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Reviewers: **doc. Ing. František Dařena, Ph.D.**
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Ing. Martin Pelikán, Ph.D.
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Faculty of Economics and Management

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Content

Use of the Big Data platform and cloud applications in the SME segment in the Czech Republic

Homan, J.

Abstract: This article aims to explain the features of the cloud computing platform and the possible deployment modes of these services. It further explains the concept of big data. Because these phenomena could have a positive benefit in the case of implementation for small and medium-sized Czech companies (SMEs), we devote ourselves to the description and use of existing methodologies that explain the penetration of new technologies towards their users. To form a broader view of the current situation, we, in this paper, provide an overview of the current use of individual services provided through the cloud computing platform by small and medium-sized enterprises. From this overview, it is evident that small and medium-sized enterprises use more and more applications based on cloud computing. Our overview also showed that the field of big data processing is not relevant for SMEs. They do not use cloud solutions aimed at processing big data. This area may be relevant in the future in the future by purchasing Internet of Things services. Among the implemented cloud computing services, services that implementation is not too demanding stand out. It is not yet clear what leads SEMs businesses to this behavior. In our research, we propose to find out, with the help of semi-structured interviews, how the decision-making process takes place in SMEs. We propose a series of questions for these interviews with individual investigated factors. When designing them, we are based on the preliminary research and existing research articles dealing with this topic.

Keywords: Cloud computing, SME, cloud adoption, cloud application usage, IaaS, PaaS, SaaS

JEL Classification: *A30, C40, O33*

1 Introduction

The designation of cloud computing (CC) has been established to provide information technology (IT) through computer networks. CC is a very broad concept that includes many different models of creating specific IT services. These IT services can be created only for the needs of one (typically multinational) company, which provides benefits associated with the robustness of CC. Such a solution will be referred to as a private CC, up to a unified solution (with the possibility of customization) offered by one company to the general public (almost worldwide). This solution is referred to as public CC. Among these cases, we can find a range of other IT service modifications that aim to satisfy the customer both in terms of his requirements and legislative requirements for data management. Along with the beginnings of CC, the mutual relationship with the phenomenon of Big Data (BD) was also presented. Because BD applications posed a significant challenge to IT resources, it was assumed that with the mass expansion of CC, there would also be an expansion of BD.

Small and medium-sized enterprises are part of every economy. It is typical for these enterprises that they do not use overly complex and extensive information and communication technology (ICT) solutions. At the same time, they will not make too high investments in ICT. Furthermore, many companies from this category will not have their department dealing with ICT management and development. Therefore, they will try to outsource ICT administration. Alternatively, they will have the position of an employee who, in addition to his normal work, can perform basic IT maintenance but will not have sufficient knowledge to modify the existing IT application or to implement a new one. In such cases, it is necessary to use external companies.

In this situation, a particular CC-based IT solution may be ideal for several reasons, dominated by the total cost of acquisition, management, and sustainability of the entire IT solution. On the other hand, there will still be some mistrust in the CC-based IT solution and its benefits.

The aim of this paper is to propose a methodical procedure that will enable a more detailed description and understanding of the decision-making process of CC and BD implementation, especially in small and medium-sized companies in the territory of the Czech Republic. Current knowledge does not explain the differential use of different types of CC service delivery. Together with CC, we will monitor the use of BD.

Methodologies very often evaluate the influence of factors in one or more dimensions but do not consider the course of the decision-making process. At the same time, neglect the company's characteristics regarding access to innovations. Therefore, the goal will be to propose a methodical procedure for capturing the decision-making process about the traditional characteristics of the company, supplemented by information on the approach to innovation. At the same time, it should be possible to identify whether any factors can act definitively decisive.

2 Literary overview

CC, as defined by "NIST" (Mell & Grance, 2023), is a model for providing IT services (servers, databases, storage, networks, software, and analytical tools) on demand over the internet that can be rapidly provisioned and/or released with minimal management effort or interaction with the service provider. According to "NIST", this service model is defined by five basic characteristics, three service delivery models, and four deployment models. The basic characteristics are (Mell & Grance, 2023):

- on-demand self-service – the customer can start and use computing capabilities and services provided without having to communicate with a representative of the service provider;
- wide access to the network – services are available over the network and through standard mechanisms that support heterogeneous thin or thick client platforms;
- pooling of resources – computing resources of the provider are pooled to serve multiple consumers, while resources are dynamically assigned and reassigned according to consumer demand. The customer has no control or knowledge of the exact location of the provided resources. In some cases, he can choose a higher level of abstraction (country, data center);
- fast elasticity – the required computing power is flexibly provided and also released (in some cases automatically) so that the provided services are proportional to the demand, thus the available resources may seem unlimited to the consumer;
- measured service – cloud systems automatically control and optimize the use of resources; therefore the ability to measure the use at a certain level of abstraction suitable for the given service (active user accounts, storage, used processor time) is important, which will provide transparent information about the use of the service for both consumers and providers;

In the literature, we also find a set of CC properties that can be labeled as positive properties or negative properties. Positive features include (Bezpalec, 2023; Abdalla & Varol, 2019):

- cost efficiency – no or minimal initial investments because it is not necessary to purchase server infrastructure and licenses; at the same time, it is necessary to take into account the fact that, thanks to this, repeated investments in changing the server infrastructure are also eliminated;
- simplicity of administration – IT applications provided through CC are easier to maintain, and at the same time, the CC provider has a uniform environment for all customers, which supports the possibility of outsourcing;
- flexibility – the possibility to dynamically change the capacity of IT services, the number of users contributes to the effective use of resources and the setting of resources according to the seasonal needs of the customer;
- constantly updated services – CC-based IT services are always maintained by service providers in an updated version, especially for SaaS-type services. This is a major advantage;
- SLA – Service Level Agreement, or contractually guaranteed availability of services, which guarantees the customer that there will be no outages of purchased IT services;

IT services provided through CC also have several known disadvantages. Examples of these disadvantages are (Bezpalec, 2023; Abdalla & Varol, 2019):

- limited customization – the overall CC offer is limited by what is currently offered on the market, and some configurations may not be available at all. At the same time, the fact that the service provider guarantees certain availability can sometimes significantly limit the space for custom software modifications;
- possible data leaks – all CC applications are provided via the Internet network, and the data is stored on the hardware resources of the service provider, which increases the possible scope for the leakage of sensitive data, both along the way and due to sabotage by the provider's employees;
- reaction time – because CC-based services are provided through the Internet network, the servers of the service provider may be located at a relatively significant distance. As a result, application responses may appear slow;

- little or no economies of scale – compared to a proprietary solution where companies can draw advantages of scale, there is a minimal chance of realizing these savings in the CC environment;

Other basic characteristics of CC are described in chapters 2.1 – deployment models and 2.2 – service delivery models.

2.1 Cloud computing deployment models

CC models (deployment models) describe the creation of the cloud infrastructure itself and, at the same time, determine who makes the basic investment in the hardware and software itself. Furthermore, who will be responsible for managing this infrastructure? To a certain extent, the possible customers of the resulting service are also determined.

2.1.1 Private cloud

Of all the models, private CC is most similar to the traditional on-premise model. Private CC is developed and completely customized for the needs of an organization. As for the physical location, the server room can be built directly on the premises or even outside the premises of the given company. In the case of large implementations, we can talk about a data center. In contrast to the usual on-premise approach, we can also implement a private cloud by renting space or even renting the infrastructure itself in a commercial data center. (Finn, Vredevoort, Lownds, & Flynn, 2012; Neicu, Radu, Zaman, Stoica, & Răpan, 2022)

The advantage of a private cloud is that the company can decide what services it wants to use according to its needs. Then these services are supported by an appropriately designed infrastructure. Thanks to the flexibility of the entire concept, it is possible to change the infrastructure over time without the need for significant interventions in individual applications. Private clouds provide high-quality dedicated ICT services. In addition, because only one company uses the infrastructure, it has the most control over the entire solution regarding data security. (Neicu, Radu, Zaman, Stoica, & Răpan, 2022; Jinzhou, Jin, & Zhijun, 2016)

Disadvantages include requirements for a sufficiently stable financial background. Also, if the IT solution is not managed externally, then considerable requirements for IT workers' education. At the same time, the design of the entire solution will take a considerable time for workers who create the private cloud and the company's regular employees to define the requirements for the entire IT solution. (Finn, Vredevoort, Lownds, & Flynn, 2012; Neicu, Radu, Zaman, Stoica, & Răpan, 2022)

Along with the transition to the private cloud, the role of IT administrators is changing. In a common on-premise scheme, IT administrators are responsible for everything from managing physical servers, virtual servers, and network configurations to installing individual applications. IT administrators create and manage pools of reusable components and systems within a private cloud. (Neicu, Radu, Zaman, Stoica, & Răpan, 2022)

2.1.2 Public cloud

Public cloud is the model most people associate with the general term CC. It is a model in which a cloud service provider (CSP) manages the entire IT services and provides them to multiple customers using different delivery models. Public clouds are very easily accessible. IT services based on this platform can be flexible and usually suitable for any size of organization. A CSP usually operates several data centers independent of each other, which can stand in for each other if necessary. Thanks to this, high availability of services and good protection in case of local natural disasters is achieved. Typical representatives of these service providers are Microsoft, Google, and Amazon, but we can also find several smaller companies operating locally. (Finn, Vredevoort, Lownds, & Flynn, 2012; Neicu, Radu, Zaman, Stoica, & Răpan, 2022)

The benefit of this solution should be a reduction in the cost of acquiring a certain IT application. This should be made possible because the hardware resources are shared among several customers, and thus their better utilization is enabled. Other benefits include the speed of deployment. The company can deploy and launch a new IT application in a matter of minutes and without investing in internal IT infrastructure. In addition, thanks to the uniformity of the environment, outsourcing can also be carried out effectively since external IT administrators and consultants always win with one environment that is well known to them. If the company no longer needs an application or storage space, it simply terminates its subscription. (Finn, Vredevoort, Lownds, & Flynn, 2012; Neicu, Radu, Zaman, Stoica, & Răpan, 2022; Jones, Irani, Sivarajah, & Love, 2019)

However, there are also several reasons why companies do not want to purchase services based on public CC. Concern about company data security can be identified as the most frequently cited cause. The data center, including the hardware, is completely under the control of CSP employees. Customers do not have any control over the security of their data and applications. On the other hand, it must be said that the established providers of these services do not take this concern lightly and pay great attention to processes related to IT systems security. Another security risk is the data transmission itself, as it is carried out over the public internet network, and data transmissions can be intercepted and the data decrypted. Another obstacle can be a mental barrier to switching to services that are hosted tens to hundreds of kilometers away. At the same time, the provision of support for such a solution is very often deprived of a certain personal bond between the customer and the supplier. (Finn, Vredevoort, Lownds, & Flynn, 2012; Bello, and others, 2021)

2.1.3 Community cloud

A community cloud is created when multiple entities agree to cooperate and share their infrastructures to achieve optimal results. This model should be used especially when several companies have similar requirements for information systems, security principles, purposes, and business areas. (Finn, Vredevoort, Lownds, & Flynn, 2012)

When creating a community cloud, companies take advantage of the fact that they share the costs of acquiring hardware, software, operation, and management of a certain solution among themselves. At the same time, they have a much greater overview of the physical security of the entire infrastructure than in the case of using a public cloud. Participants can use services provided by both public and private CC. Individual participants also share the risk arising from the operation of the given solution. (Neicu, Radu, Zaman, Stoica, & Răpan, 2022; Dubey, and others, 2019)

Community cloud also has several disadvantages. The first thing to mention is that the minimum availability of computing power is often not guaranteed. So, if one organization puts a significant load on the entire infrastructure, the other members compete for the remaining computing power for their applications. Furthermore, it is not a trivial infrastructure due to its great openness. Finally, the big disadvantage of this solution is related to standards and regulations. It is entirely up to the members to establish mutual rules for sharing all resources, developing and maintaining IT solutions, and promoting individual corporate interests. (Finn, Vredevoort, Lownds, & Flynn, 2012)

2.1.4 Hybrid cloud

It is wise to prepare to use a scenario that combines different approaches in certain scenarios. This combination is a combination of private and public clouds. The deployment of both models makes sense when the company and its need to use computing power is periodically changing significantly. Another scenario could be to exclude certain computationally or data-intensive processes from the public cloud and leave the support of core processes within the private cloud. The last but very common reason may be the presence of state regulation, which does not allow the storage of a certain type of data outside the territory of the given state, so it is necessary to ensure that this sensitive data is stored locally. (Finn, Vredevoort, Lownds, & Flynn, 2012)

Thanks to the combination of both approaches, it is possible to take advantage of both solutions and thus achieve a truly cost-effective, highly elastic, and well-scalable solution. At the same time, however, keep your sensitive data under control. (Finn, Vredevoort, Lownds, & Flynn, 2012; Celesti, and others, 2019)

From another point of view, the disadvantages of both solutions may accumulate. Apart from the previously discussed disadvantages, this solution is also more complex than each model separately. A good combination of both models is a non-trivial task, and it is necessary to ensure sufficiently fast and stable communication between the private and public clouds. In extreme cases, there may be complete outages of all services just because of the loss of mutual communication between the two environments. (Neicu, Radu, Zaman, Stoica, & Răpan, 2022)

