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CLOUD COMPUTING IN THE EU – DRIVERS AND CHALLENGES

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The aim of the thesis is to describe state of the art of cloud computing in the EU and to prepare model of drivers and challenges based on the available data and literature review.

Outline:
- Definition of cloud computing
- Current trends of cloud computing in the EU
- Systematic literature review to reveal drivers and challenges in cloud computing engagement
- Development of drivers and challenges model

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GIBSON, Joel, Robin RONDEAU, Darren EVELEIGH a Qing TAN, 2012. Benefits and challenges of three cloud computing service models. In: 2012 Fourth International Conference on Computational Aspects of Social Networks (CASoN) [online]. IEEE, 2012, s. 198-205 [cit. 2023-02-6]. ISBN 978-1-4673-4794-5.
MUTTIK, Igor a Chris BARTON, 2009. Cloud security technologies. Information Security Technical Report [online]. 14(1), 1-6 [cit. 2023-02-10]. ISSN 13634127.
QIAN, Ling, Zhiguo LUO, Yujian DU a Leitao GUO, 2009. Cloud Computing: An Overview. In: JAATUN, Martin Gilje, Gansen ZHAO a Chunming RONG, ed. Cloud Computing [online]. Berlin, Heidelberg: Springer Berlin Heidelberg, 2009, s. 626-631 [cit. 2023-04-5]. Lecture Notes in Computer Science. ISBN 978-3-642-10664-4.
SAVU, Laura, 2011. Cloud Computing: Deployment Models, Delivery Models, Risks and Research Challenges. In: 2011 International Conference on Computer and Management (CAMAN) [online]. IEEE, 2011, s. 1-4 [cit. 2023-01-8]. ISBN 978-1-4244-9282-4.

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AUTHOR'S STATEMENT

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All literary sources and the information used are listed in the bibliography.

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ABSTRACT

The thesis aims to present a comprehensive overview of cloud adoption in the European Union. It explores the benefits and challenges associated with cloud usage in selected member states. The subject has been thoroughly studied through both quantitative and qualitative research methods. The quantitative research utilized Eurostat data, while the qualitative research employed the PRISMA method for document analysis. The thesis provides valuable insights into the current state of cloud adoption across the EU member states. It offers statistical evidence to support the growth rates and spending patterns based on the enterprise size and time frame.

KEYWORDS

cloud computing, cloud adoption, benefits, challenges, spending patterns, EU

ABSTRAKTNÍ

Práce si klade za cíl podat ucelený přehled o přijetí cloudu v Evropské unii. Zkoumá výhody a výzvy spojené s používáním cloudu ve vybraných členských státech. Předmět byl důkladně studován pomocí kvantitativních i kvalitativních výzkumných metod. Kvantitativní výzkum využíval data Eurostatu, kvalitativní výzkum pak metodu PRISMA pro analýzu dokumentů. Práce poskytuje cenné poznatky o současném stavu zavádění cloudu napříč členskými státy EU. Nabízí statistické důkazy na podporu tempa růstu a vzorců výdajů na základě velikosti podniku a časového rámce.

KLÍČOVÁ SLOVA

cloud computing, přijetí cloudu, výhody, výzvy, vzorce výdajů, EU

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LIST OF ABBREVIATIONS AND SYMBOLS

EU	European Union
FI	Finland
GDPR	General Data Protection Regulation
IaaS	Information as a Service
IC	Inclusion Criteria
ICT	Information and Communication Technology
IDC	International Data Corporation
IT	Information Technology
IT	Italy
NIST	National Institute of Standards and Technology
NL	Netherlands
PaaS	Platform as a Service
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RO	Romania
RQ	Research Question
SaaS	Software as a Service
SE	Sweden
SLA	Service Level Agreement
SMEs	Small and medium-sized Enterprises
SMPC	Secure Multi-party Computation

INTRODUCTION

In the early days of computing, organizations relied on traditional, on-premises IT infrastructure and resources. They had to purchase, set up, and maintain their hardware and software, which could be expensive and time-consuming. They invested in physical servers and networking equipment and devoted IT staff to manage those resources (Singla, Chahat, Nisha, Harnoor 2022). Additionally, on-premises IT infrastructure was often limited in scalability and flexibility, making it difficult for organizations to adapt to changing business needs.

