivers to a single satellite. Taking the difference between two single differences for a specific receiver pair gives the carrier phase double difference:

$$\left(DD_{12}^{lk}\right)_{\Phi} = \left(SD_{12}^{l}\right)_{\Phi} - \left(SD_{12}^{k}\right)_{\Phi} = \frac{1}{\lambda}\left(\rho_1^l - \rho_2^l - \rho_1^k + \rho_2^k\right) + N_1^l - N_2^l - N_1^k + N_2^k$$

For coordinated receive and transmit times, all clock corrections have been removed for both of the GPS satellites and both of the receivers.

5 GPS an advantage for logistics.

There are lots of advantages of GPS tracking: For example a more transparent transport chain, an increasing delivery performance through faster problem identification, bottleneck identification in procurement logistics, more security for customers, more reliable data for tour or production planners, a faster reaction time in answering to delays and a growing customer satisfaction. The criticism towards GPS tracking is the unreliability and the inaccuracy of the position data because GPS signals are often not available inside of containers or vehicles, in valleys or between high-rise buildings in inner cities because the modules are not able to connect to the required minimum of four satellites. Today GPS shipment tracking is used for container monitoring of overseas transports and for the tracking of railway waggons. GPS tracking is also used in context of telematics services, e.g. fleet management. This major practical application of GPS tracking includes vehicle tracking with driver and vehicle data, traffic information and on-board navigation. A GPS module is fixed in the vehicle and connected with on-board power [Wang, Potter, 2008].In combination with a discrete tracking technology, this 'quasi-continuous' tracking solution can be realized. Therefore the loading and unloading data has to be assigned to a vehicle. It has to be guaranteed that all vehicles used in the transport chain are equipped with an on-board tracking system. However the disadvantage is, that every vehicle which is used, needs a telematics device in contrast to GPS shipment tracking which is independent from specific vehicle [He, et al. 2009]. So the introduction and integration of a vehicle independent tracking is easier, leads to a higher level of flexibility but requires more tracking modules in the supply chain.

6 Logistic Application Analysis.

Common techniques integrated in the procedures of City Logistics includes

6.1 Cooperative freight systems

The traditional delivery pattern of freight is fewer trips and more loads. The delivery companies usually maintained their business independently. It means two carriers might serve in the same area. Nowadays, the trends of urban freight transport towards to deliver Just in time and door to door. The operation of freight transport changes to have more trips but fewer loads in order to increase the efficiency differently. Without improvement, the transport costs will increase hugely to satisfy the current requirements. Cooperative freight systems are the ways which could be expected to solve this problem.

Cooperative freight systems integrate the resources of the cooperating companies to optimize the economic benefits. The main benefits of the techniques are

(1) Properly increasing delivery trip loads

(2) Reducing unnecessary trips, as well as pollution and costs

(3) Reducing service area overlaps

(4) Increasing service quality and company profits.

6.2 Freight villages (terminals)

The concept of freight villages (terminals) has been applied in several cities, such as Monaco. The goods are reorganized in the freight village before being delivered to the urban areas. This system can reduce the required number of trucks used for delivery and handling.

