Expansion of cloud computing in V4 countries

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Abstract: Currently, the trend of information technology transformation towards cloud computing is becoming increasingly apparent. This trend brings with it a number of advantages, but also concerns and limitations for end customers. The question therefore arises as to how Czech small and medium-sized enterprises react to this trend and whether they embark on the implementation of applications based on cloud computing. If they are already starting to implement it, then what types? Are only basic applications that do not require complex implementation of interest to businesses, or are they also starting to implement more complex applications? This article looks at the dynamics of cloud computing development in Czech small and medium-sized enterprises and compares them with developments at the level of the European Union and the Visegrad Four countries.

Keywords: Cloud computing, SME, cloud adoption, cloud application usage
JEL Classification: A30, C40, O33

1 Introduction

Over the past decade, advances in computing have made it possible to build cost-effective and computationally efficient large data centres for public cloud service providers. Due to the benefits of this IT delivery concept, the concept has been positively received by service providers. The cloud computing (CC) model transforms information technology into the form of public service provision – a commodity concept of service. (Alkhalil, Sahandi, & David, 2017)

Thanks to the possibility of commoditizing company information technologies, the transformation from software operated on-premise (on the company's own resources) to a cloud computing (CC) environment is a current issue in a number of Czech companies. This trend is nothing new, it was already manifested in Western countries in the last decade. (Ramchand, Chhetri, & Kowalczyk, 2021) (Senarathna, Wilkin, Warren, Yeoh, & Salzman, 2018) However, thanks to the long-life cycle of IT projects and the slight delay, it is currently becoming more and more evident in the environment of small and medium-sized enterprises in the territory of the Czech Republic.

Especially for small and medium-sized enterprises, cloud computing could be an ideal solution for the change of information technology, taking into account the presented advantages. It is necessary to add that among the available cloud infrastructures, the solution that is referred to as the public cloud is thought of. (Gutierrez, Boukrami, & Lumsden, 2015) The most important and commonly known public cloud providers (CSP) include Microsoft, Amazon, Google, and Red Hat. It is the public cloud that represents the infrastructure operated by the cloud service provider, which enables access to the infrastructure, platform, and system through a defined interface. Such a solution has a number of advantages such as overall reduction of capital expenditure, ease of implementation, high availability and others. (Alouffi, and others, 2021)

Through the public cloud, it is possible to purchase services divided into three models. The difference between the individual models is mainly in the ratio of parts of the system that are managed by the CSP and the customer. The first model is infrastructure as a service (IaaS). It is typical for this model that CSP only takes care of the operation of the hardware itself and the virtualization of individual components. The rest is up to the customer. In this model, the customer manages everything from the middleware to the application. The most common charging model is the "pay as you go" model. The second model is Platform as a Service (PaaS). For the PaaS model, the CSP additionally manages the middleware and run-time environment. The customer has control over the application and data. As an example, we can mention frequently used web servers. Again, very often charged with a "pay as you go" model. The third model is software as a service (SaaS). When using the SaaS model, the CSP manages everything, including the data and the application.

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Thus, CSP provides a ready-made application, running on cloud infrastructure, which is accessible to users through a web browser, desktop or mobile application. In this case, CSP also provides updates of the entire solution and at the same time ensures data backup. A typical charging model is payment per user and / or application. This also ensures complete licensing of the solution for the end customer. (Nguyen & Liaw, 2022) (Abdel-Basset, Mohamed, & Chang, 2018)

In addition to the mentioned advantages, individual solutions also have perceived disadvantages. In expert article, there is often a company's concern about the possibility of their data being misused. Alternatively, the company's concern about losing control over the entire solution and completely handing over its applications to CSP management. With this, CSPs can work through public opinion and prevent such a scenario with their own processes. (Christiansen, Haddara, & Langseth, 2022) (Habib, Hauke, Ries, & Mühlhäuser, 2012)

In this article, we want to focus on Czech small and medium-sized enterprises that have already implemented and operate cloud computing. In this contribution, we want to provide information on the rate at which implementations are increasing within this spectrum of businesses and compare this rate with the surrounding Visegrad 4 states and the European Union (representation of 27 countries as of 2020). Furthermore, we want to offer a view of the representation of basic groups of applications provided through cloud computing.

