Performance Evaluation of Cloud Services for Russian Companies

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***Abstract*—The current stage of development of the global economic system is characterized by the massive introduction of innovations, the characteristic feature is the acceleration of using innovative technologies: that previously took years is now being implemented in a few months. The development and using innovative digital technologies has led the economy to a new qualitative stage of development associated with the creation of a "smart economy" that allows meeting the needs and requirements of each person. Cloud computing is one of the leading technologies that have become widespread in the economy, the use of which allows significantly reducing costs and business developments. Cloud technologies are used both in enterprises and in financial institutions. Today, despite cloud computing being widespread, many companies still take a wait and see attitude on the implementation of these technologies. In this regard, a large-scale analysis of the Russian market of cloud services for data processing centers is conducted in this study, financial indicators of the market are analyzed, revenue from Russian cloud services is estimated, growth rates, leaders in the provision of cloud services and their main consumers are determined. The main task when innovative technologies are introduced is the efficiency of the used information system. In this regard, a comparative cost analysis is performed in this article using traditional corporate data centers and cloud data centers. Based on an analysis of the main indicators characterizing the capacity utilization of cloud and traditional data processing centers and value indicators, a model is obtained that determines the possibility and necessity of using cloud data processing centers in comparison with traditional data centers for Russian companies.**

I. Introduction

Cloud computing may seem like a relatively new technology. However, their story goes back to the early 1950s, when the advent of mainframes allowed several users to access the central computer.

The concept "cloud computing" originated in 1960, when John McCarthy suggested that someday computer calculations would be done using "nationwide utilities".

In the 1960s, some ideas appeared that resembled what we now call cloud computing - for example, the concept of the "intergalactic computer network" by J.K. R. Liklider.

The ideology of cloud computing gained popularity in 2007 due to the rapid development of communication channels and the growing exponentially demand of both business and private users in the horizontal scaling of their information systems.

In the 1970s, virtualization took mainframes to a new level, and in the 1990s, telecommunications companies began offering virtual private network (VPN) connectivity. In 1999, Salesforce.com became the first company to provide enterprise applications over the Internet. Several users could simultaneously download these applications in a browser at a low price.

Modern "clouds" appeared in 2006 when Amazon.com introduced Amazon Web Services (AWS), ushering in the cloud computing movement. AWS provides a wide range of services, such as computing power and data warehousing, to this day remaining the leading and highly reliable infrastructure of cloud web services platforms. [1-3]

Today, cloud computing technologies are used both in small businesses and in large companies. However, despite their development and application, many Russian companies, especially in the financial sector, have a wait and see attitude related to their implementation. Despite the declaration of cost reduction in business, the transition to cloud technologies very often incurs additional costs associated with the integration of existing infrastructure, the inability to provide the required indicators for the implementation of business processes, which leads to a significant increase in the cost of these services.

In this regard, it is necessary to assess the possibility and necessity of using cloud services for the company depending on the amount of information being processed, cost characteristics, capacity utilization, and many others, therefore research in this area is extremely important and relevant, both in theoretical and practical terms.

II. Key research findings

A. Analysis of the Russian cloud services of the data centers market

The Russian cloud computing market in 2018 amounted to $ 0.93 billion, showing an increase of 31% compared to the previous year.

The development of new technologies makes traditional data centers move to cloud services. The volume of revenue

from the services provided in the field of cloud computing from 13% in 2011 increased to 51% in 2018 (Fig. 1). [1], [4].

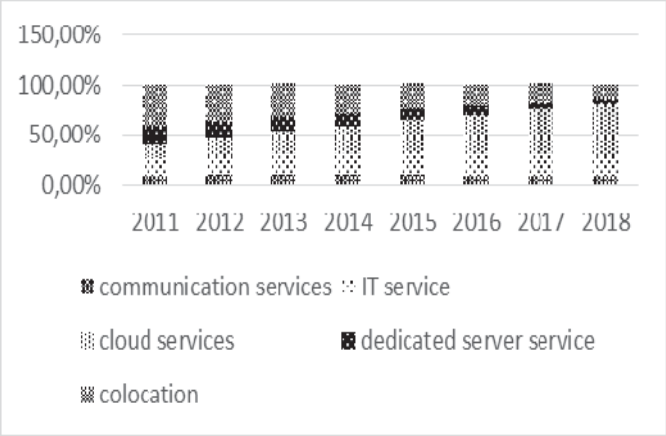

Fig. 1. Dynamics of revenue from cloud services of data centers

In general, the revenue from the provision of cloud services by data centers (DPC) grew to $ 178 million in 2018 (Fig. 2). [2-5]