2.1.5 Virtual private cloud

The virtual private cloud is a relatively new extension of the public cloud. The creation of virtual network elements and data encryption between individual network points was started to achieve greater data security. This model aims to eliminate a significant part of the risk in data transmission on a public network. With the help of virtual switches and routers, a data tunnel is established between the organization's network infrastructure and the CSP's virtual infrastructure. (Yang, Wei, Zhu, Li, & Tan, 2018)

Thanks to these additional modifications, the risk of interception of data during its transmission is significantly suppressed, but at the same time, the cost benefits of public CC remain. This solution also maintains high scalability and elasticity. Individual virtual private clouds are isolated from each other, and at the same time, thanks to appropriate settings, it is possible to isolate the virtual private cloud from the internet. Other disadvantages of public CC remained. (Yang D. , Wei, Zhu, Li, & Tan, 2019)

2.2 Service delivery models

Service delivery models describe which part of the infrastructure will be managed by the customer and which part will be managed by the CSP. Together with the model, the method of charging individual services is also implied to a certain extent. However, it cannot be said that there is no exception in the market. (Jamsa, 2022)

2.2.1 Infrastructure as a Service

Infrastructure as a Service (IaaS) is the basic model for deploying CC services and software. When discussing infrastructure as a service, we mean delivering a certain computing capacity, data storage size, and network service. The customer can easily deploy services on selected resources through a self-service environment via a virtualized image, a publicly provided container, or based on their creation. Subsequently, it can use the infrastructure created in this way. When managing the environment, the customer typically manages everything from the middleware to the application. CSP manages the hardware, network infrastructure, storage, virtualization, and OS. The situation is indicated in picture number 1. At the request of the customer, the architecture can be different. The CSP mostly manages the host OS, and the user manages the VM OS. There are services where the customer can run the application directly on the hardware, eliminating the need for a host OS. (Hurwitz & Kirsch, 2020; Parast, and others, 2022)

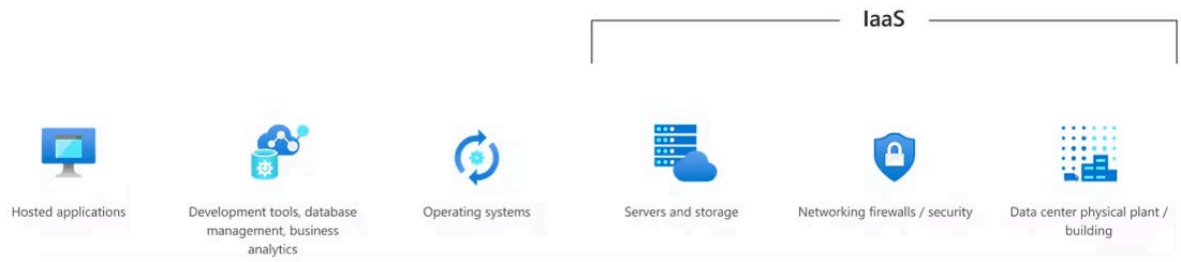


Figure 1 – Infrastructure as a Service architecture (Microsoft, 2023)

The advantage is that the service is designed as a completely self-service environment. The customer typically only needs a credit card and can create an environment for running their applications. Compared to the traditional approach of buying your physical solution, there is a lot of freedom regarding the scalability of services. This gives the company great flexibility to scale performance up and down as needed. In addition, IaaS services are typically charged based on the resources consumed (the amount of data stored in the operating memory, the number of processor calculations, the number of IN/OUT operations, the size of the storage space...), i.e., the "pay-as-you-go" model. Hence, the company only pays for what it reals and when it needs. When customers stop paying for the services, they lose access to them. Typical business scenarios are (Microsoft, 2023):

- migration using the "lift and shift" method (the fastest and cheapest way to migrate an application to the cloud);
- development and testing;

- storage, backup, and recovery;
- web applications;
- high-performance computing environment (HPC);

Customers must choose a specific service appropriately based on their needs. There can also be significant differences in security, data backup, and support between individual providers and services. As demands increase, the price of the service rises accordingly. Furthermore, during a "lift and shift" type of migration, customers may find themself in a situation where even a relatively simple application will be relatively resource-intensive, resulting in a disproportionate increase in the price of the entire service. Therefore, it is not easy to say that IaaS is automatically the right choice when deciding on a new environment. (Hurwitz & Kirsch, 2020; Jamsa, 2022)

Established IaaS services are Google Cloud, Microsoft Azure, and Amazon EC2 (Elastic Compute Cloud).

2.2.2 Platform as a Service

Platform as a Service (PaaS) follows the previous IaaS model. But PaaS goes further and allows developers to be abstract from the operating system for which they should optimize their application by providing basic operating system services and hiding them in a PaaS virtual environment. With this abstraction, developers can focus on agile application logic development to provide customers with applications that meet their latest requirements. PaaS supports rapid transformation due to containerized software deployment, thus favoring cloud models, leading to a well-scalable environment. The customer of these services abstracts from any management of the OS, middleware, or runtime environment. (Hurwitz & Kirsch, 2020; Mohammed, A. M., F., Shamsuddin, & Eassa, 2020; Oracle, 2023) The situation is shown in figure number 2.

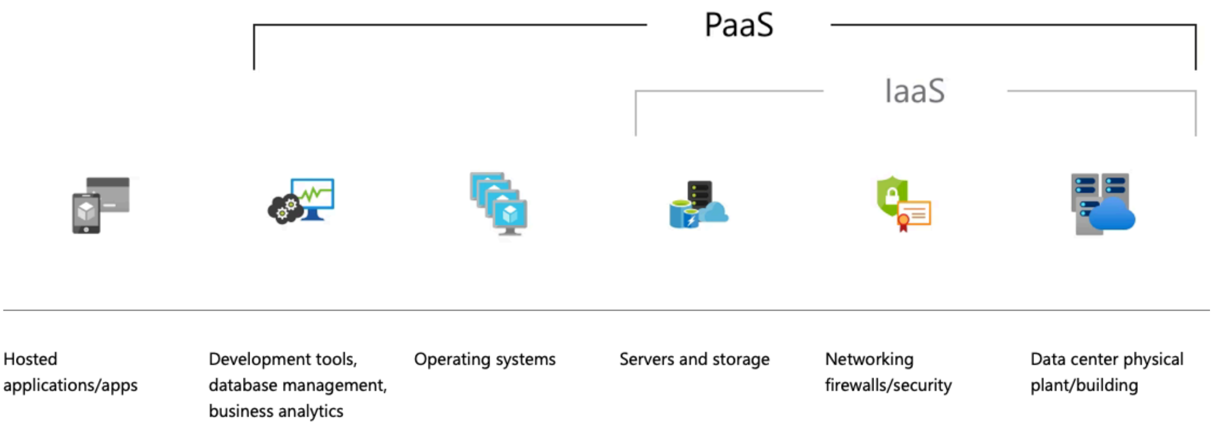


Figure 2 – Platform as a Service architecture (Microsoft, 2023)

The advantages of the PaaS platform are the same as in the case of IaaS, but additional benefits related to the level of abstraction from the OS are added. As part of the PaaS platform, the customer is usually supplied with tools supporting agile development and a container approach. Examples of these tools are Kubernetes and Docker. Thanks to this, it is possible to focus only on the application logic without the need for detailed knowledge of the OS and services necessary for the application. The typical charging model is again the "pay-as-you-go" model. Common business scenarios for PaaS (Microsoft, 2023):

- development architecture (typical cloud functions enable the possibility of integrating software components. New software can be developed more easily, and lower demands are placed on the amount of code and developers);
- analytical and business intelligence functions (the services included in the PaaS include direct support and tools for analyzing and mining knowledge from data);

In some cases, disadvantages directly related to this service delivery model include excessive connection with the CSP and its specific environment. This is because CSP provides a certain development platform that may not be completely standardized with other CSPs. Alternatively, other CSPs do not support the required programming language. At the same time, this implies another disadvantage, namely that the environments of individual CSPs can be significantly different. (Hurwitz & Kirsch, 2020; Parast, and others, 2022)

These services include Microsoft Azure App Service, Amazon web services, Red Hat OpenShift and Oracle Cloud Infrastructure, and Google App Engine.

2.2.3 Software as a Service

Software as a Service (SaaS) is the most popular service delivery model with CC among customers. This model tends to be the gateway to the world of CC for most customers, as this model provides the most used applications. When using this model, the customer leaves the complete management of the entire environment to the CSP, including the management and backup of the data storage and the application itself. Many SaaS applications are designed to support the implementation of certain business processes. An example can be a Customer Relationship Management (CRM) type application that will provide comprehensive support for the customer relationship management process. Other typical applications are Document Management Systems (DMS), Enterprise Resource Planning (ERP), email services, office application packages, and project management support. A graphical representation is shown in figure 3. In most cases, the application on the SaaS platform is charged with a fixed payment per user for a certain time (typically a month or a year). Alternatively, purchasing a certain storage size or the number of times a certain action is run for a fixed payment is possible. (Hurwitz & Kirsch, 2020)

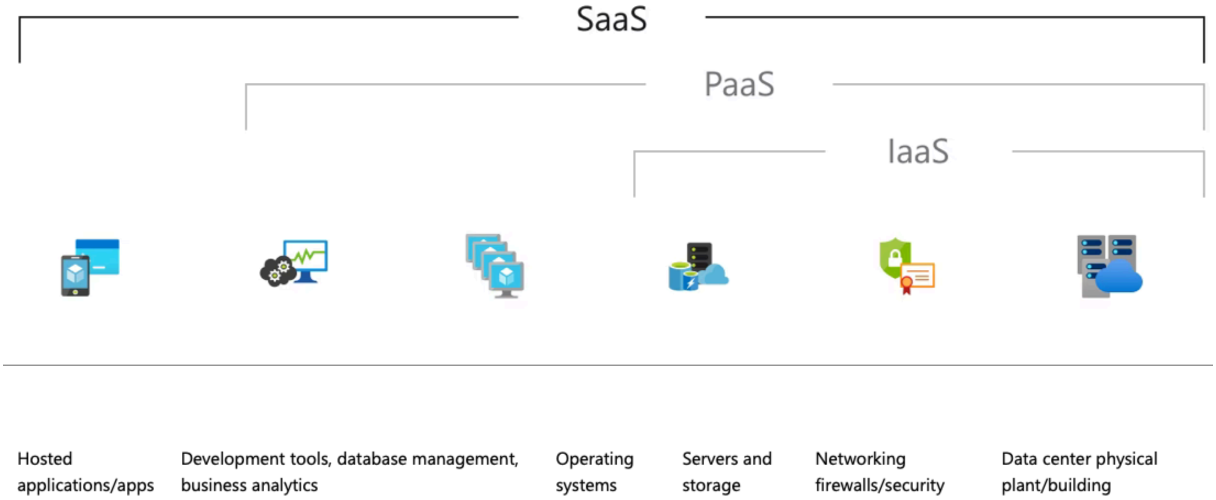


Figure 3 – Software as a Service architecture (Microsoft, 2023)

Applications on the SaaS platform offer several technological and financial benefits. Companies can deploy and use these applications very quickly. Most providers offer self-service features to their environment, thanks to which customers can almost immediately deploy a new application, change the number of users, the size of storage, etc. Some CSPs equip their applications with an environment where individual-process variant support can be quickly configured. Ad-hoc configuration can be done without programming knowledge, and the customization process is accelerated and simplified. The applications are ready for rapid scaling, so if, for example, the space for company documents runs out, the application is ready to immediately increase this space and immediately index the inserted documents, thus enabling continuous searching in the entire storage. Another advantage is linked to application integration. Companies very often run several applications that require mutual integration. For these cases, CSPs have a prepared environment to implement these integrations. (Hurwitz & Kirsch, 2020; Singh, Sharma, Kumar, & Yadav)

Regarding applications at one CSP, these integrations are usually pre-prepared, and you only need to turn them on. Again, an application is developed by the CSP to provide this service for on-premise use. The SaaS platform also contributes to the easy activation of workers or home-office support. The company always pays only for such resources it consumes. At the same time, CSPs for applications on this platform use a technique known as continuous development and deployment. Hence, the customer always has the latest functions in support of current legislation without interrupting the operation of the application. Common SaaS business scenarios (Microsoft, 2023):

- web services provided free of charge (email portals – Hotmail, Gmail, portals provided by state organizations for the management of various agendas), which the user accesses via a web browser or a client application;
- applications and tools rented by the organization to support the business process (tools for collaboration and calendars, CRM, ERP, DMS;

There are also certain disadvantages associated with this solution. One of them is the possibility of customization. CSP guarantees a certain availability of services without outages. However, they must have sufficient control over the program code to do this. If the organization has a specific process that is different from normal behavior, making such a program modification can be very difficult and, in some cases, impossible. When an organization needs complex adjustments, entering a partnership directly with a CSP or a third-party organization providing consulting services is necessary. In the case of using a wider portfolio of services, the customer is, to some extent, confined to only one ecosystem, from which there may not be an easy path to competing products. (Hurwitz & Kirsch, 2020)

Business applications include Slack, Google Workspace apps, Microsoft 365, Adobe Creative Cloud, Mailchimp, and Trello.