2 Methods

As part of the methodology, we focus only on small and medium-sized enterprises that purchase services based on cloud computing via the Internet. It is the public cloud that seems to be the ideal solution for small and medium-sized businesses. The first research question we want to answer is the evaluation of the dynamics of the development of cloud implementations. For this evaluation, we will use indices and compare the dynamics of development with the V4 countries and the EU as a whole. The second research question is whether enterprises use all cloud-provided applications equally. For the evaluation, we will perform a conversion to the percentage representation of individual applications from the total share of companies using cloud computing.

The input data was obtained from the freely accessible Eurostat database, where an own dataset was created based on data from the category Science, technology, digital society / Digital economy and society / ICT usage in enter-prises / E-business. Table 1 shows the percentage representation of companies using cloud computing for individual geopolitical areas, divided by size into small and medium-sized enterprises for the given period. Table 2 shows the percentage representation of companies from the sector of small and medium-sized companies using a given type of application for individual geopolitical regions and periods.

Table 1 – Percentage of enterprises buying CC services used over the internet

Time		2016	2017	2018	2020	2021
GEO	Enterprise size					
EU (from 2020)	Small	17	N/A	21	34	38
	Medium	26	N/A	34	46	53
Czechia	Small	17	20	24	26	42
	Medium	22	27	34	37	47
Hungary	Small	11	15	15	22	23
	Medium	19	23	29	37	41
Poland	Small	6	8	9	21	24
	Medium	13	17	19	38	43
Slovakia	Small	17	21	19	23	33
	Medium	21	27	26	33	47

Source: Own processing based on Eurostat (Eurostat, 2022)

Table 2 – Percentage of enterprises buying specific CC services used over the internet (SE – Small enterprises, ME – Medium enterprises)

Time		2016		2017		2018		2020		2021	
GEO	CC service \ Enterprise size	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME
EU (from 2020)	e-mail	11	16	N/A	N/A	14	23	25	34	30	41
	office software	7	10	N/A	N/A	10	17	19	28	23	35
	hosting enterprise‘s database	8	11	N/A	N/A	10	16	15	23	17	24
	storage of files	10	16	N/A	N/A	14	22	22	32	25	36
	finance or accounting software	6	7	N/A	N/A	8	11	16	18	19	22
	CRM software	4	7	N/A	N/A	6	10	8	14	9	16
	CC power to run own software	3	6	N/A	N/A	4	8	7	13	8	14
Czechia	e-mail	13	15	16	20	19	25	20	29	34	39
	office software	7	8	9	14	13	20	16	24	36	41
	hosting enterprise‘s database	5	7	8	12	8	12	10	15	11	21
	storage of files	8	11	12	16	15	23	17	25	25	33
	finance or accounting software	5	6	8	9	9	10	11	13	23	21
	CRM software	3	6	4	7	5	8	7	9	6	11
	CC power to run own software	3	6	3	7	4	7	8	14	4	5
Hungary	e-mail	7	13	10	16	11	21	16	29	16	31
	office software	5	10	7	12	9	16	13	24	13	28
	hosting enterprise‘s database	4	7	5	8	6	10	11	17	10	18
	storage of files	6	10	8	14	9	17	15	25	13	27
	finance or accounting software	4	6	5	8	5	10	8	13	9	17
	CRM software	3	5	3	7	4	8	5	9	4	11
	CC power to run own software	2	4	4	7	5	8	7	13	7	14
Poland	e-mail	4	10	5	12	6	13	15	30	19	34
	office software	2	5	3	7	4	10	13	24	15	28
	hosting enterprise‘s database	3	6	3	8	3	6	7	13	6	12
	storage of files	3	8	5	11	4	10	10	22	9	20
	finance or accounting software	2	3	2	4	3	4	8	11	8	10
	CRM software	2	2	2	4	2	4	4	8	4	8
	CC power to run own software	1	2	2	3	1	3	3	6	2	5
Slovakia	e-mail	14	16	18	20	16	21	19	30	29	39
	office software	9	9	11	15	12	14	14	23	21	31