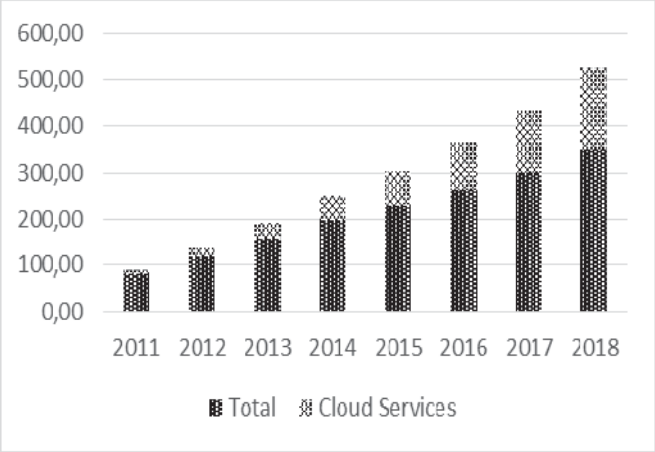

Fig. 2. Dynamics of revenue from cloud services of data centers, millions of dollars

The reorientation of data centers to cloud services is confirmed by a decrease in the share of traditional infrastructure from 2016 to 2018. It decreased by 18.5% (Fig. 3). [3], [6]

The trends in expanding the range of cloud services provided by data centers are dictated by several advantages that can be obtained using cloud technologies. First, there is a reduction in capital costs for creating own data center and purchasing equipment, which is extremely important in modern economic conditions. Secondly, it is the flexibility of cloud computing, which makes it possible to quickly obtain the necessary resources for doing business. Thirdly, modern data centers can provide data security that many companies cannot provide.

In 2018, the leader in the provision of data center services was Rostelecom, which occupies 13.4% of all capacities (Fig. 4), with revenue of almost $ 22 million (Fig. 5). [4-7]

As it is evident from the graph above, there is no pronounced leader in the Russian market in the provision of cloud services. However, it should be noted that the top five companies account for 38.5% of all revenue, which indicates a high monopolization of the market in the provision of cloud services by data centers. It should also be noted that the trend of market concentration would be continued in the current economic situation.

Traditionally, large companies mostly use the services of data centers, so the leader is the energy sector, in which 80% of companies use the services of data centers (Fig. 6). [4], [8]

