



An analytical approach on the consequence of Cloud Computing for Logistics Management

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Abstract: This paper analyzes the analytical approach of cloud computing on logistics management by studying various literatures on academic logistics journals, practitioner journals and various books. The paper sought to explain the theoretical background of articulating effective logistics information system in any industrial outfit. This is predicated on the fact that logistics is “the process of strategically managing the acquisition, movement and storage of materials, parts and finished inventory (and the related information flows) through the organization and its marketing channel in such a way that the profitability can be optimized”.

Cloud computing has emerged as a new technology that provides large amount of computing and data storage capacity to its users. With the performance of cloud computing in terms of overhead of allocation and de-allocation of virtual computing resources, and network communications, we can rely on cloud computing. In this work, we studied that the use of cloud computing, to understand the performance and usage cost. In this study we have analyzed the various security risks as cloud based services allow user to create and share virtual relations with others. This paper explores the general security risks associated with using virtual server from the public catalogs of cloud service providers.

Keywords: Logistics Management, Information Technology (IT), Cloud Computing, Performance Analysis, Cost-Benefit Analysis, Security Analysis

I. Introduction

Logistics encompasses all of the information and material flows throughout an organization. It includes everything from the movement of a product or from a service that needs to be rendered, through to the management of incoming raw materials, production, the storing of finished goods, its delivery to the customer and after-sales service (Pollitt, 1998). The scope of logistics has changed since the emergence of new technologies and strategic alliances in order to compete on flexibility and responsiveness. The growing importance of logistics arises from companies becoming globalized to gain access to new markets, realize greater production efficiencies, and tap technological competencies beyond their own geographical borders (McFarlan, 1984; Bovet, 1991; Cooper, 1993; qFawcett et al., 1993). In recent years, information systems (IS) are increasingly being regarded as resources that support various business processes.

The emerging Internet business culture is a set of expectations that we all share. We have all come to expect online services for purchasing goods and services, we expect our business colleagues to be available by e-mail and cell phone, and we expect to be able to communicate with our vendors, customers, and employees any time of day or night over the Internet. We even expect our business partners around the world to be “fully connected.” Internet culture is global.

Today, information systems provide the communication and analytic power that firms need to conduct trade and manage businesses on a global scale. Controlling the far-flung global corporation—communicating with distributors and suppliers, operating 24 hours a day in different national environments, coordinating global work teams, and servicing local and international reporting needs—is a major business challenge that requires powerful information system responses.

An information system can be defined technically as a set of interrelated components that collect (or retrieve), process, store, and distribute information to support decision making and control in an organization. In addition to supporting decision making, coordination, and control, information systems may also help managers and workers analyze problems, visualize complex subjects, and create new products.

Today, the Web is not only a communication medium but also a platform for business and society. To reach the large number of users or potential users, companies have to deliver their contents and business processes online.

This newly developed trend has created more demand for distributed computing power, which also stimulates a new paradigm – cloud computing.

In general, cloud computing is a way for companies to deliver their contents and processes online with the elasticity of computing resources (Armbrust *et al.*, 2010). From the business perspective, cloud computing is on-demand access to virtualized IT resources that are housed by the third party, shared by others, simple to use, paid for via subscription, and accessed over Web (Brynjolfsson, Hofmann, and Jordan, 2010). The objective of this paper is to enumerate current uses and highlight the importance of cloud computing in logistics. To find the consequences of cloud computing we analyzed the system by using PCS analysis (Performance Analysis, Cost-Benefit Analysis, Security Analysis).

II. Methodology

Due to resource constraints and the nature of the paper itself, the main methodology used for this paper was through the survey of journals and publications and various books in the fields of Logistic Management, Cloud Computing, computer science and engineering. The research focused on more recent publications.

III. Research Findings

A. Logistics Management

Logistics is “the process of strategically managing the acquisition, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channel in such a way that current and future profitability is maximized through the cost-effective fulfillment of orders (Somuyiwa, 2010; Somuyiwa and Sangosanya, 2007; Christopher, 1992; CLM, 1998).

The term **Logistics Management or supply chain management** is that part of Supply Chain Management that plans, implements, and controls the efficient, effective, forward, and reverse flow and storage of goods, services, and related information between the source and the destination in order to meet customer's requirements [2]. Where source is the origin from where shipping will be started and destination is the place of consumption.