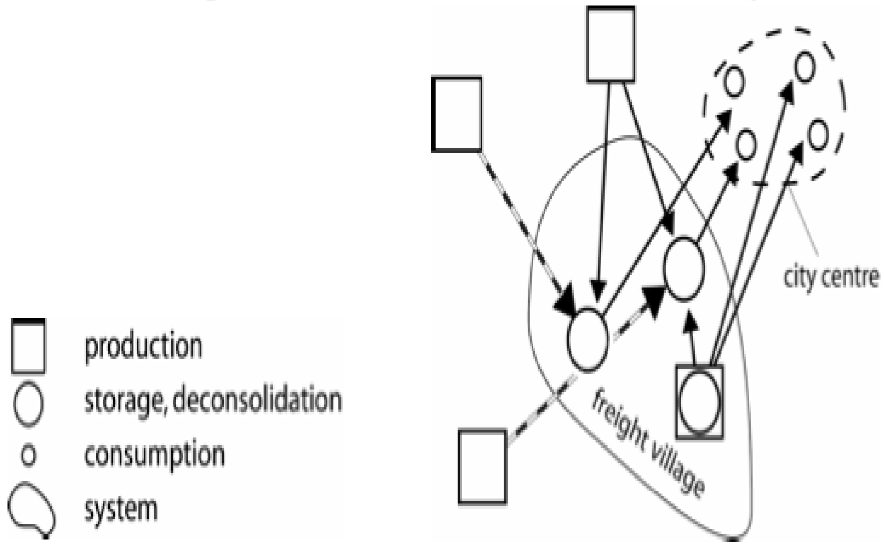

Figure 4 **The structure of freight village.**

Above Figure shows the model of freight villages. The freight from outside of a city is sent to the freight village in order to classify and prepare for delivering to city area. This could increase the carrying load of vehicles and reduce unnecessary trips in the urban area. In addition, this integration benefits the private sector by reducing costs, and also the public environment by decreasing trips and air pollution.

6.3 Controlling transport load factors

In Europe,some cities implement the limitation of load factors in urban freight transport. Companies allowed to deliver freight in urban area must have high loading rates, and the vehicles have to conform to the environmental standards. The method of regulation is through publishing special certificates and giving the right for the companies to use particular transport infrastructure in the urban area, so reducing the complexity of urban transport.

6.4 New freight transport systems

New freight transport systems range from the design of new vehicles to the underground freight transport systems. The former can be used to adjust the current resource to satisfy the short term requirements. The latter is for the long term, bringing a new era to city freight transport.

6.5 Intelligent Transport Systems (ITS)

Applications of ITS in transport systems are widespread. The most common techniques for logistics include Global Positioning System (GPS), Geographic Information Systems (GIS) and advanced information systems. GPS provides the service of vehicles positioning. It could help the control centers to monitor and dispatch trucks. GIS provides the basic geographic database for the deliverers to enable to organize their routes easier and faster. Advanced information systems provide the real-time information for both managers and deliverymen to adjust their paths as new demands occur. The integration of GPS, GIS and advanced information systems provides a high maneuverability of transport systems. The benefits of the integrations are better service quality, reduced unnecessary trips, and increased loading rate.

7 Case study in Selected Platform.

7.1 Real time tracking Solution

A mobile GPS tracking telematics system and a web portal was developed to address the issues faced by haulier and Shipping Company. The system is based around mobile smartphone (IOS device only) that can accept driver instructions from a central portal and transmit status updates and positional data back to the portal (Figure 5). The tracking issues are addressed by using GPS enabled handsets that transmit the co-ordinates of the vehicle back to the portal at fixed time intervals. The user can see the location of the vehicle on a map and because the tracking is linked to the order (and therefore the delivery location) .The system can also provide the Estimated Time of Arrival (ETA) at the delivery location. Proof of Delivery (POD) information, including the consignee,s signature is captured on the smartphone and transmitted to the portal real-time. This makes the information available without the traditional delay of waiting for the driver to return to the depot. It also makes it available on-line across the whole supply chain and provides retrieval of historic Pods for query resolution. Furthermore, the integration portal and inter-operability xml schema developed enables exchange of information with different company back-office systems. Thus the benefits of the tracking solution are extended from simple real-time visibility of location to complete integration with company order and payment systems thus providing a more holistic solution. Additional realized benefits include: cost saving by reduction of papercopies; providing improved communication with drivers and automating the daily vehicle checks. The devices used in the cabs are also mobile phones with an integrated camera which can be used to record damage in support of any claims.