	hosting enterprise‘s database	5	8	7	10	7	10	9	15	13	15
	storage of files	8	11	10	15	11	15	13	23	19	31
	finance or accounting software	8	8	10	10	9	10	11	15	18	21
	CRM software	3	4	5	7	5	8	6	10	10	11
	CC power to run own software	4	6	5	7	4	8	6	11	8	11

Source: Own processing based on Eurostat (Eurostat, 2022)

3 Research results

As part of the data evaluation, we only encountered the unavailability of some data. For the year 2017, data on the percentage of cloud usage in an aggregated form for the entire EU is not available. Other unavailable data is for 2019, which is not available at all.

3.1 Adoption of cloud computing

When evaluating the overall representation of companies using cloud computing, it is positive for Czech companies that neither at the beginning nor at the end of the monitored period do we find a significant difference compared to the European Union as a whole. We see similar results in Slovakia, which is comparable to the Czech Republic in terms of deviation from the EU as a whole. In this respect, Poland and Hungary show greater differences compared to the EU. In the case of Hungary, the gap with the EU increased at the end of the monitored period compared to the beginning of the monitored period.

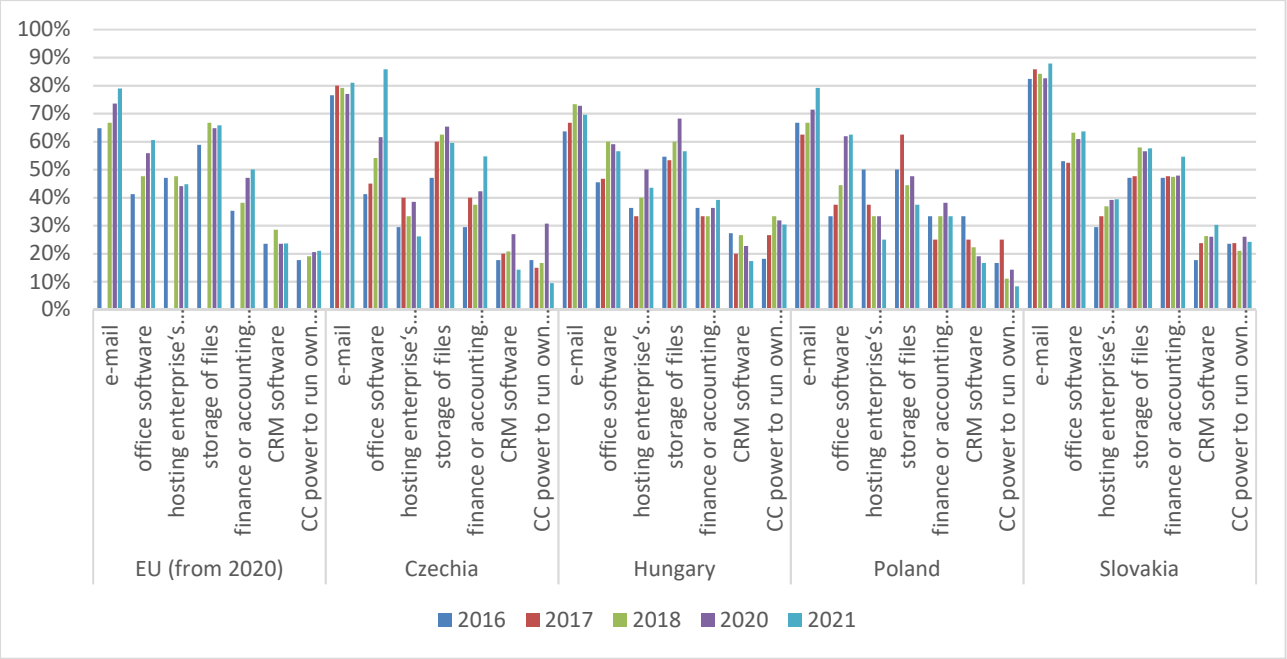
Evaluating the dynamics of development is difficult, as year-on-year comparisons are complicated by missing data. We made the comparison against the starting year 2017. Based on this comparison, we have identified the most significant growth for the EU, Hungary and Poland in the period 2020. Here it is possible that a wave of sharp increase appeared already in 2019, this cannot be confirmed or excluded. Conversely, in the Czech Republic and Slovakia, the greatest growth did not occur until 2021. For small Czech businesses, this means a 61.5% year-on-year increase in companies using cloud computing, and a 27% increase for Czech medium-sized businesses.