2.2.4 Other as a Service models

In addition to the mentioned models, we can find several other services in the literature, referred to as "as a Service". These other services are always very similar to one of the three mentioned models and are built on one of these models. At the same time, they are optimized for a certain application, so they create their "own" as and Service model. Examples are models (Alouffi, and others, 2021; IBM, 2023; VMWare, 2023; TIBCO, 2023):

- FaaS – Function as a Service (PaaS with ad hoc execution) to optimize costs but increase latency;
- DaaS – Data as a Service or Desktop as a Service, BDaaS – Big Data as a Service (SaaS with optimization for big data processing);
- CaaS – Container as a Service;
- BaaS – Backup as a Service;

2.3 Big Data

The available definitions for BD describe this phenomenon with its properties, designated as the three R's (or, in English, the three V's). Alternatively, they define BD as data that comes in larger volumes and at a greater speed than other data. In a simplified way, data sets belonging to the group BD could be characterized as complex data sets originating from new sources (for example, social networks). It is typical for these data sets that their volume and complexity make them unprocessable for conventional data processing methods. (Sagiroglu & Sinanc, 2013) The three V's for BD are (Oracle, 2023):

- volume – the size of data sets is usually larger than several terabytes; examples can be various communication threads from social networks, sequences of clicks on web pages or in applications, data from sensors located on production equipment or means of transport;
- velocity – velocity is required not only for BD itself but also for processes and reactions to the values themselves, data can come in batches or also in real-time from devices connected to the internet, and if the benefit from the evaluation is to be maximized, the evaluation must also take place in real-time;
- variety – variety is what makes BD big. Traditional data sources are structured and fit exactly into the structure of relational databases; on the other hand, new data sources represent data that is semi-structured or unstructured, and this data presents a challenge for their analysis, assigning meaning to this data is a very non-trivial task;

The term BD is also increasingly associated with value and credibility. BD has its value, which a company can only use when it discovers it. Finding the value that BD contains requires a functional discovery process. The discovery process requires analysts, users, and executives who can ask the right questions and recognize specific patterns. Along with this, the reliability of the data is also important because if the data is not accurate, it is impossible to rely on it. (Kitchin & Mcardle, 2016)

Transnational technology giants are already able to benefit from BD and, thanks to it, offer their customers more perfect products and, at the same time, make more accurate and precise business decisions. With the development of open-source tools come tools that a wider range of companies can use. In addition, with the advent of the Internet of Things (IoT), other sources of large data sets are created that can be processed and analyzed. (Sagiroglu & Sinanc, 2013)

To give a better idea of what data companies can analyze, we provide some examples of the possible uses and benefits of BD analysis (Oracle, 2023; European Parliament, 2023):

- health care – clinical decision support systems, improvement of diagnostics, treatment, and development of medicine;
- public sector – increasing the efficiency and effectiveness of public services, offering better-adapted services;
- retail – analysis of shop behavior, optimization of offer and price, product placement, optimization of distribution and logistics, web markets;
- production – more accurate forecasting of demand, planning of supply chain and production cycle, analysis of needs and requirements of target customers;
- location data – geographically targeted advertising, emergency response, smart routing;

Despite the wide range of possible applications, the question is whether small and medium-sized enterprises will see any sense in using this technology and will be interested in investing in implementing new procedures. Working with such large volumes of data is impossible without the necessary tools, procedures, and highly specialized employees. (Oracle, 2023; Sagiroglu & Sinanc, 2013)

2.4 Acceptance models

In the literature and professional articles, we can find several complex methodologies, with the help of which the authors determine individual factors (influences) that have a positive or negative impact when deciding on implementing new technology. These models can explain a greater or lesser part of the observed data. Factors identified as significant may differ for individual geographical areas and according to the representation of individual institutions in the obtained data sample. In the following paragraphs, we will describe the most famous models used to explain companies' acceptance of new technology.

2.4.1 Technology Acceptance Model

The Technology Acceptance Model (TAM) is a model that was established to predict individuals' intention to accept and use a new information system or new information technology. The model was designed by Davis more than 30 years ago (Ali, Gongbing, & Mehreen, 2018). Since then, the asked questions have evolved further, but the essence of the model has remained. The model contains only two basic determinants. The determinants are perceived ease of use and perceived usefulness. These determinants are influenced by external change.

Perceived ease of use represents the degree to which a person believes that using a new information system or other information technology will be effortless. Perceived ease of use has a positive effect on the adoption of new technology, and at the same time, it has a positive effect on perceived usefulness. In general, obtaining information about perceived ease of use with at least three different questions is recommended. Examples of these questions can be both positive and negative (Legris, Ingham, & Collerette, 2003):

- Learning to use a new application / IS is easy for me?
- Is it easy to do what I need in the new application / IS?
- Is new application / IS easy to use?
- Is the new application / IS rigid and inflexible?

Perceived usefulness represents the degree to which a person is convinced that using a new information system or other information technology will contribute to an increase in work performance or an improvement in the quality of work outputs. In general, obtaining information about the perceived usefulness level with at least three different questions is recommended. Examples of these questions are (Legris, Ingham, & Collerette, 2003):

- Will using the new application / IS increase my productivity?
- Will using the new application / IS increase work performance?
- Will using a new application / IS increase efficiency at work?
- Overall, is using the new application / IS useful for my work?

Both determinants have a direct influence on the attitude toward the use of a new information system or other information technology. The attitude towards use, together with the perceived usefulness, has a direct effect on the behavioral interest in using this new technology. Behavioral interest in using this new technology follows the actual use of the technology. (Song & Sohn, 2022)

This section has different approaches to applying this model in professional articles. Some authors omit the use of attitude or behavioral interest in using new technology. In both cases, obtaining information about the level with at least three questions is recommended. The model is shown in figure number 4.

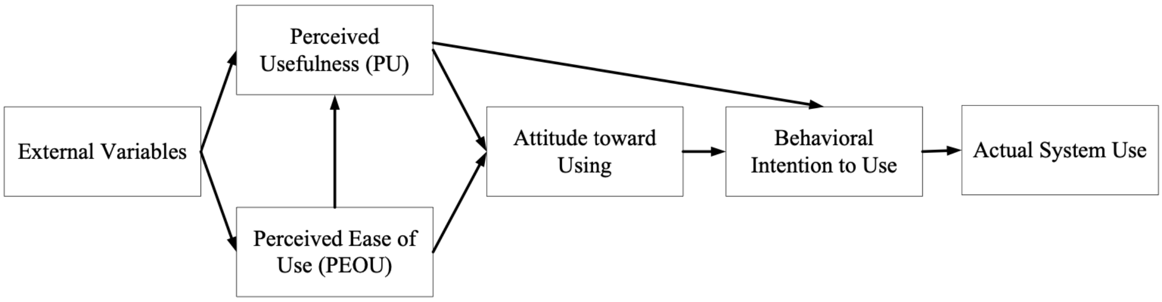


Figure 4 – Technology acceptance model (Chen, Li, & Li, 2011)

In scientific articles, opinions are often repeated that the TAM model can explain between 40% and 50% of the behavioral interest in using new technology and its actual use.

Authors Song and Sohn (Song & Sohn, 2022) conducted research among 230 business managers in South Korea. The authors identified a relationship between the main factors of the TAM model and perceived availability, reliability, and safety. In the resulting model, external factors had a significant effect only on perceived ease of use. Subsequently, perceived ease of use significantly affected the perceived usefulness of CC. A significant effect of perceived usefulness and sustainability was identified on the behavioral intention to use.

Research (Nikolopoulos & Likothanassis, 2018) conducted using the TAM3 model among 138 cloud developers, IT professionals, and managers showed that selected factors influence usage intention. The share of the influence of individual factors was as follows: perceived usefulness (6%), perceived ease of use (6%), subjective norm (13%), work relevance (8%), image (17%), experience (12%), computer own efficacy (18%), perceived enjoyment (10%) and voluntariness (10%).

Research (Gangwar & Date, 2016) conducted in India among 280 companies found that perceived usefulness is strongly influenced by perceived ease of use and external factors such as compliance, vulnerabilities, risks, and threats. External factors such as risk, availability, and support influence perceived ease of use.

Research (Alharbi, 2012) conducted in Saudi Arabia using the TAM model identified external factors influencing users' attitudes toward CC adoption. Among the significant factors were age, education, the field of employment (profession), and nationality. Some factors could be described as discriminatory.

Some authors (Gangwar, Date, & Ramaswamy, Understanding determinants of cloud computing adoption using an integrated TAM-TOE model, 2015) integrate the TOE model into the TAM model, whereby factors from the TOE model represent individual external factors. Within the framework of the study, it was identified that relative advantage, compatibility, complexity, organizational readiness, TOP management, training, and education influence perceived ease of use and usefulness. Furthermore, it was found that competitive pressure and support from business partners directly affect the intention to adopt CC.

2.4.2 Diffusion of Innovation

Diffusion of Innovation (DOI) is a theory that describes and explains how, for what reasons, and at what speed new ideas and technologies spread. An entire book of the same name, authored by Everett M. Rogers, is devoted to this theory. The first edition was published in 1962 (Oliveira, Thomas, & Espadanal, 2014), and the fifth edition was published in 2003. According to the theory, we can identify five stages of the innovation adaptation process. These stages are: "knowledge of the innovation", "conviction about the innovation", "decision", "implementation", and "confirmation". At the same time, during this process, we identify five dimensions that influence the innovation process. These dimensions are: "innovation", "adopters", "way of communication", "time", and "social system". The combination of individual factors and dimensions influences the speed of diffusion of innovation and its acceptance or rejection. First, we will look at the individual stages of the innovation process and their definition (Rogers, 2003):

- knowledge of an innovation – for the first-time information about an innovation reaches an individual who does not yet perceive any motivation to further obtain information related to this innovation;
- belief – the individual becomes interested in the innovation and actively searches for information related to the innovation;

- decision – the acceptance of the change is considered, the advantages and disadvantages of the innovation are compared, and based on this a decision is made and the innovation is accepted or rejected;
- implementation – during this phase, the innovation is gradually adopted, at the same time, additional information related to the innovation and its deployment is sought;
- confirmation – the implementation of the innovation is completed and the decision to introduce the implementation is confirmed as correct, if it is evaluated as incorrect, the use of the innovation can be terminated;

Furthermore, we should identify individual dimensions or groups of factors that influence the process of adopting an innovation. For completeness, we present the full set, as this set of factors was identified by Rogers in his work. However, we state that most scientific articles applying this theory to explain the adoption of CC drop all other groups and leave only innovation-related factors in the model. We pay more attention to these factors.

The first factor associated with innovation is **relative advantage**. Relative advantage represents the degree to which an innovation is perceived as better than current practice. Relative advantage can be perceived from different perspectives, and the specific perspective that will be most important depends on the characteristics of the recipients of the innovation. An example of different perspectives is a certain innovation's economic profit or advantage. Another possible example is perceived social prestige. The implementation of some innovations is thus associated with a certain social status in society. (Rogers, 2003)

The second factor associated with innovation is **compatibility**. Compatibility represents the degree to which the innovation is in accordance with current values, experiences from past periods, with the needs of the recipients of the innovation. The theory is that the more compatible an innovation is, the less uncertainty the recipient of the innovation has. The innovation is perceived to be closer to the current situation. Innovation can be compatible or incompatible with sociocultural values and beliefs, previously presented ideas, with the need to innovate. (Rogers, 2003)

A third factor associated with innovation is **complexity**. Complexity represents the extent to which an innovation is perceived as difficult to understand and use. Some innovations can be very easy to understand and implement. On the other hand, some require a deeper understanding of the problem and the contribution of innovation to its solution. This factor is understood as negative. The more the innovation is perceived as complex, the more likely the company will decide not to accept it. (Rogers, 2003)

A fourth factor associated with innovation is **trialability**. Trialability represents the level to which a potentially interested party can become familiar with the innovation without trying to adopt it. In this way, it is possible to non-violently and effectively convince the recipient of the innovation about the suitability of the innovation. This factor has a more pronounced influence in the case of "early adopters". (Rogers, 2003)

The fifth factor associated with innovation is **observability**. Observability represents the degree to which the results achieved through innovation are observable by others. Again, some innovations can have observable results. The more the authors of the innovation manage to draw attention to the positive results of the innovation, the more likely the innovation will be accepted globally. (Rogers, 2003)

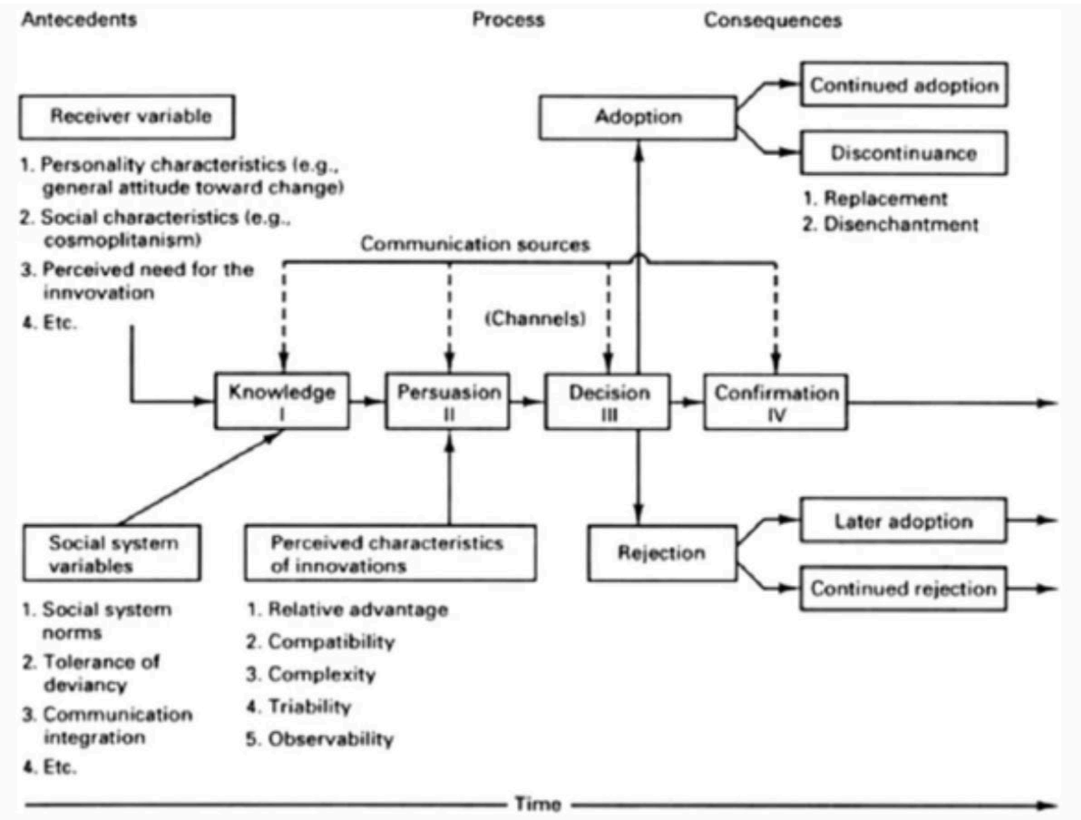


Figure 5 – Diffusion of Innovation framework (Rogers, 2003)

Because the adoption of an innovation is not influenced only by the characteristics of the innovation itself but by the recipients of the innovation themselves, Rogers defined five basic groups of adopters in his book. The adoption of an innovation follows an S-curve over time.

