# Using Information Technology To Optimize Operations Of Third-Party Logistics Provider

Hua Zhong, State University of New York, USA
Bin Zhou, Kean University, USA

**ABSTRACT**

*Advancement in information technologies has brought substantial benefits to logistics service providers, e.g. third-party logistics (3PL) companies. The development and application of these technologies such as global positioning system (GPS) are especially important and helpful in transportation and logistics activities that are integral components in any Supply Chain system. Understanding the impact and potential issues brought by using these technologies are of significant importance in global supply chain management. In this research, we investigate the application of GPS-based information technologies to optimize operations of companies providing third-party logistics service. We discuss how these technologies help to enhance the effective and efficient management of their businesses and analyze the interaction of GPS implementation and several key characteristics of the logistic distribution context. We address major benefits and challenges, and provide important insights.*

**Keywords:** Third-party logistics; Supply chain management; Information technology

## 1. INTRODUCTION

In recent years, the advancement of Information Technology (IT) has greatly facilitated business decision making in countless ways. In particular, the introduction and application of global positioning system (GPS) in the past decade provide varied benefits to both military and civil users, especially to the supply chain and logistics industry. Logistics and transportation are important areas in supply chain management since they play crucial role in the physical movement of materials, semi-finished, and finished goods in a system that consists of a variety of entities such as suppliers, manufacturers, distributors, retailers, and end customers.

Because of the wide-range of business activities involved in the transportation process, logistics related costs account for a quite substantial share of the total costs for any company. Both fixed and variable costs can be found in the logistic distribution process, which may includes the cost of vehicles, labor costs of drivers and dispatchers, cost of fuel, etc. Thus, one of the biggest challenges in the management of logistic distribution is how to efficiently move the required goods from one entity to another while effectively controlling and minimizing these costs.

New technologies such as electronic data interchange (EDI) and enterprise resource planning (ERP) systems in the past decades have substantially enhanced the efficiency of modern supply chain management. In particular, the emergence of global position system (GPS) significantly improves logistics operations. The research and development of GPS and related technologies can be traced back to the 1970s, when the NAV STAR Global Positioning System was developed and launched by a small group of military officers and civilians. The plan was to develop a new navigation system that would utilize radio-ranging measurements from a constellation of satellites. Later, wide application of these technologies was first witnessed in military, where they are used as effective planning and data collection tools, then in a wide-range of civil/commercial situations. In recent years, GPS mobile terminals are widely equipped and used in vehicles of commercial logistics service providers.

 

On the other hand, due to the newness of the commercialization of these technologies, there exist various challenges in the implementation process. In academic research, limited findings have been revealed on the development and usage of these technologies in the logistics and transportation business, especially in developing countries, where they have a relatively short history and their impacts are unclear. For instance, very few studies provide answers to questions such as: i) what are the roles played by GPS and related technologies in logistics companies; ii) what are the major benefits and challenges when applying these technologies; and iii) what are the impacts.

Some past research provided important discussions. For instance, Zito et al. (1995) explored the application of GPS technologies for constructing vehicle-highway control systems. Their paper discussed the use of GPS for obtaining information with respect to the position, speed, and travel direction of vehicles. Hafberg (1995) studied the concepts and techniques to combine GIS, GPS, and other digital communication technologies to locate the position and velocity of vehicles. Their paper emphasized the importance of the connection with the central monitoring system. Weigel and Cao (1999) studied the application of GIS and OR techniques in the problems of technician-dispatching and home-delivery of Sears. Similar problems are analyzed in the practice of home delivery business. For instance, Jung et al. (2006) studied the implementation of GPS and related technologies in parcel delivery service. They analyzed a GIS and GPS intelligent system for parcel collection and delivery in Korea. Derekenaris et al. (2001) investigated a system that integrates GIS and GPS technologies for the effective management of ambulances and emergency incident handling.

Imielinski and Navas (1999) described the technical development of GPS and its important usage for geographic data collection. Their research studied the problem of global positioning system based addressing, vehicle routing, and resource discovery. Other research on GPS technologies also focuses on a variety of situations, including for instance, vehicle delivery and routing (Keenan, 1998), urban and forest planning (Sui, 1998), emergency management of fire truck and ambulances (Derekenaris et al., 2001), as well as construction and engineering management (Li et al., 2003). However, limited work has been done on GPS and related technology application in logistics firms in emerging economies. Hence, this paper aims to address these issues by presenting a case study and providing insights with respect to the interaction of GPS and other essential functions of a firm.