In the dynamically shifting technology landscape of the information age (Toffler, 1981), the transition towards cloud computing commenced as the need for computing resources grew and technology advanced. It has revolutionized the delivery and use of computing resources (Firdhous, 2014). Cloud computing is a foundational element of the recent digital transformation movement for companies and organizations (Nguyen & Chirumamilla, 2019). Cloud computing allows users to access services without worrying about the infrastructure they are hosted on (Buyya et al. 2009). This shift to cloud-based solutions has fundamentally transformed the way businesses operate.

Cloud computing has become increasingly widespread since the late 2000s (Patrick et al., 2016) (Wang et al., 2008). The adoption of cloud computing services has been growing steadily across all sectors of the economy and among various economic operators (Orue-Echevarria et al., 2016; Dekker, 2012). Business owners are drawn to Cloud Computing (CC) because it eliminates the need for users to anticipate provisioning requirements, enabling enterprises to begin with minimal resources and scale up only as service demand increases (Zhang et al., 2010).

Cloud computing has been adopted rapidly because of its stability, flexibility, and cost-effective services. Gartner report described that the worldwide end-user spending on public cloud services is forecast to grow 21.7% (total $597.3 billion) in 2023, compared to 18.8% growth forecast for 2022 (Gartner, 2022). Zippia stated that 94% of companies adopted cloud services in 2022. Due to the COVID-19 pandemic and remote work, 61% of businesses have migrated their workloads to the cloud (Zippia, 2022).

In the last decade, the EU has significantly transformed how businesses and organizations utilize technology to drive innovation, efficiency, and growth. According to Statista, European

cloud computing is worth 63 billion euros in 2021 and is forecast to reach 560 billion Euros by 2023 (Cloud computing in Europe statistics & facts, 2023). Investment in the cloud is a critical differentiator between developed and developing countries. The limited availability of cloud applications, platforms, and services in emerging nations hinders widespread adoption (Gartner Forecasts IT Spending in Europe to Record 9% Growth in 2024, 2023).

Given the increasing significance of cloud adoption in the EU, exploring its adoption patterns and implications is imperative. The primary aim of this thesis is to provide an overview of the current adoption of cloud services within the EU compared to its earliest state. It will involve a detailed exploration of the usage patterns, benefits, and obstacles associated with cloud adoption in various member countries. Rather than attempting to cover all 27 states, nine member states are selected, focusing on their rank of Cloud usage within the EU to achieve the research aim.

1. BACKGROUND AND CONTEXT

Cloud computing has revolutionized the field of information technology by enabling the access and utilization of computing resources through the internet. The origins of cloud computing can be traced back to the early 1960s when time-sharing systems were conceptualized, allowing multiple users to access a single computer simultaneously, leading to efficient resource utilization (Heilig 2014). In the 1990s, the Internet revolutionized how computing services were delivered, leading to Application Service Providers (ASPs) offering users software applications and services over the Internet (Churakova, Mikhramova, Gielen 2010).

The term "cloud computing" gained prominence in the early 2000s (Bayramusta, Nasir 2016), coinciding with utility computing and virtualization technologies advancements. Large technology companies like Amazon and Google have begun offering Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) solutions. These solutions allow users to access computing resources and development platforms online and only pay for what they use.

The release of Amazon Elastic Compute Cloud (EC2)(Amazon 2009) in 2006 marked the beginning of scalable compute capacity being provided via the cloud (Armbrust et al. 2009). This development brought about the widespread adoption of cloud computing paradigms across businesses of different sizes. Cloud computing is a rapidly evolving field that has transformed the information technology landscape by allowing computing resources to be accessed and utilized through the Internet (Raju Narzary 2023).

1.1. The Rise of Cloud Computing in the Digital Era

The digital transformation process has occurred in various stages, beginning with automation (Siderska 2020) and leading to significant changes in business models using disruptive technologies (Parviainen et al. 2017). The introduction of Big Data and cloud computing has dramatically altered how computing is approached for data transformation and delivery (Chan 2020). Cloud computing has become a significant and transformative trend in information technology in the digital era. It has emerged as a new infrastructure that provides numerous benefits, such as cost savings, scalability, and flexibility, making it a popular choice for various businesses and organizations (Ku, Chiu 2013).