We attribute the increase that occurred in some countries in 2020 or 2021 to changes caused by the corona virus pandemic, together with various forms of support in individual states.

3.2 Type of services

In the relative comparison of small companies for each observed period, there are common features for all countries. Small companies primarily focus on services, that have low technological complexity, and have rapid implementation. These are email services and office software. Within small businesses in the Czech Republic, office software experienced significant growth, from a share of 62% to 86%. Email services based on cloud computing for the entire monitored period copy the development of the use of the cloud as a whole. In the case of the purchase of storage for files, this is again a more than half representation of these services, and with the exception of Poland, we can observe a growth trend. The lowest use of cloud services in the Czech Republic for small businesses is seen in the purchase of computing power to run their own software, where Czech small businesses experienced the most significant drop from 31% to 10% in 2021. While, the European-wide share is 21% in 2021, and other countries are following this trend. In the overall overview of purchased services, this is the least purchased commodity. All this is shown in detail in Figure 1.

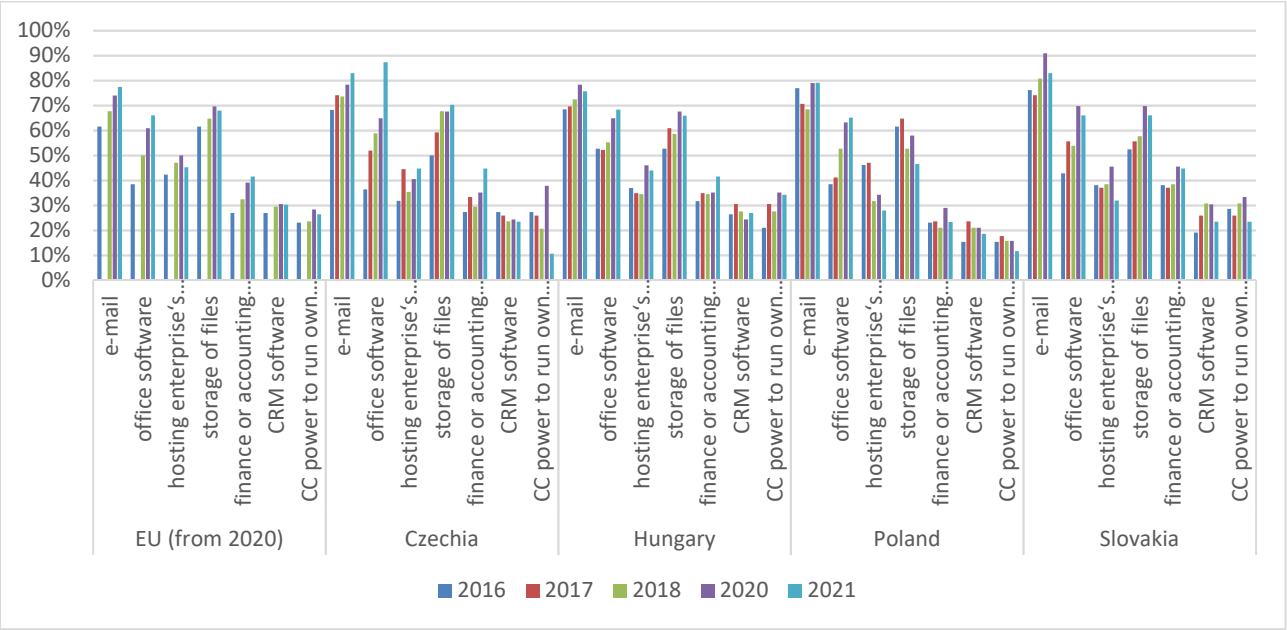
Figure 1 – Relative percentage usage of cloud services in small enterprises