The remainder of the paper proceeds as follows. In the next section, we discuss research methods and procedure employed; Section 3 integrates this study's results and the findings of previous research, reveals important issues in the implementation process, and elaborates major benefits and challenges found in such situations. Valuable insights for logistics companies in emerging economies are also provided. In Section 4, we conclude with a discussion of the study in terms of contributions and limitations.

## 2. RESEARCH METHOD AND PROCEDURE

In this section, we provide a discussion on the methodology used in this research. As mentioned, wide commercial usage of GPS and related technology has a relatively short history. Though there is a number of articles discussed the applications and impacts of GPS and related technologies, academic research in this area is still at a preliminary phase where no theoretical base has been established. In such situations, case study method is appropriate and suits the purpose of this research to reveal some important findings that can be used in future research for more generalized results.

The research focuses on exploring effects of GPS and related technologies on third-party logistics service providers and therefore studying a medium-sized logistics company, Company A, with about 200 employees and more than 150 trucks and vans in the city of Beijing, China, which is a major emerging economy in the world. In the study, both telephone and on-site interviews were conducted to gather important information. Truck drivers, dispatchers, and senior management were all included in our interviews to collect comprehensive and diversified data and inputs. We also conducted field trips to the research site and obtained a better understanding of their operating environment.

Research questions used in interviews are open-ended and cover a variety of issues on technologies as well as collaboration issues in logistics operations. A typical starting question is "how do you describe the impact of

using GPS and related technologies?" The question is very simple but serves as a good start that leads to detailed follow-up questions to investigate the practices that contribute valuable information to this study. Interviewees were also encouraged to raise their own issues and describe their experiences. Each interview lasted 20 to 30 minutes, during which notes were taken and these notes were further reviewed and analyzed in later stages.

An iterative "explanation-building" method was used for analyzing results. Specifically, this method consists of four steps.

*Step 1. Firstly, a single participant's answers were randomly selected from the pool and then carefully reviewed and analyzed.*

*Step 2. Secondly, research hypotheses related to the research questions of interest were developed based upon detailed analysis of the results of the first participant's answers.*

*Step 3. Thirdly, the second participant's answers were picked and explored. And special attention was paid to confirming or rejecting the initially listed hypotheses. Moreover, in light of the answers from the second participant, we revised the original list of hypotheses.*

*Step 4. In the last step, we continued the iterative process by analyzing the answers of the third participant, based upon the revised list of hypotheses.*

This procedure was followed until all the interview answers were investigated. We then revised and finalized all the interviewed questions and research questions with a complete list of findings from the research. We finished the analysis by comparing all the findings and formalized a final list of hypotheses and concluded the entire study.

## 3. RESEARCH FINDINGS AND ANALYSIS

In this section, we presented our research findings and analysis with respect to the application of information technologies (IT), including GPS and GPRS wireless communication equipments and software, and their impacts on the logistics operations. In particular, we first provided an overview of the company's operations and IT implementations. We then discussed the chief advantages or benefits resulted from using these new technologies. Lastly, we highlighted some critical issues and challenges during the application process.

### 3.1 Overview of Logistics Operations and IT Usage

We now present a brief overview of the company's operation and the technologies they used. Company A's delivery service begins with the receipts of customers' orders. These orders are then put into computers terminals. Practically, delivery schedules are generated by computers based upon the expected delivery date, time, and location. Dispatchers, after verifying the delivery schedules, forward these timetables to drivers, who load the products on the trucks from warehouses either at the companies' or customers' facilities. Last step of the operation is the delivery of the products to the desired locations.

Strict requirements (for instance, specific delivery time, special handling of certain products) and high expectations from customers lead to higher costs for Company A. While order receiving and delivery scheduling are conducted at the dispatching center where customer and order related database is kept and managed in computer terminals, the delivery of goods is the last step of the operating process. Hence, delivery is the critical contacting point where the service quality is experienced and the place that company aims to monitor and evaluate. It is therefore very important for the company to enhance the effective control of its delivery operations for competitive and sustainable advantage via applications of advanced information technologies.

The company equipped both mobile GPS and GPRS-based wireless communication hand-held terminals. These new technologies were applied and expected to improve three major areas:

- Provide flexible and optimized delivery guidance
- Generate real-time product tracking information
- Reduce redundant manual operations

GPS is used extensively and intensively in the daily delivery operations by truck drivers. Based on our interviews and observations, the primary roles of the GPS mobile receiver are to: a) send and receive satellite signals, b) demonstrate planned delivery routes and projected delivery time, c) illustrate customers' locations and neighborhood, d) provide flexible guidance. Each driver (truck) is provided with a GPRS-based communication mobile terminal (e.g. handheld PDA). While the GPS receiver serves as the media to transmit data for better real-time guidance, the GPRS mobile terminal is used to achieve products-related information exchange between drivers and the control center. The GPS and GPRS-based technologies are widely used in the company and the manger describes the system as "part of the company" and "can't work without it". Daily operations are frequently monitored to ensure procedure is complied and policies are followed.