Logistics can be broadly classified into following categories:

- 1. Material Management:-** the materials management component is the foundation for the logistics functions of a company. The agent includes Purchasing, Accounts Payable, Fixed Assets, and Inventory which are completely integrated within the Materials Management system, as well as with the General Ledger and Budget Control process and the material master file, which contains the information on all materials and services used at a company. The primary goal is to control inventory and in order to achieve its goal, it communicates and coordinate with sales and distribution agent and production planning agent.
- 2. Sales and Distribution Management:-** the sales and distribution incorporates the processes from customer order to the delivery of the product to the customer. The component includes the sales functions, pricing, picking, packing and shipping. It keeps records of sales status, payment status, stock report as well as expense report. It communicates with scheduling agent for the smooth delivery of finished goods to customers. It performs the important task in supply chain by controlling stock by not allowing excess / shortage of stocks. It keeps on communicating to information Monitor to ensure that supply chain should not suffer from any market fluctuations.
- 3. Quality Inspection Team:-** This agent is used to ensure and improve on the quality of your company's products. The functions of this component include the planning and execution of quality inspections of purchased and finished products.
- 4. Production Planning:-** It manages a company's production process. The functions of this component include capacity planning of a company's production, master production scheduling (MPS), material requirements planning (MRP) and the shop floor functions of producing a company's finished products. It takes inputs from scheduling agent regarding production and delivery schedule and plan accordingly. It also communicates and coordinates with material management agent for raw material acquisition, storage management and shipment of raw materials and finished products.
- 5. Warehouse Management:-** helps companies to accurately manage inventory and maximize storage capacity. This component can reduce time it takes to place and remove items from the warehouse by suggesting the most efficient location to store a material and the most efficient way to place and remove that material from the warehouse.
- 6. Customer Service Department:-** manages a company's service that it provides to customers for repairs and warranties. Items can be sent back for repair or visits made by staff to customer facilities. If a company makes finished products that are sold with warranties, then the agent will help a company to service and repair those items with maximum efficiency.
- 7. Scheduling Department:-** This agent interacts with monitor agent , production planning agent and sales and distribution agent . It gets requirements from monitor agent and inform production management for planning of production. It also informs the delivery schedule to sales and distribution agent. The goal of the agent is coordinate with production planning agent and sales and distribution agent and ensures that lead time is reduced considerably.
- 8. Information Monitoring Manager:-** it is the heart of logistics management system. It communicates and coordinated with all agents in supply chain logistics and eliminates the inconsistencies.

A logistics manager has to take care of all the categories and his job is well defined and also supposed to communicate with other.

Companies are now equipped to make effective use of data, from warehouse management systems, which contain information on supplier/customer warehouse inventory levels and key customer ordering patterns and transportation management systems within which information pertaining to the location of important supply chain assets, such as products or vehicles is typically stored [3]. The integration of these systems leads to global inventory visibility which, in turn, leads to reduced costs and improved customer services by decreasing shipping and receiving cycle times, increasing shipment and inventory accuracy, and decreasing lead time variably that all have impacts on logistics cost (Moberg, 2002; Somuyiwa, 2010).

It is always a challenge for logistics service providers to deliver products to customers as quickly as possible [5]. Logistics is concerned with the flow of materials in the supply chain, from source through the industrial process to the customer, and then on to re-use re-cycle or disposal. A broad view of logistics management then includes the supervision and control of procurement, production, transportation, warehousing, and inventory stocking across enterprises.

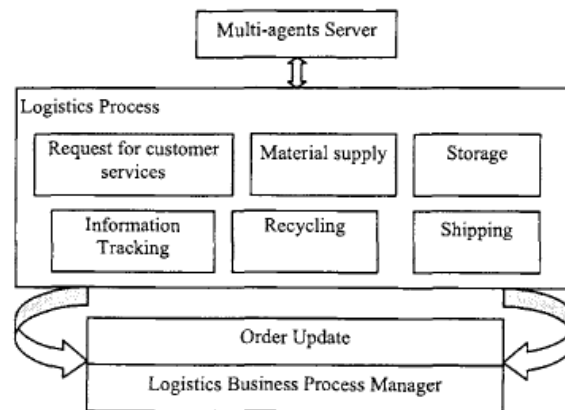


Figure 1: View of Integrated Logistics Processes.

