

Cloud computing in logistic and Supply Chain Managementenvironment

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Abstract

Today in the era of digitalization Cloud computing is the cornerstone of modern business models in every industry. Cloud computing is a high-tech platform that will facilitate companies or organizations to manage and host their services without worrying about the stability and security of information telecommunication. Rapid driving technological changes are unstopped process in this Industry 4.0. world. Cloud computing is a trend with enormous implications. Cloud computing provides access to large-scale remote resources in a very efficient and quick manner, with huge potential to adapted and dramatically changed business models in line with current needs and requirements.

Despite all the benefits of digital technology, the loss of data and security is the primary concern for companies, which are boosting companies from moving to the cloud entirely. Cloud technologies allow companies to quickly adopt emerging technologies like augmented reality, stability, security, advanced mobile apps, and advanced analytics.

Their application is becoming ubiquitous and standardized in the logistics and Supply chain management sector. The logistics industry is characterized by many parties collaboration, where actors that must be integrated and synchronized along the supply chain. Logistics companies get enormous benefits with saving costs, time, and efforts on establishing their own IT infrastructure by applying cloud computing in supply chain management. In this digital transformation, the cloud computing has a key role, it becomes the catalyst for this transformation. Cloud computing, as one of the forces for digitalization, can foster collaboration among the parties in a supply chain, can promote innovation and embed it into organizations, and enable new competitors to enter the market with innovative offers. This makes the usage of cloud computing a very promising issue in global market competition condition.

Keyword

Cloud computing, DigitalisationEnvironment, Logistic, Supply chain management, Distribution channels

1. Introduction

We are living in a world in continuous evolution, where all companies need to drive their activity to new forms of technology. Digital transformation of the global world imposed the need for structural business change. Therefore, Cloud Computing is the ubiquitous appearance within the rapid transformation of business models in almost all industries and is an integral part of the business environment. Cloud computing in combination with machine learning, IoT, blockchain technologies, it can bring even more opportunities for logistic and supply chains environment. Limited resources and increased customer demand can be catalysts for cloud adoption. Logistics companies get enormous benefits with saving costs, time, and efforts on establishing their own IT infrastructure by applying cloud computing in supply chain management. In this digital transformation, the cloud computing has a key role, it becomes the catalyst for this transformation. While from one hand the IT infrastructure needs to be reachable within a short time in the case of an emergency, from the other it should not waste resources during normal operation. The use of cloud computing with its elasticity ensures that costs are held low, the quality is raised, and the time of distribution is on acceptable capacity. This is a typical advantage of cloud computing: fast access to services and infrastructure when needed without prior large investments.

Nowadays every company measures their performance through customer experience, a cloud-enabled and cloud-delivered business model supports organizations to adopt newer channels to offer high-level customer experience by differentiating its strategy and solutions over the current market competitors.

2. Cloud Computing as vital force to digital business transformation

Without a well-developed transport, logistics and supply chain management system, well-configured IT infrastructure, quality and professionally trained and motivating staff not all the benefits of a country's economic policy can be guaranteed. Only a planned and organized transport system can provide better logistics efficiency, reduce operating costs, and promote the quality of services, and thus greater competitiveness in global markets. Improving transport systems strengthens the public and private sectors. A well-managed logistics system can significantly increase and strengthen the competitiveness of public enterprises and private companies. Companies' efficiencies and transformation in on-going global processes and implementation of high-tech are imperative toward better market position. Those new technological models as well as Cloud computing system has become a new standardize norm across dynamic industries such as the logistics sector.

Innovation, especially technological innovation over the last decades, has led to significant productivity improvement and, thus, to economic growth increasing trade volumes and associated logistics activity.[1] In order to be competitive, and to bring an added value to the company, each company should embrace the digital transformation process when required, to upgrade their old IT infrastructure into a new one. Beyond adopting cloud solutions, a company should integrate new forms of technologies that speed up, automate and improve business, such as Artificial Intelligence, Machine Learning, Big Data Analytics, and the Internet of Things (IoT), etc. Considering that these technologies require heavy computational power and storage space, Cloud Computing comes as a solution to integrate these technologies.[2]

Today in the digitalization era the logistics industry has plenty of potential to be transformed and cloud computing is an important factor. Increasing demands from customers, pressure on prices, fuel costs, ecommerce, and environmental awareness among others have raised the bar by which logistic activities are measured.