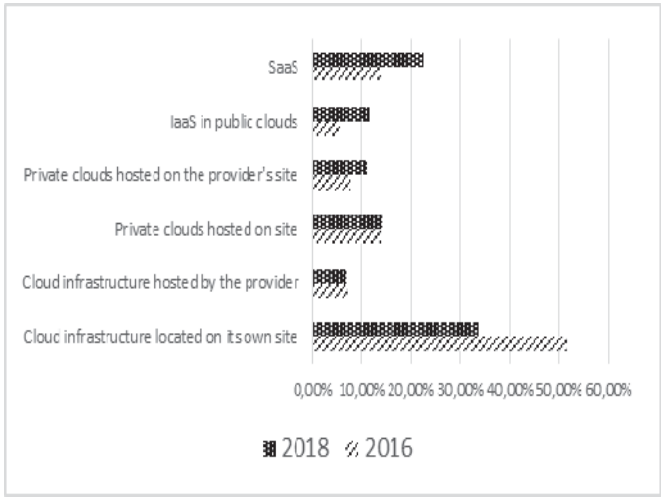

Fig. 3. Dynamics of changes in infrastructure in data centers

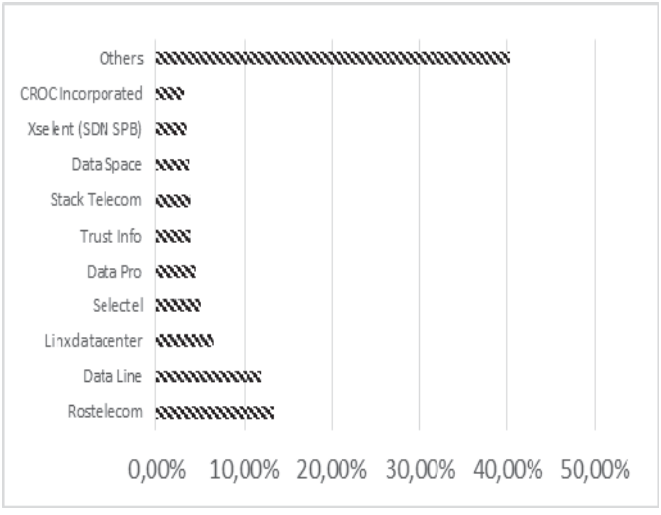

Fig. 4. Share of leading companies in the data center market

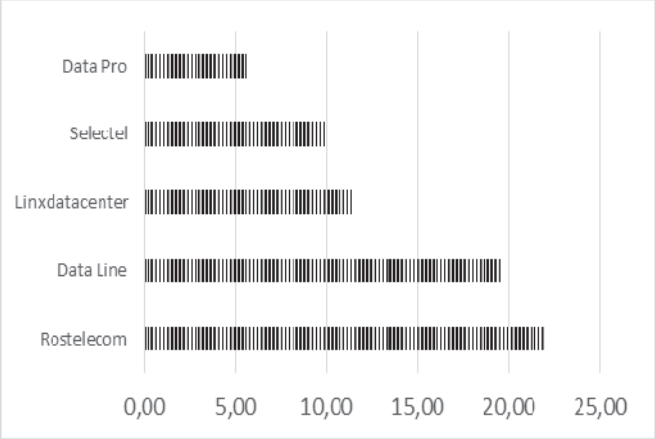

Fig. 5. Leaders revenue from cloud services of data centers, millions of dollars

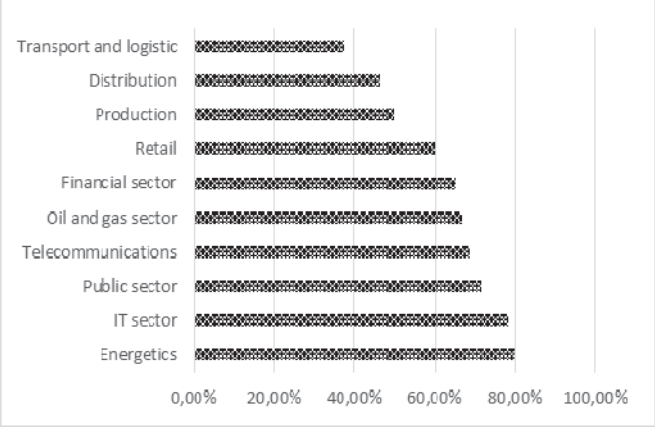

Fig. 6. Consumers of data center services by industry

If the consumers of data centers for cloud services are considered, then the first place goes to IT companies, where the number of cloud computing clients reaches about 31% (Fig. 7). [9-12]

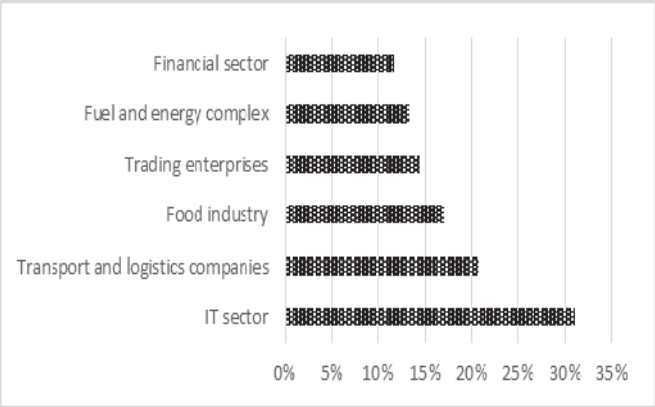

Fig. 7. Consumers of cloud data centers

The financial sector was in the last place as a consumer of cloud services of data centers, although it was a leader in using traditional data center services. This is explained by that most heads of financial institutions do not trust cloud technologies in terms of maintaining the confidentiality of information.

B. Cost analysis when using cloud services

The main advantages of cloud computing are the following ones:

1. Reducing the cost of organizing a data center and its maintenance.

2. The ability to quickly enter the market in the absence of a long period of building an information structure.

3. Availability of high-performance applications for small or medium businesses.

4. Unlimited scalability and flexibility.

5. Improving reliability and guaranteed uptime.

6. Increasing employee mobility worldwide.

7. IT department with a focus on innovation and the development of a new one against the IT department for data center maintenance.

8. Greening the data center by reducing the idle capacity.

The economic benefits of cloud computing are undeniable and obvious when it comes to startups or a significant expansion of companies already established on the market. In this case, there is no need to spend time and money on organizing a data center, its maintenance, on disposing of old equipment and acquiring new ones, finalizing the application to be compatible with legacy systems, retraining employees, etc. [10], [13-17]

The cost of organizing and maintaining the data center is the largest expense item of the company, accounting for 50% or more of the total cost, but not a very large proportion of companies are startups or rapidly developing organizations. For long-standing companies in the market, the introduction of cloud computing is associated not only with economic benefits but also with additional costs.