The typical logistics processes include request for customer services, material supply, product storage, product shipping, information tracking, and recycling for used product. Compared with the supply chain business process, logistics business process has fewer and more stable customers. Obviously, integrated services are the core competition ability of a logistics business. It can help its customers to optimize their logistics management strategies, build up and operate their logistics systems and even manage their whole distribution systems. By providing integrated logistics services to various customers, logistics providers could respond their customers quickly and deliver service or product timely and cost effectively.

B. Information Technology

The evolution of information technologies (IT) and the internet technologies have provided momentum and challenges to the logistics. New technologies present new means to manage the flow of information [4]. IT as a productivity tool can be utilized to both increase the capability and decrease the cost at the same time (Closs et al., 1997). It has been widely accepted that firms can achieve competitive advantage by cost reduction or differentiation with the proper implementation of IT (Porter & Millar, 1985). Enabled by IT the logistics has become a source of competitive advantage for many firms.

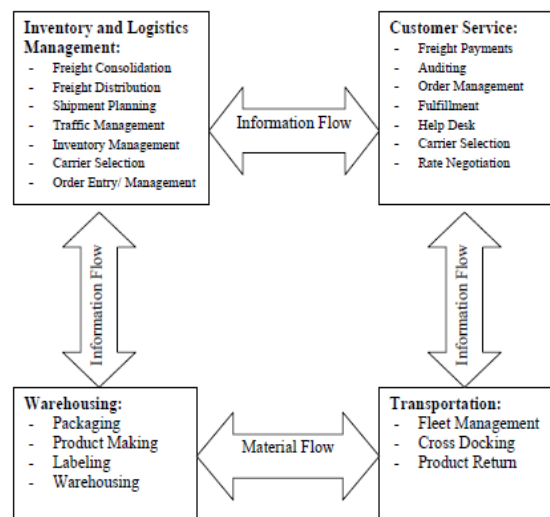


Figure 1: Categorization of Logistics Functions (adapted from Vaidyanathan 2005)

A system of logistics functions can be divided into following five broad areas (Bowersox, 1974): facility location, transportation, inventory, and communication and material movement. Based on the problem areas that application addresses, seven areas of logistics has been identified as facility location, inventory control, order entry, vehicle scheduling, warehouse layout planning, freight rate retrieval, and product and shipment tracing (Ballou, 1976). Another survey identified five categories as facility location, inventory control, transportation, production scheduling, and total physical distribution (House, 1978).

C. Cloud Computing

Cloud computing gets its name as a metaphor for the Internet [6]. Typically, the Internet is represented in network diagrams as a cloud, as shown in Figure 3. The cloud icon represents “all that other stuff” that makes the network work. It’s kind of like “etc.” for the rest of the solution map.

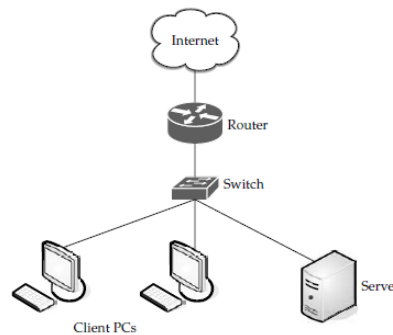


Figure : 3 -A cloud is used in network diagrams to depict the Internet.

Cloud computing promises to cut operational and capital costs and, more importantly, let IT departments focus on strategic projects instead of keeping the datacenter running [8]. Pioneers in the field of cloud computing are Amazon and Google.

Amazon, the first ‘cloud’ provider, faced a different set of challenges as it grew from an online bookseller to an online retail hub, but solved them in a highly innovative and reusable manner, leading eventually to a new cloud computing business.

Amazon exploited virtualization extensively, just as many large enterprises are also now doing, to automatically and dynamically provision hardware with those applications that were most utilized as demand fluctuated through the year. The high degree of automation they were able to achieve in this process enabled them to conceive of and launch their S3 (simple storage system) and EC2 (elastic compute cloud) whereby users could rent storage and compute power on Amazon servers.

In the case of Google, on the other hand, the scale of computing power needed to support large-scale indexing of the web, the immense volume of searches, and machine-learning-based targeting of advertisements across this volume meant orders of magnitude larger computational needs as compared to even the largest enterprise. Large banks today often have tens of thousands of servers; Google, on the other hand is estimated as running over a million servers, as of today.