Without a well-developed transport, logistics and supply chain management system, well-configured IT infrastructure, quality and professionally trained and motivating staff not all the benefits of a country's economic policy can be guaranteed, pointed out Gomez, Grand and Grivas. [3]

They indicated that the logistics industry can also profit from these innovations, however, it is marked by the large number of involved parties along the supply chain which brings new challenges of integration. Although many standards such as container sizes, the Serial Shipping Container Code or the electronic data interchange (EDI) have been established, the industry procedures remain very heterogeneous. Cloud computing, as one of the forces for digitalization, can foster collaboration among the parties in a supply chain, can promote innovation and embed it into organizations, and enable new competitors to enter the market with innovative offers.

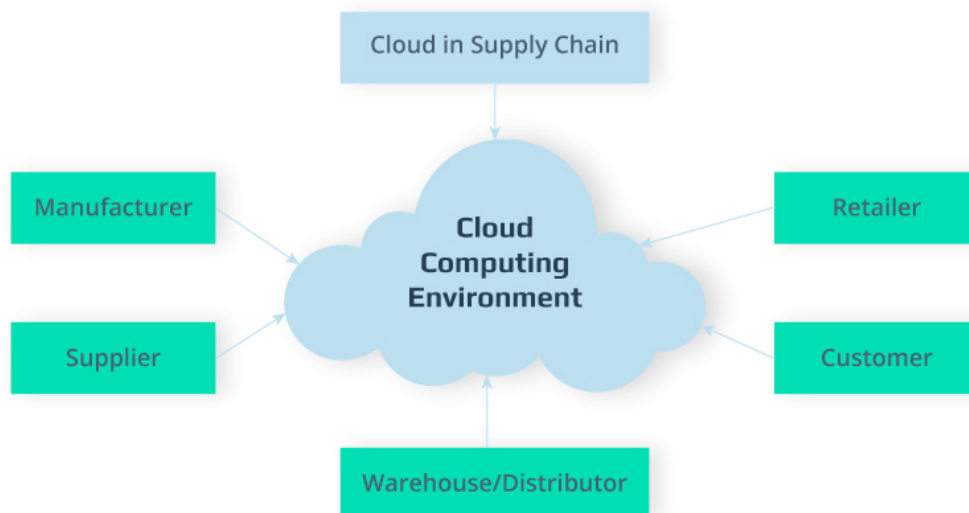


Figure 1 Cloud Computing Environment in market conditions

Source: Zagorulko A.: Logistics and Supply Chain in the Cloud: Capabilities and Migration Strategies. Intellias: Intelligent software Engineering. [4]

Cloud environments, which are known for their flexibility, noted Zagorulko[5] is enabler of previously untapped business models. Logistics as a service (LaaS) is one of them. With LaaS, customers can use only necessary parts of cloud based supply chain solutions or access only critical parts of the supply chain via customizable modules within a cloud based logistics platform. Logistics providers, in turn, get a scalable infrastructure with advanced capabilities for managing cloud computing in supply chains without traditional on-premises development, setup, and maintenance, saving money compared to running one's own IT infrastructure.

Digital connectivity is a vital force and strengthens the economic cohesion of companies for more stable competition in the global market. These aspects are key elements for the development of cloud computing platforms of companies in the logistics sector. It aims to offer high quality digital infrastructure, combined with all transport models that will enable optimal use of existing facilities. Undoubtedly, such an approach will be maximized with some national, regional and global support through clearly defined standardized norms. Furthermore, standardized and automated processes may not be enough. Such digital processes require a comprehensive and thorough transformation using new insights and thinking from important institutional bodies, to use all available new technology to create new opportunities and tackle problems that the industry may not have enough of.