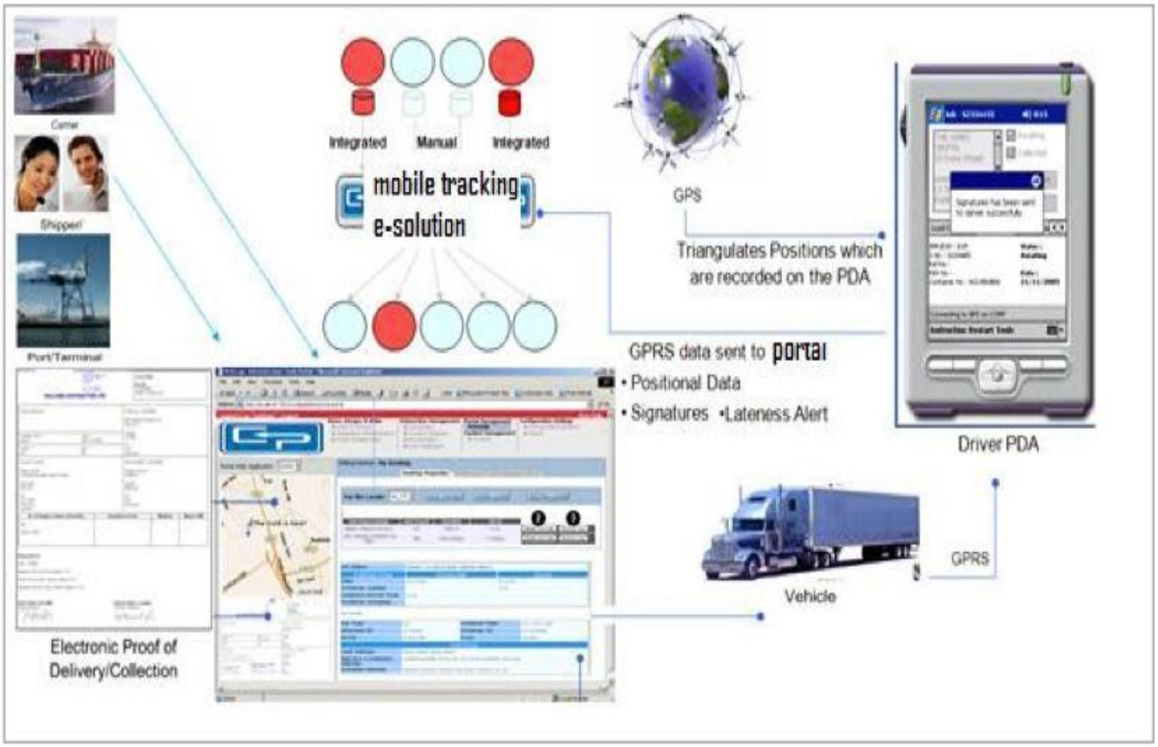

Figure 5 Real time tracking management solution (michaelides et al ,2008)