Integrating cloud computing into information systems development indeed has the advantages of having flexible IT resources without making large up-front commitment. However, the development of cloud computing is still at the early stage [7]. Cloud computing researchers points out that some existing obstacles may prevent companies widely adopt cloud computing services.

Based on the various cloud computing service models, the deployment models could be either public cloud or private cloud. A public cloud refers a service provider makes resources, such as applications and storage, available to the general public over the Internet. Public cloud services may be free or offered on a pay-per-usage model. The main benefits of using a public cloud service are:

1. Easy and inexpensive set-up because hardware, application and bandwidth costs are covered by the provider,
2. Scalability to meet needs, and
3. No wasted resources because it is either free or pay-per-usage (What is a public cloud?).

A private cloud refers to a proprietary computing architecture that provides hosted services to a limited number of people behind a firewall. Private cloud deployment allows corporate network and datacenter administrators to make their IT infrastructure virtualized and remain having control over their data (What is a private cloud?). The main benefits of using private cloud computing are:

- (1) High availability,
- (2) Speed of deployment,
- (3) Hardware independence,
- (4) Optimal resource usage, and
- (5) Ease of monitoring (Sintobin).

D. The Importance of cloud computing in Logistics Management

The evolution of information technologies (IT) and the internet technologies have provided momentum and challenges to the logistics.

By 'enterprise computing' we mean the use of computers for data processing in large organizations, also referred to as 'information systems' (IS), or even 'information technology' (IT) in general. The use of computers for enterprise data processing began in the 60s with the early mainframe computers [8]. Over the years enterprise computing paradigms have changed dramatically with the emergence of new technology: The advent of the PC in the 80s led to the replacement of large mainframe computers by client-server systems. The rise of the internet in the 90s saw the client-server model give way to web-based enterprise applications and customer-facing e-commerce platforms.

With each of these advances, enterprise systems have dramatically improved in terms of scale and ubiquity of access. At the same time their complexity, and consequently cost, has increased as well: Trillions of dollars are spent world-wide on information technology, including hardware and software purchases as well as application development (in-house or outsourced). It is also estimated that enterprises spend between two and ten percent of their revenues on IT.

Now, cloud computing offers the potential for revolutionizing enterprise computing once more, this time by transforming computing itself into a utility that can be accessed over the internet. The importance can be viewed by P-C-S Analysis (Performance analysis, Cost-Benefit Analysis, and Security Analysis of the Cloud Computing [9].

IV. (P-C-S) ANALYSIS

1. Performance Analysis

The performance and availability of cloud applications has a dramatic impact on user adoption and revenue. Cloud monitoring and management demands uninterrupted visibility across the entire application delivery chain – from the user's device, across the Internet or a corporate WAN, to the complex application components inside data centers. Traditional data center monitoring tools simply don't work in the cloud.

Cloud computing has emerged as a new technology that lets the users host and deploy their applications in a secure environment with a promise of increased scalability, availability, and fault tolerance [13]. As the use of cloud computing environments increases, it becomes crucial to understand the performance of these environments in order to facilitate the decision to adopt this new technology, and understand and resolve the performance problems. In this paper, we present C-Meter, which is a framework for generating and submitting test workloads to computing clouds. By using C-Meter, users can assess the overhead of acquiring and releasing the virtual computing resources, they can compare different configurations, they can evaluate different scheduling algorithms and they can also determine the costs of their experiments.

Big vendors and users are getting more and more interested in the cloud computing technology. As a result, it becomes crucial to assess the performance of computing clouds in order to adopt this emerging technology, and identify main performance problems when using this technology. Currently there is a lack of frameworks for assessing the performance of computing clouds. The requirements for such frameworks should be identified and a framework adhering to these requirements should be implemented in order to conduct performance studies with computing clouds. Since no resource management components and no middleware exist for accessing and managing cloud resources, the problem of resource management in computing clouds should also be addressed by identifying various resource management alternatives and by discussing the advantage and disadvantage of these alternatives.