The S curve is shown in figure 6. Individual types of adopters then determine when the innovation is adopted. The categories of adopters then follow a normal distribution curve. Adopter groups are (Rogers, 2003):

- innovators – they are characterized by a high-risk tolerance that allows them to adopt new technologies, possible failures are absorbed by high financial liquidity, apart from financial liquidity they also have a high social status and close contact with scientific resources and other innovators;
- early adopters – these groups are a bit more discreet than innovators, they proceed more judiciously when choosing innovations, and the choice of innovations is chosen in such a way as to maintain their position but not threaten it, they are financially stable and have a certain social status compared to latecomers;
- early majority – this group has an above-average social status, but rarely belongs to the leaders in any field, with the selection and adoption of innovations coming after a significantly longer time than the previous two groups;
- late majority - approaches innovation with a high degree of skepticism and accepts the innovation only after it has been accepted by the majority of society, social status tends to be below average and financial liquidity is low;
- latecomers – they usually focus on traditions, usually do not show any opinion leadership, and approach innovations very skeptically, they also have the lowest financial liquidity;

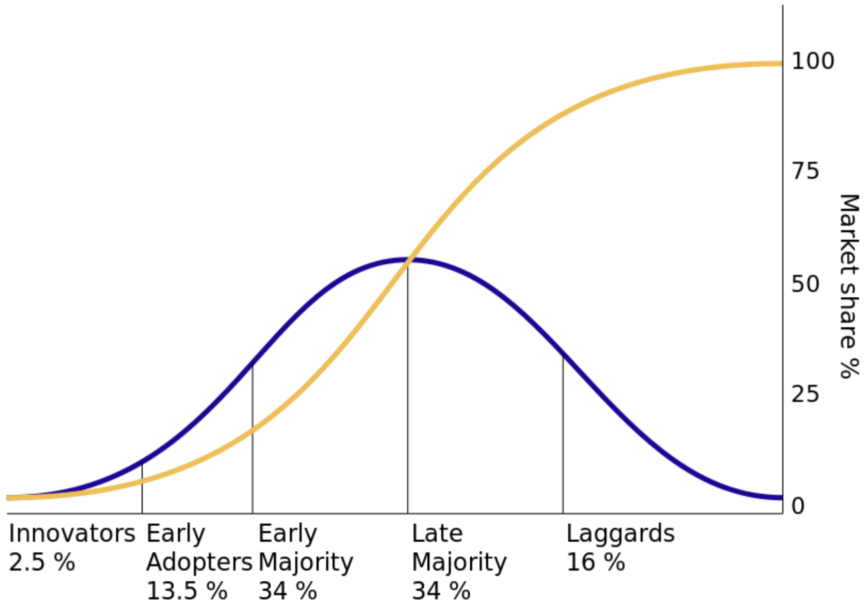


Figure 6 – S-curve of innovation adoption (Rogers, 2003)

The mode of communication represents the degree to which individuals talk and spread information about an innovation. The theory is based on two communication channels:

- mass media – effective in creating knowledge about innovation;
- interpersonal channels – especially effective in changing attitudes towards innovation, subjective evaluation from close people and colleagues is very influential;

Time represents involvement in the process from several different perspectives. One of the aspects is the course of the innovation adoption process. Time represents the time from the first acquaintance with the innovation to the final acceptance or rejection of the innovation. Another point of view is the diffusion of innovation across individual groups of recipients of the innovation. A certain time interval is needed before the innovation gets from the innovators to the laggards. The last temporal aspect is the acceptance of innovation in a certain organization among individual members of the organization. In this case, time plays a role in looking at the innovation's final adoption rate. (Rogers, 2003)

The last dimension is the social system, which represents the target group for innovation. The target group can be the employees of a certain institution, a geographical area, or the entire nation. (Rogers, 2003)

A certain problem with this theory is due to the assumptions. This theory assumes rational behavior and, thus, the maximization of one's benefit. The problem is that many people are influenced by irrational influences such as social trends and conventions. Another problem is trying to describe human behavior comprehensively, and in general, we can say that this effort is very difficult, if not almost impossible. Even more so if the theory only follows a one-way flow of information. (Charlebois, Palmour, & Knoppers, 2016)

The authors (Alkhalil, Sahandi, & John, 2017) of a scientific work focusing on CC adoption combined the TOE and DOI models. From the perspective of the theory associated with the DOI model, they identified a significant influence of the relative advantage, complexity, and risk factors. The tested factor was not found to be significant.

A survey conducted among 369 companies in Portugal (Oliveira, Thomas, & Espadanal, 2014) also combined the DOI and TOE approaches. From the perspective of DOI theory, it has been identified that relative advantage and complexity influence CC decision-making. Among other things, only cost savings implies relative advantage, and the safety factor did not significantly affect relative advantage. Compatibility was significant only for a selected subset of enterprises, not the total number of samples.

Many of the reviewed articles applying the DOI theory combine this theory with other theories. A common limitation of many studies is that they only focus on the factors described above but neglect other aspects of DOI theory.

2.4.3 Institutional Theory

Institutional Theory (INT) describes how firms function as institutions. The theory assumes that not every institution's decision is based on rational goals. Other driving forces are defined in institutional theory. These forces are driven by cultural and social factors and concerns about legitimacy. External pressures can influence the actions of people who have decision-making power towards imitating their surroundings or adapting to general procedures known from surrounding institutions that face similar problems and challenges. In other words, a firm as an institution can decide to implement a certain innovation without having sufficient information about it or without evaluating the innovation as positive in terms of benefits for the firm. It is enough that this new technology will be implemented by the company's surroundings, and the company's management will be informed about it. (Ciganek, Haseman, & Ramamurthy, 2014)

Thanks to this behavior, companies can also draw certain advantages. If a company invests in implementing a certain innovation, it undertakes the associated risk and its consequences. In the end, innovation may not benefit the company in any way and can only wear out the company in terms of financial, human, and other resources. By copying the leaders in a certain industry, the company avoids this risk or at least reduces it. The company's behavior is explained by the theory of the existence of three types of external pressures. These species are (Martins, Oliveira, & Thomas, 2016; Oliveira, Martins, Sarker, Thomas, & Popovič, 2019):

- mimetic – this type is represented by the wide adoption of some new technology, without the existence of reliable information about the effect on the functioning of the organization, this type of pressure is created by leaders in the field who adopt the new technology and thanks to copying the decisions of the leaders in the field, the technology is adopted by a wide range of companies in the field, mimetic pressure captures the imitative behavior of companies with an effort to copy success;
- coercive – this type of pressure can be represented by a resource-dominant organization, a parent organization, a legal, governmental, or other official organization that actively works to push for the widespread adoption of some technology, standard, system, or structure that is favored by that organization, it is external pressure from an organization that has some influence on the firm;
- normative – this type of pressure is created based on norms, rules, professional standards, and information shared between firms, pressure is spread from institutions that act on surrounding firms to convince a shared decision that this institution considers correct, the originators of these pressures are mainly the general public, organizational associations, suppliers, customers;

Institutional theory completely neglects the key features of the researched innovation and technology and focuses only on the environment of society. It is unsuitable for a comprehensive evaluation, but it can bring insight into other theories into a certain part of technological and cost-irrational behavior in the adoption decision. (Martins, Oliveira, & Thomas, 2016)

Despite the limitations of this theory, it was used during the research on the adoption of CC by businesses in Ghana (Adjei, Adams, & Mamattah, 2021). Based on 79 samples, the authors of this work concluded that thanks to this theory, they were able to explain 27% of the variance in CC adoption. And the mimetic pressure was the one that had the greatest influence on the final decision.

Research carried out in the public sector in the United Arab Emirates (Alsharari, 2022) points to the finding that institutional theory gains importance, especially in strongly institutionalized societies. In such societies, institutional pressures will generate appropriate organizational responses.

Another research (Tomás, Thomas, & Oliveira, 2018) already combined the INT theory with the TOE model to research in Portugal among 317 companies. The model explained 67.5% of the variance in SaaS adoption. In the model outside of TOP management support and Technology competence, the factor of normative and coercive pressure gained a significant position. The mimetic pressure factor did not prove to be significant.

The research (Martins, Oliveira, & Thomas, 2016) was conducted across 265 companies, combining the DOI and INT theories in the TOE model. Within the framework of the model, it was found that, from the point of view of INT theory, only the factor of normative and coercive pressure influences the adoption of the SaaS platform. The mimetic pressure factor did not prove to be significant.

2.4.4 Technology-Organization-Environment

The theoretical framework of technology-organization-environment (TOE) was proposed in 1990. The authors of this model are Tornatzky and Fleischer. (Skafi, Yunis, & Zekri, 2020) The authors identified three groups of factors – contextual aspects that can influence organizations' decisions to adopt new technology. The individual contexts are also included in the name of the theoretical framework, i.e., the technological, organizational, and environmental contexts. This model is among the most frequently used and frequently modified research frameworks in the information technology environment. Modifications come mainly by integrating other models (DOI, INT) into this model. This makes building on the considerable empirical support of individual applications for this framework possible. (Gui, and others, 2020; Alkhater, Wills, & Walters, 2014)

The individual three contexts include both opportunities for technological innovation and constraints. Because it is a frequently used model, several different modifications of individual factors included in individual contexts are also available. In the following section, the definitions of the individual contexts are presented, along with the most frequently used factors within the context. There have been significant changes compared to the original model from 1990, shown in picture number 7.

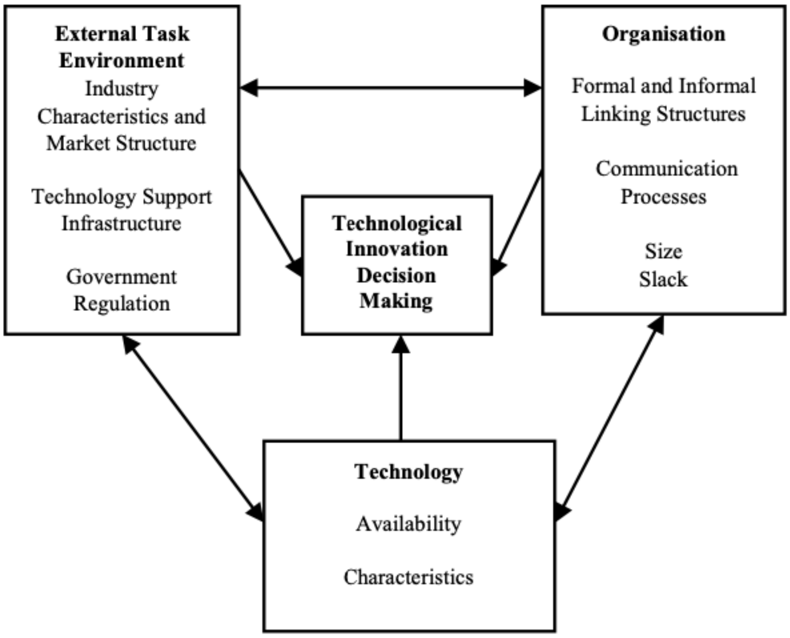


Figure 7 – Technology-Organization-Environment framework (Tornatzky & Fleischer, 1990)

The technological context in this model represents the combination of relevant properties of internal and external technologies. The technology concept includes the devices themselves – hardware, software, and related processes. Examples of individual factors are (Gui, and others, 2020; Alkhater, Wills, & Walters, 2014):

- availability – the information system must be fully functional and ready for use whenever it is needed and must be available to connect from any place it is needed;
- reliability – expresses the ability of the system to perform all the intended functions of the system correctly and as expected, reliability includes ensuring high-quality services for end users with a minimum error rate, fast recovery, and a high level of responsiveness;
- security – relates to the protection of data and the information system against unauthorized access, or other security threats threatening the operation of the information system as a whole;
- trust – is linked to an institution or other entity that provides an information system, trust represents the level to which the firm can rely on and believe in another institution/entity that it will behave as expected;

- customer lock-in – represents a situation where the customer is locked in the ecosystem of a certain supplier and cannot switch to another service/information system supplier without significant investments or in a short time;

Within scientific articles, factors primarily originating from the DOI model are often included in the technological context. Most often, these are relative advantage, compatibility, and complexity.