Last year, digital business transformation has entered a more challenging and urgency-driven phase due to the COVID-19 pandemic. Global giants are obliged to providing customers with cost-effective and productive digital solutions as every industry is economically hard-hit from the pandemic. The sudden shutdowns of offices, schools, and enterprises have increased the demand for cloud solutions and services. According to GlobeNewswire report,[6] the global cloud computing market size is expected to grow from USD 371.4 billion in 2020 to USD 832.1 billion by 2025, at a Compound Annual Growth Rate (CAGR) of 17.5% during the forecast period.

Cloud computing will be continued with their attractiveness to business owners as it eliminates physical obstacles of working processes due COVID-19 19 pandemic. Further, the forecast will go-on to greater adoption of cloud services to replace conventional apps, platforms, and business services. Trends like the internet of everything, something that cloud computing offer in every business, where things start to communicate directly with each other and become autonomous, will be imperative forthcoming period and new levels of automated processes.

3. Cloud computing system and distributingeecosystem

In the future strategic projections of the companies, a new type of technology called "cloud" computers stands out. Cloud computing systems are a model of computer systems in which companies and individuals receive power and software applications over the Internet, rather than buying hardware or software and installing it on their computers. Cloud computing is currently the fastest growing form of computing.

According to Glöckner and Franczyk[7]Cloud Logistics is a model, based on and inspired bythe paradigm of cloud computing, for enabling ubiquitous,convenient, on-demand network access to a shared pool ofconfigurable and virtualized logistics resources (e.g. meansof transportation from different modes of transport, warehouses,domain-specific knowledge, logistics applications,and services) that can be rapidly provisioned and releasedwith minimal management effort or service provider interaction.This cloud model is composed of the five essentialcharacteristics of cloud computing (on-demand self-service,broad network access, resource pooling, rapid elasticity,measured service) but is adjusted in consequence of logistics'more physical character. This comprises: a locationdependency of services, the need of knowledge about thatcurrent location as well as a lower elasticity due to slowerallocation of physical resource.

The idea of cloud computing was envisioned even before Internet was created. The first scholarly use of the term "cloud computing" was in a 1997 lecture by Ramnath Chellappa[8]whereas he advised that cloud computing is going to be a "new computing paradigm where the boundaries of computing will be determined by economic rationale rather than technical limits alone". The first practical implementation of cloud was by Salesforce.com where it became the first enterprise-level application provider by offering its services through Internet.

According to the National Institute of Standards and Technology (NIST)[9] Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

The authors Peter Mell and Timothy Granceof the National Institute of Standards and Technology (NIST)[10] define the notion Cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider

interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Table 2 Structure of cloud model according NIST

Essential Characteristics:	<i>On-demand self-service.</i>	A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider
	<i>Broad network access</i>	Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).
	<i>Resource pooling</i>	The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
	<i>Rapid elasticity.</i>	Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand.
	<i>Measured service</i>	Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts)
Service Models:	<i>Software as a Service (SaaS).</i>	The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure . The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface.
	<i>Platform as a Service (PaaS).</i>	The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider.
	<i>Infrastructure as a Service (IaaS).</i>	The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.
Deployment Models:	<i>Private cloud.</i>	The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.
	<i>Community cloud.</i>	The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance

		considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises
	<i>Public cloud</i>	The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider
	<i>Hybrid cloud</i>	The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

Source: Mell P., Grance T.: The NIST Definition of Cloud Computing: Recommendations of the National Institute of Standards and Technology. NIST: Special Publication 800-145, 2011

Cloud computing system enable the creation of new markets and provide communication between resources and demand. As a result, companies and individuals around the world can participate in innovation, wealth creation and social connectivity in ways previously unknown.

Cloud computers provide software applications, access, storage and data management without requiring users to know location information and other details of the computer infrastructure. Working "on the cloud" is not a short-term phenomenon, but a permanent trend. Thanks to this model, the economy is expected to be more efficient, to provide more room for maneuver and to use the most modern and secure software at a much more favorable price. For users, this means that they will only need internet access, where all their data will be stored.