We have identified three main requirements for framework to assess the performance of computing clouds:

- 1) The framework should be able to generate and submit both real and synthetic workloads. It should gather the results and extract various statistics specific to computing clouds such as the detailed overheads of resource acquisition and release. It should also provide performance analysis reports to the users as well as a database of obtained statistics in order for the users to perform offline analysis for their own needs. The framework should also be able to determine the costs of the experiments.
- 2) It should let the users compare computing clouds with other environments such as clusters and grid. It should also let the users perform experiments with different configurations such as with different type and amount of resources.
- 3) Since currently no resource management components and no middleware exist for accessing and managing cloud resources, the framework has to provide basic resource management functionalities. The framework should be extensible in the sense that new resource management algorithms and support for new cloud environments can easily be added. It should also be platform independent and easy to use.

C-Meter is a portable, extensible and easy-to-use framework for generating and submitting both real and synthetic workloads to analyze the performance of cloud computing environments.

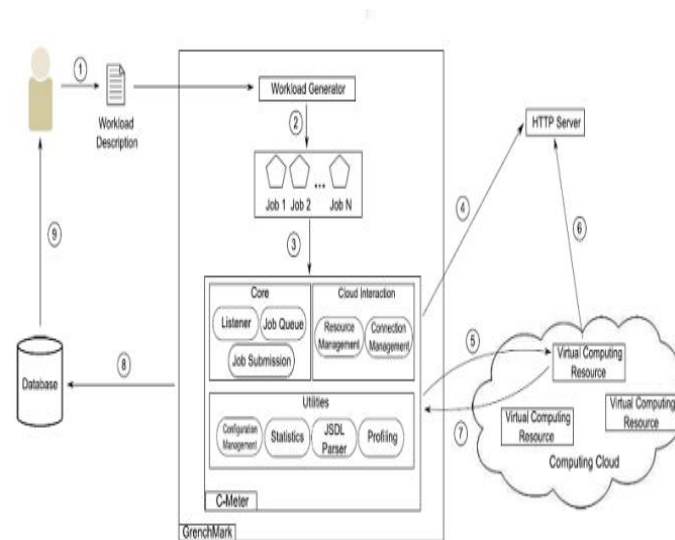


Figure 4 - The architecture of C-Meter.

The architecture of C-Meter is illustrated in Figure 4. C-Meter consists of three subsystems. The *Utilities subsystem* is responsible for providing basic utilities and consists of four modules. The *Configuration Management module* is responsible for the configuration of the experiments. The other modules are the *Statistics module*, the *JSDL Parser module* and the *Profiling module*.

The *Core subsystem* is responsible for providing the core functionalities of C-Meter and it consists of three modules. The *Listener module* is responsible for listening job submissions from the workload generator and commands from the user such as a command to terminate the experiment. After receiving the job descriptions, these descriptions are queued in the *Job Queue* until some resources become available for submitting these jobs. The *Job Submission module* is responsible for copying the executables and stage in files of the job to the HTTP server.

The *Cloud Interaction subsystem* is responsible for interacting with the cloud environment under test. This subsystem consists of two modules. The *Resource Management module* is responsible for acquiring, managing and releasing the virtual resources from the cloud. The *Connection Management module* is used to establish connections to the cloud environment in order to submit the jobs by the *Job Submission module*.

With this approach the authors checked the performance of the Cloud Computing.

2. Cost - Benefits Analysis

Cloud Computing has taken commercial computing by storm. Cloud computing platforms provide easy access to a company's high-performance computing and storage infrastructure through web services [10]. With cloud computing, the aim is to hide the complexity of IT infrastructure management from its users. At the same time, cloud computing platforms provide massive scalability, 99.999% reliability, high performance, and specifiable configurability [13]. These capabilities are provided at relatively low costs compared to dedicated infrastructures.

In, the author conducts a general cost-benefit analysis of clouds. It is well-known that ISP's have always offered similar services as clouds but at much lower rates. However, ISP's resources are not as scalable (according to variable workloads), configurable nor as reliable. The ability to adapt to workload changes is important as server workloads can change rapidly. Configurability is important to suit project programming and application needs. Reliability is important for project scientists to receive and access results, and also to project volunteers as they prefer to receive credit for computation as soon as possible. Thus, we do not consider ISP's in our analysis.

Clouds provide higher quality-of-service than VC systems. Cloud resources appear dedicated, and there is no risk of preemption. Many cloud computing platforms, such as Amazon's EC2, report several "nine's" in terms of reliability. Cloud infrastructures consist of large-scale centralized compute servers with network-attached storage at several international locations. Project cost calculation on the basis of various components is shown in the above table for large size and small size projects.