It is necessary to invest significant funds, completely rebuild an already established business and take risks that are not fully understood, on the one hand. It is necessary to assess whether the absence of cloud computing will deprive the company of competitiveness in the future, on the other hand.

The table describes the likely scenarios for the implementation of cloud technologies. In the first scenario, the application is developed from scratch using a traditional model. In the second case, development is initially based on cloud technology. In the third case, the company already has a ready-made application and transfers it entirely to the clouds. In the fourth case, using the existing non-cloud application continues without modification.

In each case, one has to deal with one-time and recurring costs: the former only occurs during the development and implementation of the application, and the latter has to be carried out regularly until the application is decommissioned (Table 1). [18-21]

TABLE I. COSTS FOR VARIOUS CLOUD DEPLOYMENT SCENARIOS

Types of expenses	New app development		Complete application migration to cloud technology	Continued use of the application created using the traditional model
	using the traditional model	using cloud technology		
One-time: on equipment	High	No		
developing or improving the application	High		Medium	No
disposal of equipment	No		Medium	No
staff training	Low, medium	Medium		No
Periodic: for renting cloud services	No	Medium		No
technical support	No	Medium		No
employee salaries	High	Medium		High
rental of premises and infrastructure	High	No		High

According to this table, when new applications are developed, the application of the traditional model is less attractive than cloud technology. If we talk about one-time costs, then cloud computing technology requires higher costs not only for software development but also for the purchase of equipment. In the long term, it will be necessary to bear significant costs associated with using their computing capacities (payment of rental premises, electricity and Internet bills, and salaries for employees).

The introduction of cloud technologies allows not only to completely abandon the costs associated with the purchase and subsequent operation of their equipment, but also to save on the wages of those employees who would be primarily responsible for the operation of the equipment, and not applications.

For existing systems, the use of cloud technology eliminates the recurring costs associated with supporting own equipment. In this case, there are costs associated with processing the application and minimizing its own data center. Depending on the specific tasks and conditions of each organization, any of the scenarios described above may turn out to be the most economically feasible.

C. Evaluation of the efficiency of using cloud data centers

Despite the whole range of advantages of cloud technologies, one of the most important factors is cost reduction; it is not always rational to use the transition to cloud services.

Let us make a comparative assessment between a classic data center and a cloud data center.

When using a classic data center, profit can be calculated using the following formula:

$$P_{DPC} = T_{DPC} * (I_{DPC} - C_{DPC}) \quad (1)$$

where

P_{DPC} is the data center profit;

T_{DPC} is the used hours of the data center;

I is the income from using the data center in one hour;

C_{DPC} is the cost of one hour of the data center.

Formula (1) calculates the profit of the data center provided that the data center is fully loaded if the data center is not fully loaded, it is necessary to enter the average data center load in the formula, then formula (1) is reduced to the following form:

$$P_{DPC} = T_{DPC} * (I_{DPC} - \frac{C_{DPC}}{Q/100\%}) \quad (2)$$

where

Q is the average data center load, percent.

To calculate the profit of a cloud data center, one can use the following formula:

$$P_{clDPC} = T_{clDPC} * (I_{clDPC} - C_{clDPC}) \quad (3)$$

where

P_{clDPC} is the profit from the work of a cloud data center;

T_{clDPC} is the used time of cloud data center;

I_{clDPC} is the income from the use of the cloud data center in one hour;

C_{clDPC} is the cost of one hour of the cloud data center.

The cost-effectiveness of using a cloud data center will be satisfied if the following inequality is met:

$$P_{clDPC} \geq P_{DPC} \quad (4)$$

This inequality, taking into account formulas (2) and (3), can be represented as follows:

$$T_{clDPC} * (I_{clDPC} - C_{clDPC}) \geq T_{DPC} * (I_{DPC} - \frac{C_{DPC}}{Q/100\%}) \quad (5)$$

Let us consider the extreme case where the customer does not care about using a conventional data center or cloud, in which case inequality (5) becomes equal:

$$T_{clDPC} * (I_{clDPC} - C_{clDPC}) = T_{DPC} * (I_{DPC} - \frac{C_{DPC}}{Q/100\%}) \quad (6)$$

Let us consider the following assumptions when the architecture of the traditional and classical data center is the same, then the profitability of the data centers is comparable, and, therefore, the time to complete the same tasks is the same.

Then, based on these assumptions, the cost per hour of a cloud data center can be calculated using the following formula:

$$C_{clDPC} = (1 + k/100\%) * C_{DPC} \quad (7)$$

where

k is the increasing cost factor that determines the final cost of one hour of the cloud data center.