In what follows, we first provide a discussion on the major benefits brought by using these new technologies to the company and their possible impacts on the entire supply chain. Then we present issues and challenges found during the implementation process.

### 3.2 Benefits of the IT Usage

As a logistics service provider, Company A needs to deliver goods in a timely manner to their customers. For instance, due to the special characteristics of certain products (perishable seafood and fruits) specific delivery time windows are required by customers. In addition, majority of the customers (supermarkets and restaurants) are located in downtown Beijing area. Hence, providing just-in-time (JIT) service to their customers under accepted costs is one of the biggest challenges faces by the company.

Complicated traffic conditions, which are often times highly unpredictable, further create problems for providing JIT service. According to our interview with the drivers, in the past, a driver normally made no more than three deliveries per day. Large time gaps between schedules (created to buffer unexpected situations) were very common. As one dispatcher mentioned in the interview, "delivery schedules were really difficult to keep primarily due to demand uncertainty, (customers') requirement, and traffic condition…". One driver said, "…when we returned to the center, it was too late to make the next shipment." The company has a strong need to improve their operation and reduce lead times.

One of many benefits brought by the usage of GPS and related technologies is that they significantly help to improve just-in-time (JIT) service. During the interview, many drivers commented the traffic issues and describe the traffic condition as "horrible". The use of GPS and related technologies has substantially improved this aspect. In particular, the just-in-time service is improved by real-time guidance provided by the GPS navigational system. The mobile terminal is so useful for truck drivers, especially in the situations that traffic condition is really bad or the drivers are not familiar with the neighborhood environment.

Based on our study, 98% of the interviewed employees find that their delivery management has been improved significantly. They rely on the GPS to generate optimized delivery route and projected delivery time. During the interview, the mobile devices are described as "simple", "flexible", and "fast". Thanks to the new technology, drivers are able to find the best routes to their customers and avoid traffic conditions such as accidents and construction activities.

In addition, through using GPRS-based PDA device, the company effectively reduces redundant manual operations and shortens total operating time. The mobile PDA can receive customer and order information from the computer communication terminals in the dispatching center. It sends delivery confirmation messages back to the company. With the assistance of the new system, operating lead time is considerably shortened. As one dispatcher commented, "sending and receiving information are much faster and easier than before (using GPS/GPRS), which greatly improves efficiency and accuracy." The company has witnessed a substantial improvement in its trucks utilization. Comparing to the past, a driver can almost double its number of delivery during a normal 8-hour working day. Another benefit mentioned by the interviewees is that fuel cost per delivery has also dropped considerably.

The other major benefit brought by using these technologies is that they help to optimize company management, particularly in the areas of order and delivery status. This advantage can be enjoyed by their customers in the supply chain. Prior to the use of GPS and GPRS technologies, tracking of products and delivery status was really difficult. There is limited information and knowledge in the control center once the products are on the road. This procedure creates two significant problems.

First, the information with regard to when the product is delivered is substantially delayed at the control center. Hence, customer service was very poor since there is no real-time product tracking available. Second, delivery schedules are also delayed at the dispatching center for next possible shipments, since they will have to wait for the trucks that can return to the company sooner.

The new technologies provide many "real-time" functions that improve company management. In particular, though the "real-time" information in the GPRS-based mobile terminal, important customer and products information is transmitted between the driver the control center. In this situation, the company has a better knowledge with respect to the status of truck, driver, and products. Dispatchers described the benefits as follows, "Knowing the "real-time" status of our trucks and products delivery information is very important for enhancing our management and meeting our goals for providing better service to our costumers. They can help us to have better planning and schedules, thus effectively control of trucks and personnel." As some drivers pointed out during the interview, "the GPS terminal is very useful. We now can manage our work more efficiently through using these new technologies. We deliver faster and communicate with our company better."