The organizational context includes the characteristics of the firm. The company's characteristics are determined by the size of the company, the resources available to the company, the degree of centralization, the organizational structure, human resources, ties between employees, or the unused resources of the company. Examples of organizational context factors are (Oliveira, Martins, Sarker, Thomas, & Popovič, 2019; van de Weerd, Mangula, & Brinkkemper, 2016):

- company size – for the needs of the TOE model, the size of the company is defined in a different way than the commonly used division within the European Union, most often the size is determined only according to the number of employees;
- unused resources – unused resources represent the potential that the company can use to implement new information technology, especially unused financial resources;
- technological readiness – represents the level of readiness of the organization for the implementation of new information technology in terms of IT infrastructure and terms of human resources, some authors also include readiness in terms of the company's mental attitude and alignment with the main features of the information system;
- support of top management – support of new technology from senior employees is necessary for making the initial decision to adopt new technology, it also has a significant effect on supporting the certain adaptation of company processes to new technology and consolidation of resources needed to carry out all the necessary steps;
- formal and informal organizational structure – formal and informal relationships within the organization influence the formation of opinions on new technology and decisions on access to this technology, positive communication even within the informal organizational structure can have a positive effect on the acceptance of technology by end-users;

The environmental context includes the company's surroundings. For the model's needs, the company's surroundings are defined by the size and structure of the industry in which the company operates. The environment is further defined by the company's suppliers and customers, the regulations of the entire environment, and to a certain extent, the macroeconomic context. Examples of factors are (Gui, and others, 2020; Oliveira, Martins, Sarker, Thomas, & Popovič, 2019):

- competitive pressure – represents the degree of pressure faced by the company from its competitors, in a highly competitive environment, pressure is exerted on organizations to adopt new technologies to maintain a strategic edge over competitors, this pressure forces some organizations to adopt new technologies in response to their environment;
- compliance with laws – compliance with laws is a very important factor, but only in certain cases, when it comes to areas that are regulated by laws, then ensuring compliance with these laws represents a very strong motive for accepting or, conversely, rejecting new technology;
- government assistance – the government can support the spread of new technologies through its regulations by introducing regulations or supporting incentives such as tax benefits and subsidy titles to support the implementation of new technology;
- pressure from business partners – business partners are an important part of the organization's surroundings and to a certain extent influence the organization's performance, this can positively affect the implementation of new technologies to get closer and strengthen mutual relations;
- location – physical location can be a critical factor due to legal steps and enforceability of data storage and protection regulations, at the same time the service provider needs to inform the customer in which countries their data will be stored;

To further expand the environmental context, it is possible to incorporate institutional theory, which will provide another level of understanding of the influence of the organization's environment on the decision to implement new technology.

Because applications of the TOE model very often overlap with other methodologies, we have chosen a table to present the most frequently achieved outputs, which contains individual factors and frequencies of significant applications. This data is displayed in the 1 table. Please note that the TOE model as it was originally designed cannot be found in the CC application at first glance. For this reason, 1 table contains factors that come from other theories.

Table 1 – TOE framework factors and number of occurrences in the literature with an identified influence on the CC implementation decision (van de Weerd, Mangula, & Brinkkemper, 2016; Zhang, Wnag, & Liang, 2021; Oliveira, Martins, Sarker, Thomas, & Popovič, 2019)

Technological factors		Organizational factors		Environmental factors	
Compatibility	15	Top management support	13	Competitive pressure	5
Relative advantage	14	Organizational size	10	Trading partner pressure	5
Complexity	7	Organizational readiness	5	Government support	5
Data security	7	Innovativeness	1	Industry	4
Trialability	4	Technology-sensing capability	1	Supplier computing support	2
Technology readiness	4	Cloud knowledge	1	Competition intensity	1
Cost savings	4	Resistance to new technologies	1	Market scope	1
Observability	3			SLA	1
Availability	2			Suppliers competences	1
Accessibility	2			Share best practices	1
Uncertainty	1			Advice from friends and families	1
Perceived benefits	1			The advice of business network	1
Reliability	1			Advice from IT specialists and consultants	1
Easy of use	1			Choice of skilled cloud vendors	1

2.4.5 Cost-Based Approach

We find several approaches and claims in the articles devoted to the cost side. In this part, it is necessary to be more specific regarding the investigated element than in previous models. Individual research articles apply different legal approaches to a certain decision-making problem. When it comes to decision-making in the field of new technologies, or in our case, CC, an approach with an evaluation of the total cost of ownership (TCO) is very often implemented. (Walterbusch, Martens, & Teuteberg, 2013; Martens, Walterbusch, & Teuteberg, 2012) Other authors (Makhlouf, 2020) build on the theory of transaction costs and the theory of production costs with specific views on resources. The used theories are divided according to the situation in which the organization finds itself. The first possible situation is that the organization is deciding on the choice of technology. The second situation is that the organization has already decided on the technology, and the costs associated with this decision are subsequently examined.

In our case, we will focus on studies dealing with the decision-making phase. At this stage, the TCO-based approach is most often applied. As part of the project evaluation, the initial stages' costs are the same, regardless of which service or deployment model the company will deal with. Because the costs associated with the initial stages must be spent by the company, regardless of which service it ultimately chooses, we can characterize these costs as irrelevant to the decision. In the next stages, the costs already depend on the selected service, and the structure of cost factors mainly depends on the deployment model. We will focus on the structure of these costs.

This service or component most often defines the cost structure for services based on IaaS. This means that the provider defines the price for a certain volume (Walterbusch, Martens, & Teuteberg, 2013; Martens, Walterbusch, & Teuteberg, 2012):

- used computing power:

$$C_{cp}^{charIaaS} = \sum_{i=1}^{n} a_{cp,i}^{charIaaS} \ x \ p_{cp,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the used computing power ($C_{cp}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per calculation unit at a certain moment ($p_{cp,i}^{charIaaS}$) multiplied by the number of used calculation units at a certain moment ($a_{cp,i}^{charIaaS}$).

- storage size:

$$C_{sto}^{charIaaS} = \sum_{i=1}^{n} a_{sto,i}^{charIaaS} \ x \ p_{sto,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the used storage ($C_{sto}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per storage unit at a certain moment ($p_{sto,i}^{charIaaS}$) multiplied by the number of used storage units at a certain moment ($a_{sto,i}^{charIaaS}$).

- internal data transfer:

$$C_{intdt}^{charIaaS} = \sum_{i=1}^{n} a_{intdt,i}^{charIaaS} \; x \; p_{intdt,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the internal data transfer ($C_{intdt}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per internal data transfer unit at a certain moment ($p_{intdt,i}^{charIaaS}$) multiplied by the number of used internal data transfer units at a certain moment ($a_{intdt,i}^{charIaaS}$).

- size of input/output data:

$$C_{inb}^{charIaaS} = \sum_{i=1}^{n} a_{inb,i}^{charIaaS} \; x \; p_{inb,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the used input data transfer ($C_{inb}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per input data unit at a certain moment ($p_{inb,i}^{charIaaS}$) multiplied by the number of used input data units at a certain moment ($a_{inb,i}^{charIaaS}$).

$$C_{outb}^{charIaaS} = \sum_{i=1}^{n} a_{outb,i}^{charIaaS} \; x \; p_{outb,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the used output data transfer ($C_{outb}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per output data unit at a certain moment ($p_{outb,i}^{charIaaS}$) multiplied by the number of used output data units at a certain moment ($a_{outb,i}^{charIaaS}$).

- the number of queries:

$$C_{que}^{charIaaS} = \sum_{i=1}^{n} a_{que,i}^{charIaaS} \; x \; p_{que,i}^{charIaaS}$$

The formula represents the calculation for the total cost of the used queries ($C_{que}^{charIaaS}$) for the period. The calculation is realized as the sum of the price per query at a certain moment ($p_{que,i}^{charIaaS}$) multiplied by the number of used query at a certain moment ($a_{que,i}^{charIaaS}$).

- numbers of SSL certificates, licenses, domains, and fees of services:

$$C_{dom}^{charIaaS} = n\ x\ p_{dom}^{charIaaS}$$

The formula represents the calculation for the total cost of the used domains $(C_{dom}^{charIaaS})$. The calculation is realized as the price per domain $(p_{dom}^{charIaaS})$ multiplied by the number of used domains (n).

$$C_{ssl}^{charIaaS} = n\ x\ p_{ssl}^{charIaaS}$$

The formula represents the calculation for the total cost of the used ssl certificates $(C_{ssl}^{charIaaS})$. The calculation is realized as the price per ssl certificate $(p_{ssl}^{charIaaS})$ multiplied by the number of used ssl certificates (n).

$$C_{lic}^{charIaaS} = n\ x\ p_{lic}^{charIaaS}$$

The formula represents the calculation for the total cost of the used licences $(C_{lic}^{charIaaS})$. The calculation is realized as the price per licence $(p_{lic}^{charIaaS})$ multiplied by the number of used licences (n).

$$C_{bc}^{charIaaS} = n\ x\ p_{bc}^{charIaaS}$$

The formula represents the calculation for the total cost of the fees of services $(C_{bc}^{charIaaS})$. The calculation is realized as the price per fee of service $(p_{bc}^{charIaaS})$ multiplied by the number of used services (n).

The total price is given by the sum of the price of all components. IaaS represents the easiest way to migrate on-premise services to a CC environment. Still, we must be aware that the total cost can cause a disproportionate increase in costs in the case of migrating applications that are not optimized. At the same time, determining the price is not a trivial operation. Suppose the price is determined, for example, by the use of operating memory. In that case, the company would have to have a perfect overview of the hardware utilization to determine a relatively accurate price. For these very reasons, the authors of professional works recommend this model, especially for computationally intensive applications that only start intermittently.

Regarding services based on PaaS, the situation is very similar. The cost structure is almost the same, but there is also some uncertainty about the total cost, as API usage fees may apply. In addition, the customer cannot influence this part because the API is managed by the service provider. The individual components of the total price are (Walterbusch, Martens, & Teuteberg, 2013; Martens, Walterbusch, & Teuteberg, 2012):

- used computing power:

$$C_{cp}^{charPaaS} = \sum_{i=1}^{n} a_{cp,i}^{charPaaS} \ x \ p_{cp,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used computing power ($C_{cp}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per calculation unit at a certain moment ($p_{cp,i}^{charPaaS}$) multiplied by the number of used calculation units at a certain moment ($a_{cp,i}^{charPaaS}$).

- user-dependent amount of data and document, storage capacity:

$$C_{udats}^{charPaaS} = \sum_{i=1}^{n} a_{use,i}^{charPaaS} \ x \ p_{udats,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used user data storage ($C_{udats}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per user data storage unit at a certain moment ($p_{udats,i}^{charPaaS}$) multiplied by the number of used user data storage units at a certain moment ($a_{udats,i}^{charPaaS}$).

$$C_{udots}^{charPaaS} = \sum_{i=1}^{n} a_{use,i}^{charPaaS} \ x \ p_{dots,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used user document storage ($C_{dots}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per user document storage unit at a certain moment ($p_{dots,i}^{charPaaS}$) multiplied by the number of used user document storage units at a certain moment ($a_{dots,i}^{charPaaS}$).

$$C_{sto}^{charPaaS} = \sum_{i=1}^{n} a_{sto,i}^{charPaaS} \ x \ p_{sto,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used storage $(C_{sto}^{charPaaS})$ for the period. The calculation is realized as the sum of the price per storage unit at a certain moment $(p_{sto,i}^{charPaaS})$ multiplied by the number of used storage units at a certain moment $(a_{sto,i}^{charPaaS})$.

- input and output data size:

$$C_{inb}^{charPaaS} = \sum_{i=1}^{n} a_{inb,i}^{charPaaS} \; x \; p_{inb,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used input data transfer $(C_{inb}^{charPaaS})$ for the period. The calculation is realized as the sum of the price per input data unit at a certain moment $(p_{inb,i}^{charPaaS})$ multiplied by the number of used input data units at a certain moment $(a_{inb,i}^{charPaaS})$.

$$C_{outb}^{charPaaS} = \sum_{i=1}^{n} a_{outb,i}^{charPaaS} \; x \; p_{outb,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used output data transfer $(C_{outb}^{charPaaS})$ for the period. The calculation is realized as the sum of the price per output data unit at a certain moment $(p_{outb,i}^{charPaaS})$ multiplied by the number of used output data units at a certain moment $(a_{outb,i}^{charPaaS})$.