Using formula (7), formula (6) can be written as follows:

$$T_{clDPC} * (I_{clDPC} - (1 + k/100\%) * C_{DPC}) = T_{DPC} * (I_{DPC} - \frac{C_{DPC}}{Q/100\%}) \quad (8)$$

Based on the above assumptions, equality (8) can be reduced to the following form:

$$k = (1 - Q)/Q \quad (9)$$

As a result, the dependence of the increasing coefficient on a load of equipment is obtained (Fig. 8)

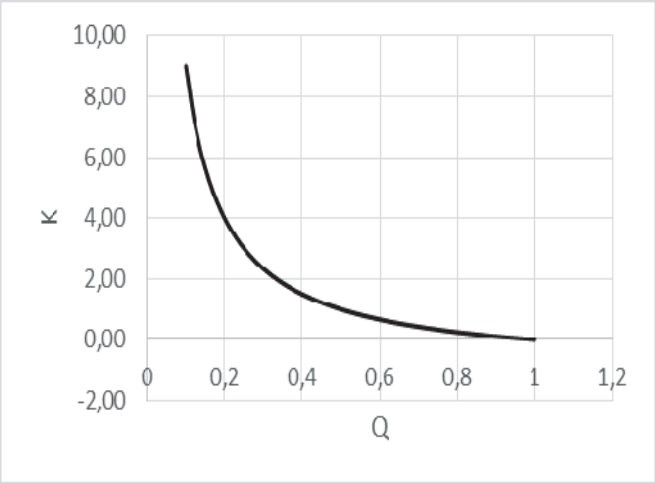

Fig. 8. Dependence of the increasing cost coefficient of one hour of a cloud data center on the workload of equipment of a classic data center

The resulting dependence determines the choice of a traditional data center or cloud if the equipment is loaded and the cost of one hour of cloud service.

Based on the cost analysis in the cloud services market, the average increasing coefficient is about 50%. In this case, the equipment load of the traditional data center will be about 40%.

Based on the above indicators, one can determine the ranges of the efficiency of cloud services depending on a load of equipment. Cloud data centers are more efficient up to 40% of equipment load, there is no single answer from 40% to 50%, and traditional data centers are more efficient from 50% and higher.

Accordingly, at the initial stage of the company's development, it can be used cloud services, while there is no corresponding capacity utilization. Within three years, the capacity utilization of the company with its sustainable development increases to 30 - 40 percent, respectively, at this stage it is better to use cloud services. In the interval from three to five years, the workload can reach 50%, at this stage there is some balance in decision making if there is a tendency to increase the amount of data processing, and then perhaps it is needed to think about switching to a traditional data center. If the company has been operating for more than five years and sustainable development, the workload can exceed 50% and in this case, it is cheaper to use a traditional data center.

III. Conclusions

Today, the development of the world economic system is influenced by the development of innovative digital technologies, which are used in almost all areas of economic development. It allows talking about the beginning of the fourth industrial revolution;

One of the most promising areas in the field of innovation is cloud computing, which is widely used in the Russian economy; in 2018, the volume of the cloud services market reached almost $ 0.93 billion, showing a 31% dynamics over the previous year, which distinguishes this direction as one of the most dynamic in the Russian market;

One of the trends in the Russian information technology market is the transition of data centers to the provision of a full range of cloud services. In 2018, the revenue from cloud computing in data centers grew by 38% compared to 2011, and its value amounted to $ 178.3 million;

Due to the development of cloud computing technologies, the corresponding infrastructure of data centers is changing. The transition to cloud infrastructure was carried out in the period from 2016 to 2018, the share of traditional infrastructure in data centers decreased by 18.5%;

The leader of the Russian market of data center cloud services is Rostelecom, which occupies 13.4% of all data center capacities in Russia, and the revenue from the provision of cloud services exceeded $ 22 million in 2018;

The Russian data center market is under difficult economic conditions, in this regard, there is a consolidation of the main players through mergers and acquisitions, as well as the departure of several players. The share of the five leading companies in the market is 38.5%, and the total revenue from cloud services exceeded 68.3 million dollars;

The main consumers of cloud services provided by data centers are IT companies with an indicator of 31%, transport and logistics companies with a value of 20.7%, and the food industry with an indicator of 17.2%;

Analysis of the cost-effectiveness of introducing and using cloud services provided by data centers in comparison with classical ones shows that cloud data centers are effective if the capacity utilization of a traditional data center company does not exceed 40%. It is cheaper to operate a traditional data center with an increase in information processing volumes and, consequently, an increase in load capacity. Therefore, cloud services are more effective for start-up companies operating in the market for up to five years.

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