Distributed systems have incorporated many systems and new technologies that are compatible with collaboration tools for optimizing processes. More and more companies are opting for an on-demand service model based on the cloud computing paradigm to transform their costs of infrastructure investment into variable costs. This change in the economic model is having an important impact on the companies' cost of accessing technology.

According to Rauch et al. [11] next essential components of collaborative cloud manufacturing (CCM) are cloud computing and the concept of cloud manufacturing. The idea of "cloud manufacturing" is currently raising high expectations for the still-visionary value concept. In the future, industrial production changes in the medium and long term through the wider use of advanced manufacturing technologies by no longer selling the physical product but only the product data. The transport of products could be replaced in the future via the data transfer of product data according to visionary approaches. The products could then be manufactured and assembled in distributed networks of small factories with highly adaptive and changeable manufacturing systems and qualified staff for final assembling and finishing. Essential elements for realizing cloud manufacturing are digitalized manufacturing technologies, cyberphysical production systems, cloud computing, Internet of Things, semantic web, and high-performance computing.

Benefits of Cloud-computing in supply chain management

Adam Robinson[12] recommends a clear solution proposition to compare advantages of cloud-based Supply Chain Management Solution over the traditional model of manual inventory analysis combined with local area purchasing. Most notably, the Cloud solution will typically be more affordable, more efficient, safer thanks to redundant systems, infinitely scalable, and easier to integrate with existing systems than localized software. Cloud architectures provide unlimited resources that can support big data management and exploitation. The essential characteristics of the cloud computing lie in on-demand self-service, broad network access, resource pooling, rapid elasticity and measured services (Mell and Grance, 2011).[13] These characteristics make it possible to design and implement services to deal with big data management and exploitation using cloud resources to support applications such as ITS.

His focus on clarifying these principles is conducted to these five Big benefits of Cloud-based supply chain management:

Table 2 Five big benefits of Cloud-based supply chain management

Affordability	The core principles of supply and demand haven't lost any of their power over how we do business, even with the shift towards online interactions. The wide market offered by Cloud-based supply chain management technology creates a highly competitive environment where the service user wins in terms of both features and cost. In this environment the scale of the Cloud companies allows them to continuously reduce costs as their capabilities and customer base expands. A fully fledged data storage network with management software, system administrators, and integration with your local systems could cost an unpleasantly large amount of the budget when you add up the costs of equipment, personnel, and time. By spreading the cost amongst you and other clients that need their service, the Cloud solution spreads the cost and develops affordable pricing schemes for businesses that might not otherwise have the same capability.
Integration Capable Design	From the core, the software and platform services on the Cloud-based supply chain management integration solution are designed to work in a simple and expeditious manner with the IT solutions businesses already utilize. A service that requires too much setup or major modifications to other factors of a business create secondary costs that drive away customers, so the hand of the market has driven the service providers to ensure that their systems are fully capable of integration with either minimal effort or included support.
Redundancy	One of the most common worries about switching over to Cloud systems for any type of service is the fear of downtime or accidental data loss resulting in lost profits and catastrophic interruptions. The reality of the situation is that a Cloud-based supply chain management solution, such as a web-based Transportation management system (TMS), implemented properly has more redundancy and established failsafe methods that are far less likely to suffer damage than local solutions.
Efficiency	Cloud solutions leverage the power of managed automation and data analysis to form an intelligent system of resupply processes. The word "automation" can induce fear of quadruple-sized orders mysteriously appearing due to a glitch in the code, but the cloud-based supply chain management system performs step-by-step, efficient analysis based on the input of business and programming experts. Instead of taking control of your business, the software

	provides the ability for your management team to make the most informed decisions they can with minimal strain on the budget or time of your current workforce.
Scalability	With a traditional supply chain, modifications in your demands cascade into a multitude of considerations. Downsizing is typically an easy endeavor, but increasing your supply for additions like a new storefront can wreak havoc on the normal supply methods. With the older supply model, hunting for the inventory you need to manage multiple locations can quickly become a nightmarish, migraine-inducing process.