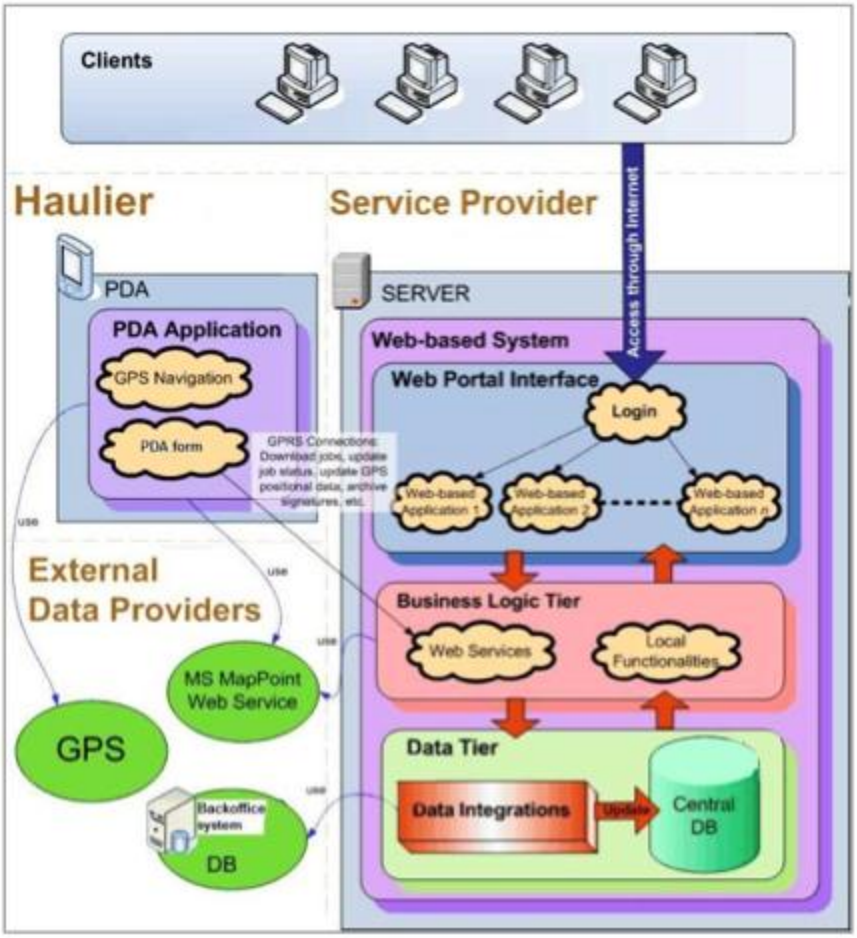

Figure 6 SaaS architecture

The advantage of using SaaS is that it eliminates customer effort of software maintenance, security updates and support as the actual application is installed on a service host. In addition to the above, the haulier company incurred no up-front cost and benefited from virtually unlimited computing power with a reasonable monthly service cost.

8 Implementation Assessment.

Facing the worldwide competition, the improvement of logistics system should be advanced by both private companies and government. Weeld and Roszemeijer (Ho, 1997) discerned three revolutions in business that have substantial impacts on the purchasing and supply strategies of the manufacturing sectors. These three revolutions are

- The globalization of trade
- The coming of the information era
- More demanding consumers and continuously changing consumer preferences

The main characteristics of future logistics development are

a. Government role- To keep competitiveness of industries, the government has to lead the way to assist the logistics industries. For instance, the idea of freight village of city logistics provides the environment to promote logistics efficiency and to reduce operation costs. However it involves large of investments and some problems relating laws and national policies. Without the lead and support of government, achieving the plan is difficult.

b. Growth of international goods transport- The up-growth of international freight transport is contributed by several factors. Firstly, the blossoming of E-commerce pushes ahead the international business activities. Secondly, the change of production strategy needs international cooperation, e.g. importing the semi-finished products from countries with cheaper human resources to those with higher technology to assemble the final goods. Thirdly, the pressure of globalized market, such as World Trade Organization (WTO), pushes local industries to promote themselves to reach an international standard and face the worldwide competition.

c. Improvement of services- Providing a good customer service becomes a necessary requirement of business operation with the intense competition of global market. The quality of services is the main factor to affect consuming behavior among the enterprises with high similarity. The service systems involve several developed techniques now, such as Efficient Consumer Response (ECR) and Quick

Response (QR). In the near future, more new techniques would be applied in providing better services for customers.

d. Revolution of logistics operation- IT techniques and its products bring efficiency and fluency to the logistics systems. Radio Frequency ID (RFID) is one of these techniques. The main difference between the bar-code system and RFID is that RFID does not need the action of scanning the barcode on goods. RFID could save manual operation time dramatically. RFID systems could sense the amount of goods input in the tags automatically and immediately when the costumers push their trolley through the exit (Carroll, 2004).
e. Shorter product life cycle-With the current trend, the merchandise design is changing day by day, and therefore, the product life cycle is shorter and shorter, especially in computer science. Logistics system must improve its efficiency and reliability of goods delivery to confront the impacts. Otherwise an inappropriate logistics system would hinder the competitiveness of new products and the business profits.
f. Improvement of logistics facilities-The advancement and development of logistics are based on several techniques and complete theories. High-tech facilities and systems, e.g. ITS, could bring more possibilities and advantages to logistics. For example, the improvement of related facilities, e.g. Forklift Trucks, is necessary for transport efficiency. In the future, factory automation is the main target for the whole supply-chain procedures. It could help to improve efficiency and also reduce the operation costs.
g. Channel cooperation between companies- In order to save the logistics costs, a key concept is to maximize the usage of available transport capacity. Integrating the logistics demands between numerous departments helps achieve this purpose. In practice, a conglomerate could develop its own logistics service for the branches. For some medium size companies, they could cooperate transport channels with others.
h. Specialized logistics delivery-One of the notable trends of logistics industries is specialized delivery service. For instance, delivering fresh food from the place of origin needs low-temperature containers. Compute chips, gases and petroleum

need particular conveyances to carry. These demands are rising since the products became more and more delicate.

i. Logistics centers- The development of logistics centers is good for industry promotion and the development of national economic system. Logistics centers could successfully shorten the distance between production and marketing vertically and also integrate various industries horizontally, and thus decrease the costs. Governments can propose special areas for storehouses and logistics to reduce land acquisition. The future logistics will cooperate e-commerce, the Internet and the newly door to door service to create new business prospects.

j. Freight transport- The alliance between middle-small size delivery companies is an important trend in the future. The strategy could help to expand service areas and increase service quality, and meanwhile raise the loads of single trips to reduce delivery costs.