- databases, secure connections, and connection to other services:

$$C_{db}^{charPaaS} = \sum_{i=1}^{n} a_{db,i}^{charPaaS} \; x \; p_{db,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used database $(C_{db}^{charPaaS})$ for the period. The calculation is realized as the sum of the price per database at a certain moment $(p_{db,i}^{charPaaS})$ multiplied by the number of used databases at a certain moment $(a_{db,i}^{charPaaS})$.

$$C_{seclog}^{charPaaS} = \sum_{i=1}^{n} a_{seclog,i}^{charPaaS} \ x \ p_{seclog,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used secured connections ($C_{seclog}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per secured connection at a certain moment ($p_{seclog,i}^{charPaaS}$) multiplied by the number of used secured connections at a certain moment ($a_{seclog,i}^{charPaaS}$).

$$C_{con}^{charPaaS} = \sum_{i=1}^{n} a_{con,i}^{charPaaS} \ x \ p_{con,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the used connections to other services ($C_{con}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per connection to other service at a certain moment ($p_{con,i}^{charPaaS}$) multiplied by the number of used connections to other services at a certain moment ($a_{con,i}^{charPaaS}$).

- API fees:

$$C_{api,i}^{charPaaS} = \ a_{api,i}^{charPaaS} \ x \ p_{api,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the API fees ($C_{api,i}^{charIaaS}$). The calculation is realized as the price per API fee ($p_{api,i}^{charIaaS}$) multiplied by the number of used APIs ($a_{api,i}^{charPaaS}$).

- sent emails:

$$C_{email}^{charPaaS} = \sum_{i=1}^{n} a_{email,i}^{charPaaS} \ x \ p_{email,i}^{charPaaS}$$

The formula represents the calculation for the total cost of the sent emails ($C_{email}^{charPaaS}$) for the period. The calculation is realized as the sum of the price per sent email at a certain moment ($p_{email,i}^{charPaaS}$) multiplied by the number of sent emails at a certain moment ($a_{email,i}^{charPaaS}$).

SaaS-based services are usually charged based on the price per application and the number of active users. Alternatively, some providers offer billed services based on the number of runs.

Then the purchased packages are in certain quantities, and if the customer consumes all the runs of the application, then he buys another count of runs. The last price factor is the volume of stored data. Again, the provider offers packages of a certain amount of data. The individual price factors are therefore (Walterbusch, Martens, & Teuteberg, 2013; Martens, Walterbusch, & Teuteberg, 2012):

- the number of active users in the application:

$$C_{acc}^{charSaaS} = \sum_{i=1}^{n} a_{use,i}^{charSaaS} \; x \; p_{acc,i}^{charSaaS}$$

The formula represents the calculation for the total cost of the active users in the application ($C_{acc}^{charSaaS}$) for the period. The calculation is realized as the sum of the price per user in application at a certain moment ($p_{acc,i}^{charSaaS}$) multiplied by the number of users at a certain moment ($a_{use,i}^{charSaaS}$).

- the number of runs (usually package):

$$C_{run}^{charSaaS} = \sum_{i=1}^{n} a_{run,i}^{charSaaS} \; x \; p_{run,i}^{charSaaS}$$

The formula represents the calculation for the total cost of the used runs (packages) ($C_{run}^{charSaaS}$) for the period. The calculation is realized as the sum of the price per run at a certain moment ($p_{run,i}^{charSaaS}$) multiplied by the number of runs at a certain moment ($a_{run,i}^{charSaaS}$).

- storage capacity:

$$C_{sto}^{charSaaS} = \sum_{i=1}^{n} a_{sto,i}^{charSaaS} \; x \; p_{sto,i}^{charSaaS}$$

The formula represents the calculation for the total cost of the used storage ($C_{sto}^{charSaaS}$) for the period. The calculation is realized as the sum of the price per storage unit at a certain moment ($p_{sto,i}^{charSaaS}$) multiplied by the number of used storage units at a certain moment ($a_{sto,i}^{charSaaS}$).

Of all the models, this is the simplest charging approach, making it very easy for customers to determine the total price for the services they need.

The aim of the presentation of the method of calculating the total costs for individual solutions is primarily to point out the complexity of determining the total costs of CC in the provision of services based on IaaS and PaaS. In context with the simplicity of total cost calculation for SaaS-based CC services. It is the determination of the costs of a certain solution that could enter the decision-making process and explain the use of services based on a certain CC model.

Many articles on the topic of costs were published. If they contained any specific comparison, then it was a case study. Based on the choice of services, it was then evaluated which solution was more suitable. However, in our opinion, a general generalization as to whether CC is cheaper is not possible. Generally, one can agree that CC can be more suitable for small and medium-sized enterprises, which can also realize savings for IT experts. In the case of large companies, we expect the suitability of an on-premise solution, thanks to which sufficiently large operations can realize economies of scale.

2.4.6 General characteristics of outsourcing

Because CC is a certain form of outsourcing, we will also list the reasons why some companies choose IT outsourcing instead of running IT by their employees. These reasons are general and do not come from scholarly articles focused on CC but from scholarly articles focused on IT outsourcing in general. First, we will list the positive features associated with outsourcing (Gonzalez, Gasco, & Llopis, 2010):

- focus on strategic issues – thanks to the separation of all non-strategic functions, the company can benefit from simplifying the relationship with the IT department and the IT department can focus only on its core competencies, the most routine actions can be carried out by an external company and also take responsibility for hardware and software updates;
- increasing flexibility – outsourcing can contribute to equalizing fluctuations in work levels and, at the same time, achieve sufficient flexibility when adopting new technologies, responding to client requirements and needs, during company reorganization, or restructuring;
- quality improvement – the reason for improving the quality of services should be the provider's access to more advanced technologies, the ability to employ motivated and

educated workers in a specific field, the possibility to share amortization among several clients;

- getting rid of routine tasks – many activities performed by the IT department are still repetitive and without added value for the company;
- facilitating access to technologies – outsourcing appears to be an effective way to experiment with new technologies, as the company does not have to invest in them, at the same time, leasing new technology reduces the risk of its failure;
- reduction of the risk of obsolescence – in times of rapid IT development, the company has the option of constantly investing in renewing IT technologies, or staying with a certain version until it becomes obsolete, outsourcing removes this dilemma by having an external company assume responsibility for updating technologies;
- cost savings for employees – because there is a rapid development of IT technologies, there is also a rapid deterioration of the level of knowledge of an IT specialist without his constant training, this training entails several costs, when the worker spends time improving his knowledge, on the other hand, a normal company does not need IT staff with expertise all the time, which leads to outsourcing as an effective tool;
- cost savings – cost savings are based on the assumption that the company providing outsourcing services can realize economies of scale, and also because in job is to solve IS problems, it can be assumed that it knows these problems and their effective solutions;
- transformation of the cost structure – from a certain time horizon (short period), outsourcing has the effect of transforming fixed costs into variable ones, and if the contract is designed appropriately, these are predictable costs;
- access to alternative resources – thanks to outsourcing, the company does not have to rely only on its resources, but also has access to external IT resources;

Apart from the expected positive benefits of outsourcing, it is also necessary to consider some risks associated with this model, examples of these risks are (Gonzalez, Gasco, & Llopis, 2010):

- personnel qualification – a possible pitfall is that in the initial stages of establishing cooperation, the customer comes into contact with the best employees of the service provider, but after the conclusion of the contract, the provider does not take the initiative and follows the customer's instructions;
- excessive dependence – the customer's inability to precisely define their needs can cause lock-in with one provider, as they will not be able to define their requirements sufficiently to possibly address the competition;
- lack of compliance – a risk arising from the contractual relationship, because the client may not receive the performance that he expects from the supplier;
- loss of knowledge – outsourcing very often means slacking off in the training of its employees, and thus the client may lose important knowledge that his regular employees would have to have;
- failure to adapt to technology – the service provider may neglect or completely miss the introduction of new technology, and this reluctance to innovate will subsequently affect its customers;
- hidden costs – costs that are not invested directly according to the contract, but will arise anyway, such as data transfer costs, selection of a suitable solution, etc.;

3 Current situation

In this section, we provide a broader view of the use of selected information and communication technologies in the Czech small and medium-sized enterprises sector. Along with monitoring selected technologies, we also add information about workers from the field of information technology, used applications, and other factors that we perceive as related to the issue. The data presented are drawn from the Czech Statistical Office, which annually issues a report on the use of ICT. The published statistics are published annually. In terms of selected indicators, the content of individual statistics differs slightly from year to year, even in relation to the current situation. At the same time, it should be added that the last few years were not among the standard ones, but the year 2020 was marked by the COVID pandemic, then the year 2022 was affected by global events in Ukraine, which was reflected in the energy crisis. Also, for these reasons, the questionnaire's content published in the direction of businesses changed. Therefore, if possible, we will look at 2019 as a baseline for individual data and then at the latest available period. Another important piece of information is that, for these statistics, the

CZSO divides enterprises according to size into three categories according to the number of employees:

- 10 to 49 employees;
- 50 to 249 employees;
- 250 or more employees;

For this publication, values for small and medium-sized enterprises are monitored only. Large businesses are not part of the target focus.

3.1.1 Cloud computing

The data presented in this chapter are devoted to the overall use of CC and, together with it, to individual types of applications used by small and medium-sized enterprises. Paid services provided in the form of CC in table 2 are included in the statistics. The presented data represent the percentage of businesses using a certain service from all businesses that fall within a given size. Since there was no evaluation in 2019, data from the surrounding years, i.e., 2018 and 2020, are presented. N/A is used for data that are not available. In 2021, the office software section was not presented in the public statistics of the Czech Statistical Office. Therefore, this data comes from the Eurostat database. As part of drawing this data, a check was made to see if the other data associated with using other types of applications agreed with the data from the Czech Statistical Office. Because no difference was found, we assume that only the Czech Statistical Office does not present this section, but the data have the same source.

Table 2 – Percentage representation of companies using selected CC services in the Czech Republic (Český Statistický Úřad, 2023; Eurostat, 2023)

period	service	10-49 emp.	50-249 emp.
2021	e-mail	33.7	38.7
	document storage and sharing	24.5	33.1
	office SW*	35.7	40.8
	security SW	34.5	33.0
	database system	11.5	20.5
	financial and accounting applications	23.4	20.7
	ERP	6.4	14.9
	CRM	6.1	10.7
	computing power to run your applications	4.2	5.4
	overall	42.1	47.2
2020	e-mail	20.3	29.0
	document storage and sharing	16.6	24.7
	office SW	15.9	24.0
	security SW	N/A	N/A

	database system	10.3	15.2
	financial and accounting applications	10.5	12.8
	ERP	N/A	N/A
	CRM	6.6	9.0
	computing power to run your applications	7.5	13.9
	overall	25.7	36.9
2018	e-mail	18.9	25.2
	document storage and sharing	14.8	23.0
	office SW	12.8	20.4
	security SW	N/A	N/A
	database system	8.5	11.6
	financial and accounting applications	8.6	9.8
	ERP	N/A	N/A
	CRM	4.7	7.6
	computing power to run your applications	3.5	7.3
	overall	23.8	34.3

* data comes from Eurostat

Because certain applications are also available for free on the market, the Czech Statistical Office began to determine the share of these services in the total representation. This data is only available from 2021 and only for certain applications. The current status is presented in table number 3. The presented data represent the percentage representation of companies using the application in relation to all companies belonging to the given group.

Table 3 – Percentage representation of companies using selected free CC services in the Czech Republic (Český Statistický Úřad, 2023)

service	10-49 emp.	50-249 emp.
e-mail	32.3	19.0
document storage and sharing	20.8	20.9
other services	24.4	17.8

3.1.2 Commonly used business applications

The Czech Statistical Office also investigates the use of selected information systems or applications. The use of basic enterprise IS is shown in table number 4. We are monitoring this data to determine the potential for the expansion of adequate CC-based applications. The presented data represent the percentage of businesses using the given application from the total number of businesses falling within the given size.

Table 4 – Percentage representation of companies using the selected IS in the Czech Republic (Český Statistický Úřad, 2023)

period	used IS	10-49 emp.	50-249 emp.
2021	ERP	29.2	63.7
	CRM	14.1	28.7
	SCM	5	12.2

2019	ERP	28.7	68.0
	CRM	19.2	39.1
	SCM	4.9	9.9

3.1.3 Big Data

Statistics regarding the use of BD for the comparable period are not available on the website of the Czech Statistical Office nor the publicly accessible part of Eurostat. The most recent data provided by the Czech Statistical Office are data for the period of 2019. To illustrate the use of BD by Czech small and medium-sized enterprises, we show the development from 2015 to 2019 in table number 5. These data are extended by data for 2020 coming from Eurostat. The data represent the percentage representation of companies using BD in relation to all companies from the given size group. Because there is not a very dynamic development, we show the sources of BD only for the period of 2019 in table number 6. The data represent the percentage representation of companies using a certain source of BD in relation to all companies from the given size group. Each business can combine different sources, so data between individual sources cannot be added together. We assume that this statistic has not been monitored because of the low dynamics and overall representation of companies that use BD in recent years.

Table 5 – Percentage representation of companies using Big Data in the Czech Republic (Český Statistický Úřad, 2023; Eurostat, 2023)

period	10-49 emp.	50-249 emp.
2015	6.7	13.5
2017	6.2	12.6
2019	7.4	13.5
2020*	7.3	13.5

* data comes from Eurostat

Table 6 – Percentage representation of companies using the selected data source in 2019 in the Czech Republic (Český Statistický Úřad, 2023)

data sources	10-49 emp.	50-249 emp.
production and logistics activities	1.2	3.5
location data	4.4	7.8
data from social networks and media	2.8	4.9
data from other sources	3.4	6.3

When researching, the reports of the Czech Statistical Office for individual periods led us to the Internet of Things (IoT). Table 7 shows the individual sources for the use of IoT by small and medium-sized enterprises in 2021. The data represents the percentage of businesses using a particular IoT data source and size group versus all businesses in that size group. Again, businesses can combine individual data sources.