Source: Own processing

In a relative comparison of medium-sized companies for individual monitoring periods, common features are again identifiable. Like small companies, medium-sized companies focus more on services that are not too technologically complicated and can be implemented quickly. Again, this is mainly about services for email and office software. It is interesting that for Czech medium-sized enterprises we can once again identify significant growth in office software between 2020 and 2021. Specifically, it is a growth from 65% to 87%. We have not seen similar growth in any other geographic area. If we look at another significant change, we can again identify a significant decrease for Czech medium-sized enterprises in the purchase of computing power to run their own applications between 2020 and 2021. In percentage terms, this is a decrease from 38% to 11%. The European-wide average for this commodity is around 26%, and other countries, with the exception of Poland, follow this trend. All this is shown in detail in Figure 2.

Figure 2 – Relative percentage usage of cloud services in medium enterprises



Source: Own processing

If we compare the distribution for individual geographical areas and periods in relation to the size of the company, we will find that there are no significant differences between small and medium-sized companies in terms of the choice of services provided by the form of cloud computing.

The three most represented services are email services, office software and file storage. It is these services that are often offered in the form of SaaS, thanks to which companies can easily determine the costs of their solutions in advance with great accuracy. At the same time, the services offered are generally simple and easily acceptable. In doing so, we can support the findings from articles focusing on the factors affecting the adoption of cloud computing as a whole, which claim that service complexity has a negative effect on cloud adoption.

The least represented service is the purchase of computing power. We expected this mainly because of the complexity of the given solution. Businesses may mistakenly believe that by purchasing computing power (typically IaaS) they will easily transfer their entire infrastructure to the cloud. However, the problem arises during operation. Migrated applications are not optimized for operation in a cloud environment, and in particular inappropriate use of resources can make services based on the "pay as you go" charging model significantly more expensive.

4 Conclusions

The evaluation of the dynamics of the development of Czech small and medium-sized enterprises compared to the average of the European Union is ambiguous due to the missing year 2019. Based on this, it cannot be said that the delay of Czech companies compared to the EU as a whole is one or two years. However, there is some delay. It is interesting that at the beginning of the monitored period the average of the EU and the Czech Republic and Poland was very similar, and 5 years later the percentage representation of companies using cloud computing in these countries is again very similar. However, the year-to-year changes are very different. In the case of small businesses from Slovakia and Hungary, we identify a slight lag compared to Czech small businesses and the EU average. Slovak medium-sized enterprises caught up with Czech medium-sized enterprises only in the last year of the monitored period and reached the same percentage representation. In the monitored period, Hungarian medium-sized enterprises have the smallest representation of companies using cloud computing of all monitored geographical areas.

From the point of view of cloud computing-based services used, it has been confirmed to us that companies are increasingly implementing services that are technologically simple, easier to grasp and quick to implement. We explain this state precisely by the simplicity and friendliness of these services. At the same time, we think that the simple determination of the total costs incurred for the operation and licenses of the given solution also contributes to this. The three most frequently represented services have in common that they are most commonly provided in the SaaS mode. Furthermore, it is interesting that we do not identify significant differences between small and medium-sized enterprises in terms of the use of services based on cloud computing. Here again, a simple determination of the total costs incurred for operation probably plays a role. In our future research, we will focus on the representation of individual cloud computing services in Czech small and medium-sized enterprises and try to clarify why and how individual services are chosen.

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