9 Discussion

How to speedily deliver products to consumers' hands is a common consensus of operators. Integration of logistics and e-business is the future trend. In order to get more advantageous position and build a complementary and dependent relationship, networking industries, such as Amazon and e-Bay, usually cooperate with logistics industries. The integration could reduce the middle-level procedures. The producers could immediately give the products over to the terminal customers. This could reduce expenses and also administer sources more efficiently. Besides, the companies do not have to take the costs of inventory and warehouse, and therefore they become modernized industries of low cost, more efficiency and division of specialty. For example, customers could get ordered goods from convenience stores. Through e-logistics, the competition condition of industries could be promoted in knowledge economics.

The application and the case study presented here suggests that it is possible to develop real time tracking e-solutions for the transport industry that not only improve internal operational efficiency but also extend visibility to supply chain partners and clients thus achieving an integrated solution. Thus an application to demonstrate the impact of technology over the ever evolving logistic scenario was implemented.

10 Conclusion

Through the empirical study the benefits of using GPS vehicle tracking and integration portal technologies within the context of the transport container industry have been demonstrated. Transport practices are influenced by regulatory and global economic environments, available company infrastructure and competition with other supply chains Sharing information such as container location through real-time vehicle tracking has enabled the case study haulier company as well as the shipping partners to quickly identify job status as well as establish appropriate control measures to overcome the uncertainty of the last mile. Increasing delivery visibility and reducing delays and errors helps organizations along a particular supply chain to share the same objective which identify as satisfied end-customers. Meanwhile, in addition to the direct operational benefits of "quicker response" integration between the carriers and the haulier company, the Internet based container tracking system could generate considerable macro opportunities as a result of improved physical flows and trade security. For example new business contracts could be won from the client market that demand tracking systems to be in place for security as well as customer services purpose.

11 Bibliography

1 Hillbrand, C., Schoech, R. (2007) Shipment Localization Kit: An Automated Approach for Tracking and Tracing General Cargo. In: Proceedings of the Sixth International Conference on the Management of Mobile Business 2007, Toronto, Ontario, Canada, pp. 46-52

2 GPRS classes and coding schemes, http://www.cellular-news.com/ gprs/GPRS_classes_and_coding_schemes.shtml

3 GPRS handset development, Challenges and Opportunities, http://www.gsmworld.com/cgi/bounce.pl5/www.gsmworld.com/technology/ gprs/presentations/stefan_berggren_ericsson.zip

4 GPRS White Paper, http://www.cisco.com/warp/public/cc/so/neso/gprs/gprs_wp.html

5 Ho, J.K. (1997). What can contemporary systems thinking offer to logistics management as a management discipline, European Journal of Purchasing and Supply Management, Vol. 3, No. 2, 77-81.

6 Cooper, M.C., Lambert, D.M. and Pagh, J.D. (1997) Supply chain management: more than a new name for logistics, International Journal of Logistics Management, Vol. 8, No. 1, 1-13.

7 Ross, D.F. (1998) Competing through Supply Chain Management: Creating Market winning Strategies through Supply Chain Partnerships. Chapman and Hall, New York.

8 Reynolds-Feighan, A.J. (2001) Air freight logistics. In A.M. Brewer, K.J. Button and D.A. Hensher (eds.), Handbook of Logistics and Supply-Chain Management. Elsevier Science Ltd., UK, 431-439.

9 Taniguchi, E., Thompson R.G., Yamada, T. and Duin R. (2001a) Introduction. In City Logistics: Network Modelling and Intelligent Transport Systems. Pergamon, 1-15.

10 Michaelides R., Liu K. and Jervis S. (2008), „ e-solutions enabling growth in the transport industry: Case study of a real- time Tracking Management System‟, LRN Annual conference, Liverpool, September 2008

11 Thomas, D.J., Grifin, P.J. (1996). „Coordinated supply chain management‟, European Journal of Operational Research 94 (1), pp 1–15.

12 Carroll, J. (2004) The magical reserve tracing system-RFID. Taiwan CNET, <http://taiwan.cnet.com/enterprise/technology/0,2000062852,2008707 1,00.htm>