Table 7 – The percentage of companies using IoT in the Czech Republic (Český Statistický Úřad, 2023)

IoT	10-49 emp.	50-249 emp.
total usage	28.2	40.8
object security	23.1	35.8
monitoring the operational status of machines/vehicles	9.7	16.8
energy consumption monitoring	6.4	16.7
production process monitoring	4.2	12.6
monitoring of goods during transport	3.3	6
monitoring customer behavior	3.8	4

3.1.4 Professional IT staff

To create a broader view of the use of IT in small and medium-sized enterprises, it can also help to look at whether companies have enough professional workers in IT departments. According to the data from the Czech Statistical Office shown in table 8, there has not yet been a significant development in terms of the representation of companies that employ IT experts. The data shows the percentage representation of companies directly employing IT experts as regular employees compared to all companies of the given size group.

Table 8 – Percentage representation of companies employing IT specialists in the Czech Republic (Český Statistický Úřad, 2023)

period	10-49 emp.	50-249 emp.
2022	12.4	38.3
2019	12.7	40.8

Because, in the case of small and medium-sized enterprises, not even half of the entities employ IT, experts, we supplement the table with an overview of information on who performs IT-related activities in the company. This data is displayed in table number 9. The data again represent the percentage representation of companies for a given indicator and size group in relation to all companies from a given group by size. In a company, IT-related activities can be divided between several workers belonging to different groups of indicators. The data for individual indicators cannot be added up.

Table 9 – Percentage representation of companies by the person performing IT activities in the Czech Republic (Český Statistický Úřad, 2023)

period	who performs the activity	10-49 emp.	50-249 emp.
2022	employees of the company	32.5	52.3
	employees of the parent company/group	11.9	31.8
	external workers	69.7	72.0
	no one	9.6	2.3
2019	employees of the company	11.9	39.0
	employees of the parent company/group	12.4	31.9
	external workers	77.9	85.6
	no one	N/A	N/A

3.1.5 Internet access and work from home

A certain factor limiting the adoption of CC may be the ability of businesses to provide fast enough Internet connections. From the point of view of the Internet connection, described in table number 10, we see that there is an evolution in the speed of the connection. The presented data represent the percentage of enterprises from the given size group and indicators against all enterprises from the given size group.

Table 10 – Percentage representation of companies according to internet access in the Czech Republic (Český Statistický Úřad, 2023)

period	connection	10-49 emp.	50-249 emp.
2021	Internet access	95.2	98.9
	≥ 30 Mbit/s	72.3	81.5
	≥ 100 Mbit/s	37.1	38.6
2019	Internet access	96.4	99.5
	≥ 30 Mbit/s	34.3	56.8
	≥ 100 Mbit/s	11.1	22.9

Support for working from home is also related to the Internet connection and CC. This data has only been monitored since the arrival of the COVID-19 pandemic, so statistics for a longer period are not available. The data presented in table 11 is for 2021. The data represents the percentage of businesses for a certain indicator and size group relative to all businesses in the size group.

Table 11 – Percentage representation of companies according to the available application from the home office in the Czech Republic (Český Statistický Úřad, 2023)

application	10-49 emp.	50-249 emp.
e-mail	64.8	88.5
company documents and files	56.3	84.5
corporate applications and IS	55.7	82.4

3.1.6 Legislation

According to available sources, Czech legislation does not consider CC a legal subject. According to Jansa (Jansa, Otevřel, & Števko, 2018), the law surrounding CC is a combination of telecommunications, software, internet law, and the law of data protection, personal data, and cyber security. It is also stated in the literature that a certain fragmentation is due to the youth and dynamism of software law. This section provides only a very brief overview of the company, assuring that subject to the fulfillment of selected conditions, they can store any data in the CC even outside the territorial territory of the Czech Republic, as well as information on the existence of a framework for the obligation to protect this data by the CC provider. (Hlaváčová & Chorvát, 2023)

From the point of view of Czech law, the Act on Cyber Security was adopted, which was subsequently harmonized according to the Directive of the European Parliament and the Council (European Union, 2023) (EU) 2016/1148 in the form of an amendment to the Act on Cyber Security No. 205/2017 Coll. In relation to the monitored issue, this law defines the obligations of the service provider, in particular, information security management, asset and risk management, organizational security, technical measures, cyber security audit, and security policy and documentation. Czech law further regulates CC regarding specific crimes committed in cyberspace (protection of data and information stored on CC repositories) by Act No. 40/2009 Coll., Criminal Code. On the contrary, from the point of view of access by criminal authorities to data stored on CC, the law is not very accommodating due to the principle of territoriality, and there is a need for the police authority to proceed within the framework of international judicial cooperation.

From the point of view of EU law, great attention is paid to the protection of personal data, which is described in the Regulation of the European Parliament of 27 April 2016 on the protection of natural persons in connection with the processing of personal data and on the free movement of such data and the repeal of Directive 95/46/ES (GDPR). (Europen Union, 2023) CC support from the point of view of the European Union is addressed by the Regulation of the European Parliament and of the Council (EU) of 14 November 2018 on the framework for the free flow of non-personal data in the European Union, which introduced the unrestricted movement of all data within the EU. According to NŮKIB (Národní úřad pro kybernetickou a informační bezpečnost, 2022; Národní úřad pro kybernetickou a informační bezpečnost, 2023), it is possible to store data for banks and medical facilities (protection of extremely sensitive data) with providers with their headquarters and data centers in the EU.

As part of the EU strategy, a set of documents that shape Europe's digital future and the European Data Strategy are presented. Within this set of documents, the EU is trying to support an easy change of CC providers to avoid vendor lock-in. Furthermore, there is an effort to support high cyber security and CC data protection with the help of already existing and mentioned directives. To protect data in the cloud, the EU Data Protection Code of Conduct for Cloud Service Providers was also issued, which sets requirements and presents recommended practices to increase the level of data protection in CC based on the GDPR. As further support of the CC, it is planned to ensure a transparent market for cloud services with a single portal containing all available services of individual providers that meet all the rules and standards defined by the EU. (European Commission, 2023; European Commission, 2023)

In this section, state administration regulation was not mentioned, which is still being created and, at the same time, does not affect the target companies of this work.

4 Summary

4.1 Evaluation of methodologies

We can also find their weak points identified in the literature for the mentioned methodological approaches. For this reason, it is also advisable to combine factors considered by individual methodologies with each other. At the same time, certain overlaps can be identified during the implementation of individual factors. For example, the definition of perceived usefulness from the TAM model may partially overlap with the relative advantage factor from the DOI model. The perceived ease of use factor from the TAM model can be overlapped with the complexity factor from the DOI model. This overlay can enrich the resulting form of information acquisition with another view of the factor.

If we look at the theories separately, then the approach presented in the DOI methodology assumes rational behavior and the effort to maximize benefits. However, the decision-making processes of individual people are not completely rational. We can get a view of irrational factors from institutional theory. From the DOI theory, we could adopt the division into groups of adopters, which could influence access to other factors.

Compared to other theories, the institutional theory completely neglects the characteristics of the chosen technology. However, looking at the characteristics of the given technology is important. For this reason, this theory is combined in application with other theories.

In some theories, we can identify a factor containing the expected financial benefit from the innovation. An example is the relative advantage of the DOI model. However, let's look at the Cost Based Approach. We will find that the calculation of total costs, or operating costs, may not be a trivial matter for IaaS and PaaS applications. Determining the resulting amount is completely dependent on the ability to determine the traffic rate. So, the question is whether companies implement this calculation at all.

4.2 Data Evaluation

This section summarizes the starting points obtained from the survey of the current situation in chapter 3. First, let's look at the use of CC across Czech small and medium-sized enterprises. Both CC usage as a whole and most individual applications show steady growth. According to the latest available data, 42.1% of enterprises employing between 10 and 49 employees and 47.2% of enterprises employing 50 to 249 employees use CC in some way. We expect this trend to increase further. An exception to this trend can be computing power for enterprises' applications. In this computing power, there was a significant increase in 2020 compared to 2018 and then a decrease again in 2021. During this period, there were many changes in the economy. Identifying the cause of this fluctuation is not part of this work.

If we were to look at individual IT applications used in business organizations, the most used applications would be office software, email, security software, document storage, and financial and accounting applications. These applications have a relatively high presence and, from the point of view of DOI theory, are currently being implemented by companies belonging to the early majority. The typical CC implementation of these applications is realized through services based on the SaaS deployment mode. They can be attractive to businesses due to ease of deployment, management, and clear pricing policies. Because these are basic applications that will find applications in every enterprise, we do not foresee any significant limitation in terms of market size. As late-majority business organizations continue to adopt these applications, there may be increased interest in free applications.

In the case of purchasing a database system, the situation is not so simple. We see that small business organizations use these services significantly less than medium-sized ones. Medium-sized enterprises will also experience more significant expansion than small ones. At the same time, it is not easy to determine in which part of the S curve in relation to DOI we are currently. The Czech Statistical Office does not determine the market size specifically for these IT applications. We do not dare to mark the size of the market for these applications as the same as the number of all businesses in each size group.

One of the less-used CC implementations is purchasing computing power to operate one's applications. Again, the Czech Statistical Office does not monitor the market for this application. At the same time, a decline was also visible in the development. The question is whether enterprises do not see the use of this application or whether there is another obstacle for enterprises related to the characteristics of the deployment models.

We can start with generally used business applications for ERP and CRM applications. Looking at a longer period, we can conclude that the market is already saturated, and businesses that have a use for these applications are already using them. In the case of ERP, we can look at the situation around the use of CC so that approximately one-fifth of companies use CC from the potential market. In such a case, we would be at the beginning of the early majority, according to the DOI theory. Applying the same logic to CRM applications, approximately one-third of businesses in the potential market will use CC. In relation to DOI, this is again an early majority.

Based on previous evaluations, we assume that businesses belonging to the group of innovators and early adopters are already using the CC application, and businesses that implement CC now belong to the group of the early majority. With some applications, we will be close to the late majority. As the definition of individual business groups changes, we expect the factors influencing decision-making to change.

In addition to the factors identified by various methodologies, we think it would be appropriate to pay attention to the current state of IT employees. Suppose companies have problems with the availability of IT experts. In that case, they can decide that the activities will be carried out by one of the company's employees without professional education, and these employees may stumble in the areas of new technologies, possibly even in the operation of more complex applications. We assume that applications based on CC and especially on the SaaS model, are sufficiently user-friendly that even a person without deep IT knowledge can manage their basic administration (apart from program modifications). The second option is for companies to resort to outsourcing and rely entirely on information an external company provides. Access to new technologies will develop according to the profile and this company's background. Because in Czech small and medium-sized enterprises, external workers hold a significant share of IT-related activities, we will pay attention to the profile of these workers/companies.

We perceive internet connection as a limiting factor for the expansion of CC, which is a basic condition for the possibility of using these services. The more complex services are to be used, the faster connectivity they need. Considering the detected Internet connection speeds, we do not assume that this could be a limiting factor.

Given the events of 2020, we anticipate that business organizations that have implemented work from home. As it has worked well for them, they will want to continue to support this concept. This could help contribute to the expansion of CC-based services. Since these services are typically provided through a public network, they also support the concept of working from home. Providing access to corporate applications that are run on an on-premise architecture requires sufficient knowledge to secure against misuse.

According to the established state, legislation can be both a limiting factor and, for the time being, can also be perceived as a positive factor for adopting CC. From the perspective of a limiting factor, we perceive the choice of a provider must meet certain parameters so that the company can store virtually any data with it. At the same time, from the point of view of the Czech legislation, this can also be a positive factor because securing data by police authorities outside the territory of the Czech Republic has more lengthy procedures. Companies moving in the gray zone can see this as a positive.

If we look at BD over the entire period for which usage statistics are available, we find little development. In an article dedicated to research on BD in small and medium-sized enterprises, the authors highlight several possible reasons for not using BD. These causes include insufficient understanding of the BD phenomenon, lack of business cases for BD, lack of experts for data analysis, and others. Based on this information and when comparing the identified resources for BD and IoT, we think that it is the services delivered under the umbrella of IoT that will eventually prevail, and companies will buy corresponding CC services in the future. If we take a closer look at the relationship between BD and IoT, the data generated through IoT is subsequently processed in real-time, thanks to BD technologies. It can thus be much easier for a company suffering from a shortage of skilled workers to purchase IoT services, including the evaluation of their data.

4.3 Hypotheses

The company's available resources will be a decisive factor for investment in new technologies. If the company does not have financial and/or also personnel resources, it should not embark on new projects. Resource availability should be the limiting factor.

The strategic direction of the company will also influence the IT strategy, on the basis of which changes in IT will be implemented. Strategic direction should be the basis for the implementation of other actions. It is based on the IT strategy that the coverage of needs by individual applications should be created.

The company's surroundings will influence the technologies used by the company itself. This hypothesis assumes that if a company succeeds in its field, others will follow suit and make decisions to imitate it. At the same time, both suppliers and customers will create pressure on the company in the framework of mutual connection, and this again may influence the decision to adopt new technology.

The opinion of key and senior employees about the new technology will influence the decision to adopt the technology. The decision to implement a new technology can be influenced both positively and negatively by the personal opinions or interests of executives.