Cloud computing is advantageous for variable workloads as the infrastructure can scale with rapid increases (or decreases). Moreover, costs are variable (and in total less than the fixed costs). Cloud computing is effective for small to medium sized applications. For large projects, the costs are simply too high to host on cloud.

Component	Project	
	Large size	Small size
Salaries	10K for sys admins	5K
Electricity	90 for 6 servers	15
Network	2K for 100 Mbit	covered by university
Hardware	18K for servers, 25K for air conditioner	4K
Total startup	43K	4K
Total monthly	12K	5k

Table 1. Project Costs (monthly)

We've mapped a view of how public and private clouds measure up in Figure 5. The vertical axis measures the public cloud cost advantage [11]. From the prior analysis we know public cloud has inherent economic advantages that will partially depend on customer size, so the bubbles' vertical position is dependent on the size of the server installed base. The horizontal axis represents the organization's preference for private cloud. The size of the circles reflects the total server installed base of companies of each type. The bottom-right quadrant thus represents the most attractive areas for private clouds (relatively low cost premium, high preference).

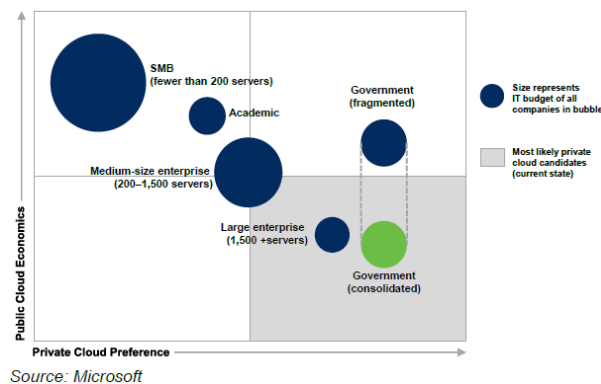


Figure: 5 - Cost and Benefits of Private Clouds

Fig. 6 shows industry variability for a number of different industries, with peaks ranging from 1.5 xs to 10x average usage.

Company	Peak Traffic/ Average Traffic
Tax Services	10x
General Retail	4x
Sports (NFL)	2.5x
Travel (airlines, hotels)	1.5x
News	1.5x – 2.0x

Source: Microsoft, Alexa Internet, Inc.

Figure: 6 Industry Variability

3. Security Analysis

Cloud services are quickly changing the way organizations are dealing with IT infrastructures and are providing online services [12]. It is easy to obtain computing power today. A popular approach in cloud based services is to allow users to create and share virtual images with other users.

Unfortunately, while the trust model between the cloud user and the cloud provider is well-defined (i.e., the user can assume that cloud providers such as Amazon and Microsoft are not malicious), the trust relationship between the provider of the virtual image and the cloud user is not as clear. The general security risks associated with the use of virtual server images from the public catalogs of a cloud service provider.

Average #/AMI	Windows	Linux
Audit duration	77 min	21 min
Installed packages	–	416
Running Processes	32	54
Shares	3.9	0
Established sockets	2.75	2.52
Listening sockets	22	6
Users	3.8	24.8
Used disk space	1.07 GB	2.67 GB

Table: 2 General Statistics

Table 1 shows a number of general statistics we collected from the AMIs we analyzed.

Security risks have been tested on Malware instances such as viruses, worms, spyware, and Trojans. This malware allows a malicious user to spy on the browsing habits of users, modify Internet Explorer settings, and download other malicious content. Malware used or created by hackers to disrupt computer operation, gather sensitive information, or gain access to private computer systems. This can affect the information received from the various components of the logistics management.

General security risks associated with the providers of the cloud services have been explored and that have been resolved. Logistics Management and Cloud service providers, both, may be susceptible of security risks such unauthorized access, malware infections and the loss of sensitive information. So, the used for the logistics management would be risk free.

V. CONCLUSION

The objective of this paper was to observe the consequences of Cloud Computing on the logistics Management. Logistics can be broadly classified into following categories: Material Management, Sales and Distribution Management, Production Planning, Warehouse Management, Information Monitoring. A logistics manager has to take care of all the categories and his job is well defined and also supposed to communicate with other.

Companies are now equipped from warehouse management systems, which contain information on supplier/customer warehouse inventory levels and key customer ordering patterns and transportation management systems within which information pertaining to the location of important supply chain assets, such as products or vehicles is typically stored.