### 3.3 Issues and Challenges

We also want to discuss some critical issues found during the interviews. One of the biggest issues that mentioned by many drivers and dispatchers is the accuracy and update of GPS technologies. The use of GPS terminals to provide navigational guidance is one of many functions that benefit the company, particularly the drivers. To sustain these benefits, data installed in GPS devices requires necessary and regular updates to keep up with real-world geographic changes such as construction of new roads or buildings. However, during the interview, many drivers mentioned that inaccuracy of the digital map and guidance can sometimes bring substantial problems. Several interviewees commented on the issue of digital map and accuracy problems and gave some typical examples, which can be summarized as follows:

- GPS cannot provide detailed geographic plots in certain areas
- Newly-constructed roads or bridges were not shown on the map
- No/wrong addresses
- Poor signals and wrong directions

Several factors lead to the above problems. Firstly, as in most developing nations, digital mapping data has been scarce and historically quite expensive to obtain in China. In deed, limited geographic data and resources as well as inadequate technological supports contribute to the poor maintenance of GPS technologies. This leads to the fact that the performance of the GPS navigation system is relatively unstable. Quality of guidance and real-time tracking is not guaranteed which can cause unexpected troubles to the company. Secondly, like many fast growing cities in emerging economies, the city of Beijing has experienced rapid development in the past decades. New roads, bridges, and buildings emerge almost every day, which make timely maintenance and updates of GPS related systems almost unavoidable. Under such a circumstance, how to update the GPS data in an effective and efficient way is a big challenge to many logistics firms.

The other major problem described by many interviewees is that there is not enough support from the new technologies in emergent situations such as traffic accidents. As far as we know, the GPS products have functions but they require necessary support technologically and organizationally. Effective use of GPS technologies for incidents handling requires necessary supports from other related organizations such police, fire departments, and hospitals as well. In our study, we found that these supports are either very limited or do not exist in the system used by Company A.

Another related issue is that no effective communicating system exists between the dispatching center and other organizations in the supply chain. Interviewees said that the lack of necessary outside supports for incidents management creates unavoidable difficulties for delivering timely and effective solutions to incident-involved drivers and trucks. Moreover, supply chain partners, such as suppliers and customers, should also have the access of such information for better preparation and management.

Solving this problem is not an easy task for the company, since the process involves broader collaborations among different organizations. Although the use of new technologies has experienced dramatic increase in the past several years, business applications are relatively isolated and exclusive to the users themselves. As in other growing economies, due to various financial and technological constraints, necessary infrastructures are either missing or still in the planning phase, which make the solutions difficult to achieve in a short period of time and thus can't satisfy the immediate needs from the society. However, despite these difficulties, these problems must be handled and resolved so as to maintain a sustainable business development for companies in developing countries.

## 4. DISCUSSION AND CONCLUSION

In this research, we present a study on using GPS and related new technologies in logistics distributions. We provide rich information about GPS usage as well as important findings that facilitate deeper understanding about the benefits and values generated by these technologies in logistic operations and provide analysis of why these benefits exist. For instance, improved just-in-time service, optimized delivery schedules and routes are made possible by these technologies, real-time monitoring and data transfer are obtained between dispatchers and drivers, and better demand and supply management are achieved. Moreover, these advantages and benefits can also be extended and enjoyed by their costumers such that the entire supply chain operations can be optimized. Our study also revealed important and critical issues during application process of these new technologies. While some of the issues are inherent and closely related with further development of these new technologies, others need stronger collaboration and support from supply chain partners and from other important players in the business and social environment, including hospitals, emergency response services, and government.

Moreover, our results further confirm the potentials of GPS and related technologies for enhancing operating efficiency and productivity, improving communication and relationship building, and facilitating collaboration and strategic planning of a firm and its supply chain. We also need to point out that our research has its limitations. The results have to be interpreted cautiously and need to be validated with further extensive studies, since we have only investigated a single organization with limited subjects. Continued larger-scale research is planned and conducted to summarize these results and to further explore broad-range of business sectors for more generalized outcomes and insights.

## AUTHOR INFORMATION

**Hua Zhong** is an Assistant Professor of Management at the State University of New York - College at Oneonta. He received his Ph.D. in Management from Rutgers University in 2006. His research interests are in supply chain optimization, scheduling, reverse logistics and integrated production, distribution and inventory management. His research papers have been published in *Operations Research Letters*, *Annals of Operations Research* and *INFORMS Journal on Computing*. He received the 2008 Bright Idea Research Award from New Jersey Business and Industry Association.

**Bin Zhou** is an Assistant Professor in the Department of Management at Kean University, USA. He obtained his Ph.D. and MBA degrees in Management Science and Supply Chain Management from Rutgers University. His research papers have appeared in different journals on production inventory systems, supply chain management, and supply chain-IT interface. His current research interests include application of supply chain management, information technology, and supply chain-marketing interface.

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**NOTES**