For example, if TOP Management wants to improve its CV, it can be decided to implement it even if it doesn't make sense otherwise. Or, conversely, fear of new technology can stop implementation altogether. Moreover, if opinions are formed on the basis of non-professional information, they can be greatly influenced.

The source of information is an important part of decision-making. Other information about technology will be given by a worker whose main job is an activity other than work in IT. Likewise, an external company may provide information related to an interest of its own. That is why the way of working with information is important.

There is trust towards established companies that provide CC based services. We assume that companies will not be concerned about their data being misused by companies that provide CC services. At the same time, we believe that there will be no fear of being locked into one CC service provider.

Expected costs have a significant influence on the decision to implement a specific service and are not always completely transparent for businesses. This hypothesis is based on the method of charging individual services. Because services based on IaaS and PaaS have a rather complex way of calculating the total costs in connection with the lack of experts, it can influence the choice of a specific application or the method of CC delivery. In addition, if a business that is unable to specify exactly what services it needs in the offer accesses these services, there may be concerns about additional costs during the implementation / operation of the service. This is again related to the lack of IT experts and the need to know the company's business processes well.

The typical characteristics of CC have a positive influence on the decision to implement services based on CC versus on-premises solutions. This hypothesis builds on the fact that CC natively solves the high availability of services from any location thanks to traffic through the Internet. Furthermore, the management of the environment on which the services are operated is outsourced, which, in relation to the lack of IT staff, enables internal IT to solve business problems as opposed to performing routine IT solution management tasks. Furthermore, CC enables the company to access new features and technologies without having to purchase licenses again when the technology arrives.

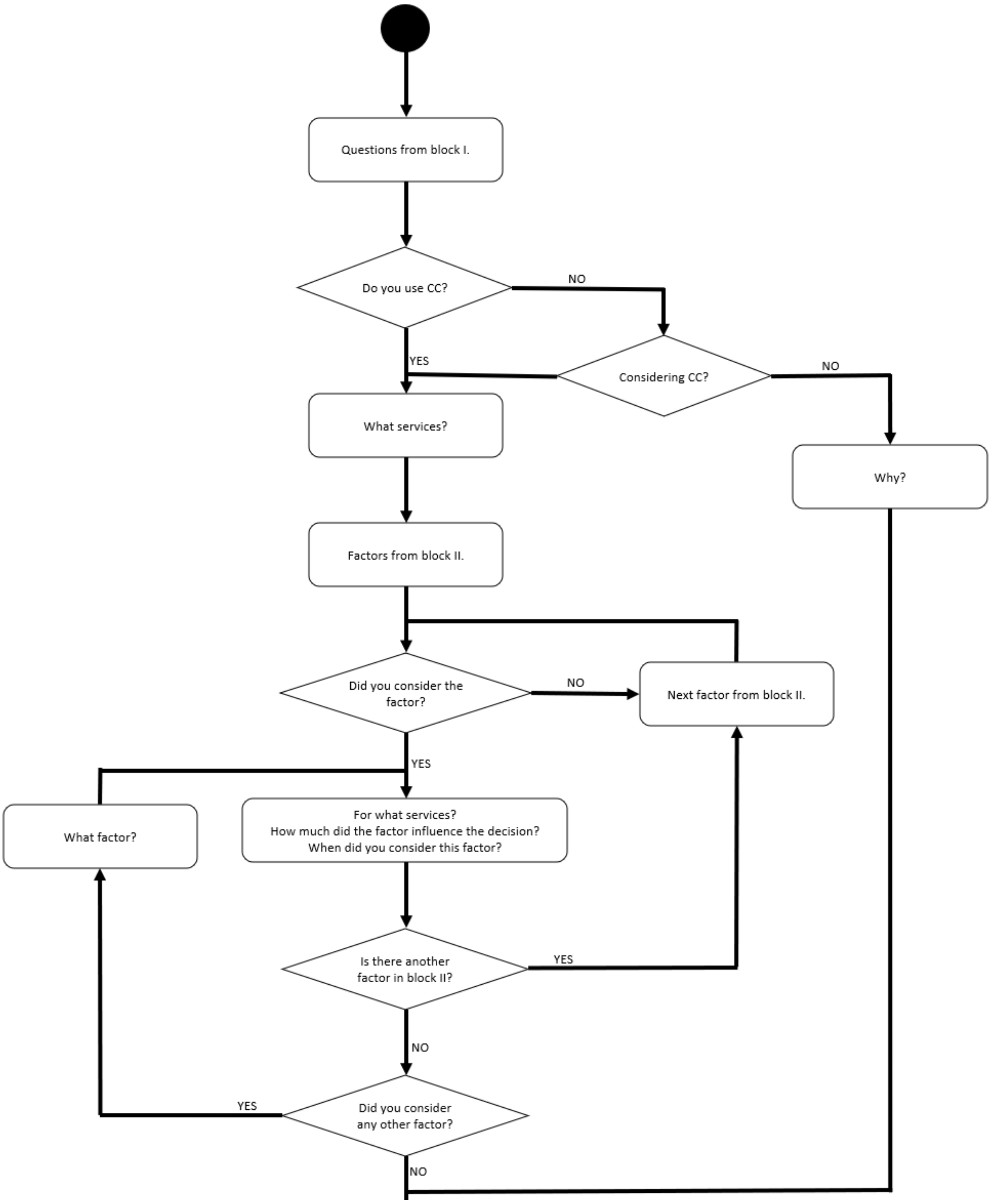
Businesses prefer an off-the-shelf solution (IoT) that handles a specific data collection problem over their own information collection and subsequent evaluation (BD). The hypothesis is based on the fact that due to the lack of IT professionals, it is easier to buy a solution that will provide sufficient information for a certain problem, compared to collecting data yourself and then looking for relationships between individual values. It is also easier for external IT to implement a certain service than a completely new solution.

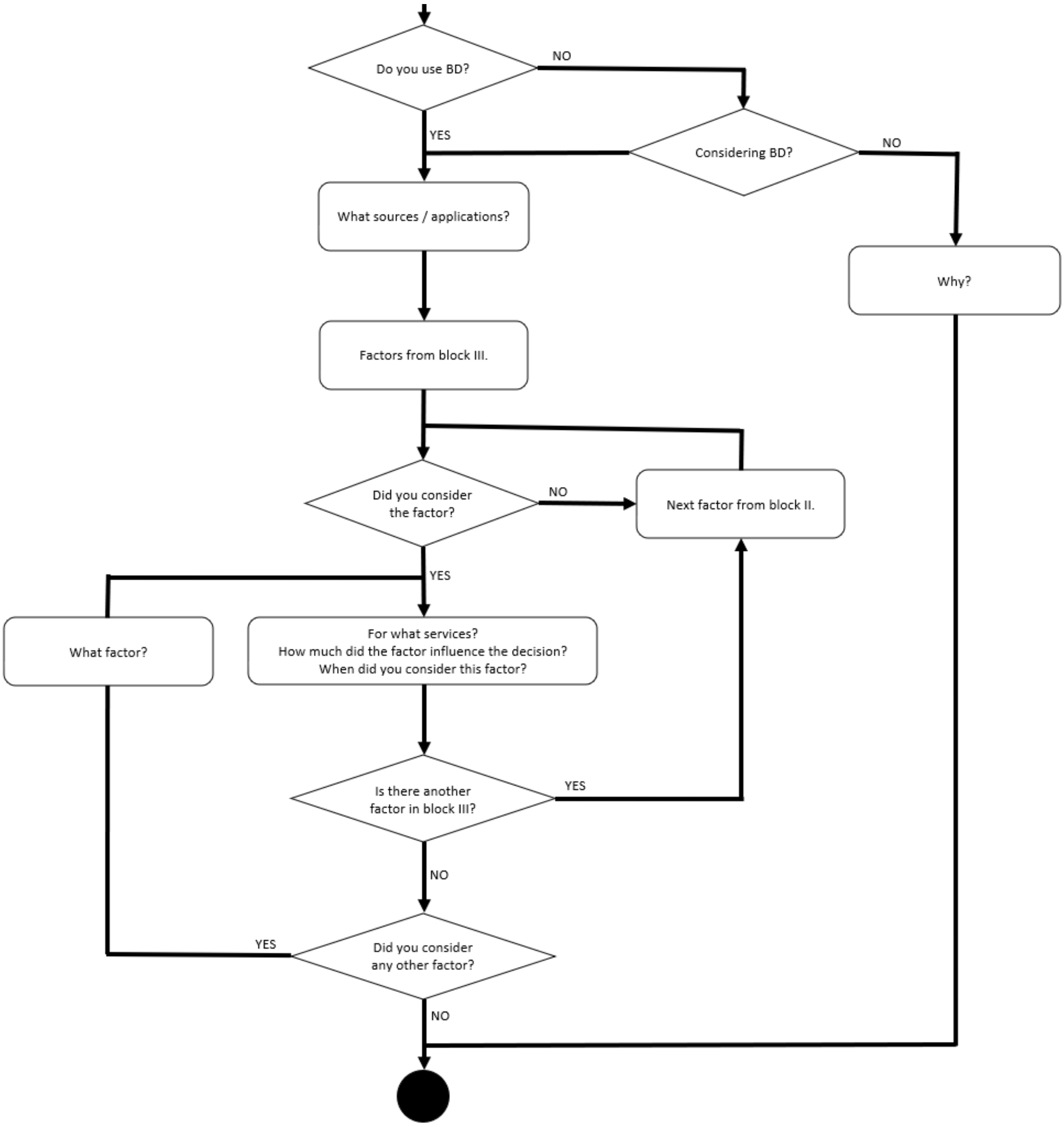
5 Methodological framework

As part of our research, we want to take advantage of the current situation where the CC diffusion is at the turn of the early and late majority. Thanks to this fact, there are already several companies that have considered CC and have also opted for this technology. We hope the current timing will allow a sufficiently varied sample of data to be obtained. Because BD is not very widespread, we will focus on awareness across companies from the point of view of this phenomenon and find out whether the company will not get the expected benefits by using IoT and purchasing a service, including data evaluation.

We prepared a proposal for conducting a semi-structured interview with individual companies to obtain the necessary data. The presented factors are proposed based on existing methodologies and their applications or based on a description of the current situation among small and medium-sized enterprises. The planned course of the interview is shown in figure number 8. The factors included in the individual stages of the interview are summarized in Table 12, together with references to their origin.

Figure 8 - Suggested course of a semi-structured interview





Factors from group I are chosen to obtain descriptive characteristics of the company. Factors from group II are chosen based on their relationship to CC. Factors from group III are chosen based on their relationship to BD.

Table 12 – Selected factors for the interview (Autor)

group	factor	the origin of the factor
I	business focus	
	company size (employees, balance sheet total, or annual turnover)	
	available funds for investment	TOE
	available human resources (IT, key users)	TOE
	management attitude toward innovation	DOI
	the current state and strategy of IT	

II, III	perceived usefulness, relative advantage	TAM, DOI
	perceived ease of use, complexity	TAM, DOI
	compatibility	DOI
	mimetic pressure	INT
	coercive pressure	INT
	normative pressure	INT
	TCO, costs	cost based approach
	personal interest in the use (implementation) of CC / BD by senior staff	
	government help	TOE
	reluctance to learn new procedures by key personnel	
	the concern of key workers about their position given the current technology	
	sources of information	TOE, DOI
II	SLA	CC characteristics
	increasing flexibility	CC characteristics
	outsourcing of maintenance, routine tasks	CC characteristics
	regular updates, risk of obsolescence	CC characteristics
	access to new technologies	CC characteristics
	home-office / availability	CC characteristics, TOE
	hidden costs	outsourcing
	legislative restrictions/location	CC characteristics, TOE
	vendor lock-in	CC characteristics, TOE
	data security	TOE
III	using IoT as a service instead of implementing BD	current situation

6 Conclusion

This article focuses on CC and BD technologies and models that can help explain their diffusion across enterprises. Regarding technologies, CC features are introduced along with a description of deployment models and a description of application delivery models. BDs are characterized in terms of their properties, which give them the attribute "BIG", and possible use cases are also presented. These theses further present individual methodologies that are used in scientific papers to explain the diffusion of innovations. Specifically, it is a TAM model that was directly designed to predict the intention to adopt a new information system or technology.

Another important theory is the DOI theory, which describes both the way, the reasons, and the speed of diffusion of new technology. The INT theory is introduced to extend the previous theories by not entirely rational influences, which examines firms from the institution's perspective. The most frequently used and modified TOE framework proves that it is possible to combine the previous theories.

Theories used to explain the spread of innovation are very often used to identify individual factors and characteristics of a given technology from the point of view of influence on the decision to implement or reject this technology. Along with information on the methodologies used, this paper also provides information on how CC and BD technologies have been used by SMEs in previous years and the current period. Along with this information, we also present other factors that may influence the decision to adopt new technology and are specific to the territory of the Czech Republic.

Despite a wide range of professional articles, the description of human behavior, and thus decision-making, is still not described in sufficient depth. This is also evidenced by individual scientific articles, which, if they already contain information on the percentage of explained variance of factors in their models, ranging from 25% to 70%.

Based on the literature review and the current situation, we propose a methodology with which we want to describe in more detail the decision-making process for implementing CC and the reasons for not using BD. The presented methodology expands currently used methodologies by the time factor and individual enterprises' control characteristics. Due to the planned data collection using semi-structured interviews, space is provided to identify additional factors. Furthermore, we would like to identify factors that can play the role of decisive (key) factors and thus exceed the influence of other factors.

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