The evolution of information technologies (IT) and the internet technologies have provided momentum and challenges to the logistics.

A literature review of the academic and practitioners journals was conducted. The information technologies related to cloud computing that have been used to support logistics Management functions were discussed.

It is apparent that academic researchers are aware of new technologies in practice. Development in technologies offers sources of competitive advantage for companies. Adoption of new technologies provides challenge and opportunities for the companies.

Cloud computing gets its name as a metaphor for the Internet. Large enterprises were able to achieve in this process enabled them to conceive of and launch their S3 (simple storage system) and EC2 (elastic compute cloud) whereby users could rent storage and compute power on Amazon servers. In the case of Google, on the other hand, the scale of computing power needed to support large-scale indexing of the web. Google is estimated as running over a million servers, as of today.

Integrating cloud computing into information systems development indeed has the advantages of having flexible IT resources.

Changing trends in business in terms of ecommerce open new markets for firms for all sizes to expand their market share. With the P-C-S analysis, we hope that cloud computing would be effective, reliable, economical for the logistics management. So that enterprises can the competitive advantages and thus leading to achieve their goals.

Future trends in logistics may prompt companies to rethink their logistics strategies. Firms may choose to use third party logistics in order to focus on their core competencies. However, firms need to have logistics information systems in place that is compatible with the third party operators in order to fully benefit from their services.

Cloud computing has present an attractive opportunity to both small business and large enterprise [7]. Traditional information systems were predominately operated on physical machines that were in house. The emergence of cloud computing makes it possible to develop information systems on virtual machines that are hosted by cloud service providers. For the companies that IT is not their core business, cloud computing presents an opportunity to save costs on the development of information systems that support their major business operations.

The adoption of cloud computing also triggers the changes of the activities in the information systems development process. As more business functions are basing on cloud services, the role of IT developers will undergo a significant transformation. Most IT developers will move from business IT departments to service providers. And the role of remaining IT staff will convert into support and consultation for service selection, engagement and management.

The resulting performance in terms of response time, wait time in queue, bounded slowdown with a threshold of 1 second and job execution time with the standard instance types.

Cloud computing services are at the early stage. There are still obstacles existing that prevent enterprises to adopt cloud computing services. Most significant obstacle is probably the availability of IT services. Enterprises have heavily invested in IT infrastructure to build redundancy to prevent single point of failure. However, relying critical IT services on a single service provider is in fact a single point of failure. Because of the concern of IT service continuity and the confidentiality of data, large enterprises may want to deploy IT services in their private cloud for the sake of keeping data onsite and retaining control. The main users of public cloud services will remain small businesses and individual consumers.

The development of cloud computing has triggered the changes of the system development activities. This paper has suggested some fundamental activities in the difference phases of systems development life cycle. As cloud computing industry keep evolving, future researches could focus more on the changes of system development methodology that build information systems in virtual operating environment.

VI. References

- [1] www.google.com
- [2] www.wikipedia.com
- [3] Managing Logistics Information System, A.O. Somuyiwa and J.O. Adewoye Ladoke Akintola University of Technology,
- [4] A Survey of Information Technologies in Logistics Management, Anil Gurung, University of Texas at Arlington
- [5] Multi-Agent-Based System for Logistics Service Process, FENG HE, QI xu
- [6] Cloud Computing: A Practical Approach, Anthony T. Velte, Toby J. Velte, Robert Elsenpeter
- [7] Cloud computing from the perspective of system analysis, Amy Y. Chou, Devid C. Chou
- [8] Enterprise Cloud Computing -Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press
- [9] Cloud-Based Analytical Framework, Ki Lee, Baryant Chong
- [10] The Economics of the Cloud – November – 2010, Ted Alford, Gwen Morton.
- [11] A Security Analysis of Amazon's Elastic Compute Cloud Service – Long Version , Macro Balduzzi, Jonas Zaddach
- [12] Cost-Benefit Analysis of Cloud Computing versus Desktop Grids, Derrick Kondo, Bahman Javadi, Paul Malecot1, Franck Cappello, David P. Anderson, INRIA, France, 2UC Berkeley, USA
- [13] C-Meter: A Framework for Performance Analysis of Computing Clouds, Nezh Yigitbasi, Alexandru Iosup, and Dick Epema, Delft University of Technology, Simon Ostermann-University of Innsbruck.