Source: Robinson A.: 5 Big benefits of Cloud-based supply chain management.
<https://cerasis.com/cloud-based-supply-chain-management/> [accessed on 02.02.2021]

In principle, cloud computing involves two components, a cloud infrastructure and software applications. The first consists of the hardware resources required to support the cloud services being provided and typically includes server, storage and network components. The second component refers to software applications and computing power for running business applications, provided via the internet by third parties. According to Eurostat estimations, 36% of EU enterprises used cloud computing in 2020, mostly for email and storage of files. Compared with 2018, the use of cloud computing in the EU increased particularly in the manufacturing sector in 2020.[14]

According to Mishra Dh.[15] Cloud computing is getting attention of all the leading business players due to its untapped potential of growth and service efficiency. In the recent years, cloud computing has grown from being a gifted logic and potential and business is virtualization concept to one of the fastest growing segments of the IT industry. Now, recession-hit companies are increasingly realizing that simply by tapping into the cloud and gain fast access to best-of-breed business applications or drastically boost their infrastructure resources, all at negligible cost.

Some research and estimates show that 90% of the \$ 16.5 trillion realized globally between business entities is based on supply chain management and the use of so-called cloud technologies as a source of professional services. [Melter J., 2016][16] Modern businesses use the Internet to enhance the research and development design of contemporary practices globally by combining greater access to information and data to foster innovation.

Cloud computing in 2021 has become the go-to model for information technology as companies prioritize as-a-service providers over traditional vendors, accelerate digital transformation projects, and enable the new normal of work following the COVID-19 pandemic. The COVID-19 pandemic and the move to remote work and video conferencing are accelerating moves to the cloud. Enterprises increasingly are seeing the cloud as a digital transformation engine as well as a technology that improves business continuity. As work was forced to go remote due to stay-at-home orders, tasks were largely done on cloud infrastructure. Collaboration tools such as Microsoft Teams and Google Meet became cogs in the companies' broader cloud ecosystem. Zoom not only lands subscription revenue, but also runs on cloud providers such as AWS and Oracle.

Nowadays is promoting Multicloud model is both a selling point and an aspirational goal for enterprises. Companies are well aware of vendor lock-in and want to abstract their applications so they can be moved across clouds. The multicloud theme is being promoted among legacy vendors that have created platforms that can plug into multiple clouds -- often with a heavy dose of VMware or Red Hat.[17]

It is expected that in the future, logistics companies will also strive for expansion in new technological challenges. Its benefits will affect the existing growth of new technological information, will accelerate growth in the overall market sphere and will affect new consumer benefits. However, the challenge for logistics organizations is to focus innovation, vision and marketing opportunity on adapting each e-business to the desired spheres of influence.

Conclusion

Cloud computing in combination with machine learning, IoT, blockchain technologies, it can bring even more opportunities for logistic and supply chains environment. Those digital systems provide cheap and fast instantiation of computer power through the use of virtualized on-demand resources. Limited resources and increased customer demand can be catalysts for cloud adoption. Logistics companies get enormous benefit with save costs, time, and efforts on establishing their own IT infrastructure by applying cloud computing to supply chain management. Digital transformation of the global world imposed the need for structural business change. Therefore, Cloud Computing is the ubiquitous appearance within the rapid transformation of business models in almost all industries and is an integral part of the business environment.

Among the biggest challenges logistics companies and their end customers face in everyday operations are transportation costs, business processes, customer service, and supply chain visibility. Most of these challenges can be solved by introducing cloud computing in supply chain management, which provides two types of opportunities.

The cloud will be a basic but advanced requirement for delivering customer-centric logistics services in years to come. Moreover, it will help cut IT costs for maintaining infrastructure and setting up solutions and allow service providers to target small businesses who prefer to pay for technology on a subscription basis. The flexibility of cloud services is one of their biggest advantages.

Summarizing, no one knows what the future holds, but it would not be surprising to see an increase in the usage of cloud computing and other technology to deal with the complex everyday challenges that the industry and humanity faces.

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