Cloud computing has evolved significantly (Jany et al. 2023), with its roots in early concepts of distributed computing and grid computing (Kaur, Madhuri 2020). The concept of cloud

computing was introduced in the 1960s and 1970s with the advent of mainframe computers, which allowed multiple users to access a single centralized computer system. This idea was then transformed into client-server architectures in the 1980s and 1990s, where dedicated servers offered client services over a network (Srinivasan, Srinivasan 2014).

The modern era of cloud computing began in the early 2000s with the introduction of Software as a Service (SaaS) models. These models delivered applications over the internet, such as Salesforce.com and Google Apps (Brown, Nyarko 2013). Later, Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) models emerged (Ashraf 2014), allowing businesses to rent computing resources, like virtual machines and databases, on-demand (Manvi, Shyam 2014). Key players like Amazon Web Services, Microsoft Azure, and Google Cloud Platform have shaped the cloud computing landscape. (Opara 2019).

1.2. Cloud Computing Worldwide

Cloud computing has been adopted rapidly because of its stability, flexibility, and cost-effective services (Lin, Chen 2012). Gartner report described that the worldwide end-user spending on public cloud services is forecast to grow to a total of $679 billion in 2024 and is projected to exceed $1 trillion in 2027 (*Gartner Says Cloud Will Become a Business Necessity by 2028* 2023). Zippia stated that 94% of companies adopted cloud services in 2023. Due to the COVID-19 Pandemic and remote work, 61% of businesses migrated their workloads to the cloud (*25 Amazing Cloud Adoption Statistics [2023]: Cloud Migration, Computing, And More - Zippia* 2023).

1.3. Cloud Computing in EU

Based on the Worldwide Software and Public Cloud Services Spending Guide from the International Data Corporation (IDC), public cloud services expenditure in Europe is projected to reach $142 billion in 2023 and is anticipated to surge to $291 billion by 2027, with a compound annual growth rate (CAGR) of 20% over five years (2022-2027). Despite facing macroeconomic challenges such as high inflation and a banking crisis scare in 2023, European businesses remain committed to advancing their adoption of public cloud services, with approximately 55% expected to transition to the cloud by the end of the year. This adoption is driven by objectives such as enhancing Information Technology (IT) staff productivity, fortifying data security, and embracing AI-driven automation, fueled by the growing

excitement surrounding generative AI (GenAI). Within this landscape, Software-as-a-Service (SaaS) continues to dominate spending, while Platform-as-a-Service (PaaS) emerges as the fastest-growing segment (*IDC Says European Public Cloud Spending Will Reach $142 Billion This Year, Defying Budget Cuts Amid an Economic Downturn* 2023).

1.4. Importance of Cloud Computing in the European Union

Cloud computing is important in the European Union as it represents a change in the business paradigm (Palos-Sanchez 2017). It bridges the gap between large and small to medium-sized companies regarding Information and Communication Technology (ICT) infrastructure investment needs (Toader et al. 2023). The EU considers cloud computing an enabler of national and regional competitiveness (Kshetri, Murugesan 2013).

Small companies can access the same technology and infrastructure as larger ones at lower costs without requiring substantial investments in computing power, networks, data storage, and specialized software products (Zuka 2014). This accessibility to advanced technology through cloud computing enhances productivity (Van Ark 2016) and competitiveness and contributes to economic growth within the EU (Etro 2009). Additionally, cloud computing aligns with the EU's focus on innovation (Aarestrup et al. 2020), digital transformation (Hunady et al. 2022), and developing a robust digital economy, making it a key enabler for businesses to stay competitive and agile in the evolving digital landscape (Milošević, Dobrota, Rakočević 2018).

Figure 1 visually represents the concept of cloud computing and its various related terms and keywords. It is based on the relationship between cloud computing and other keywords using the search query “Cloud Computing” and “EU” with the Boolean operator AND on Web of Science. The color coding and connections between terms help to show the relationships and dependencies between these different aspects. It shows how various aspects of cloud computing are interconnected. Each term represents a different consideration or application in cloud computing.

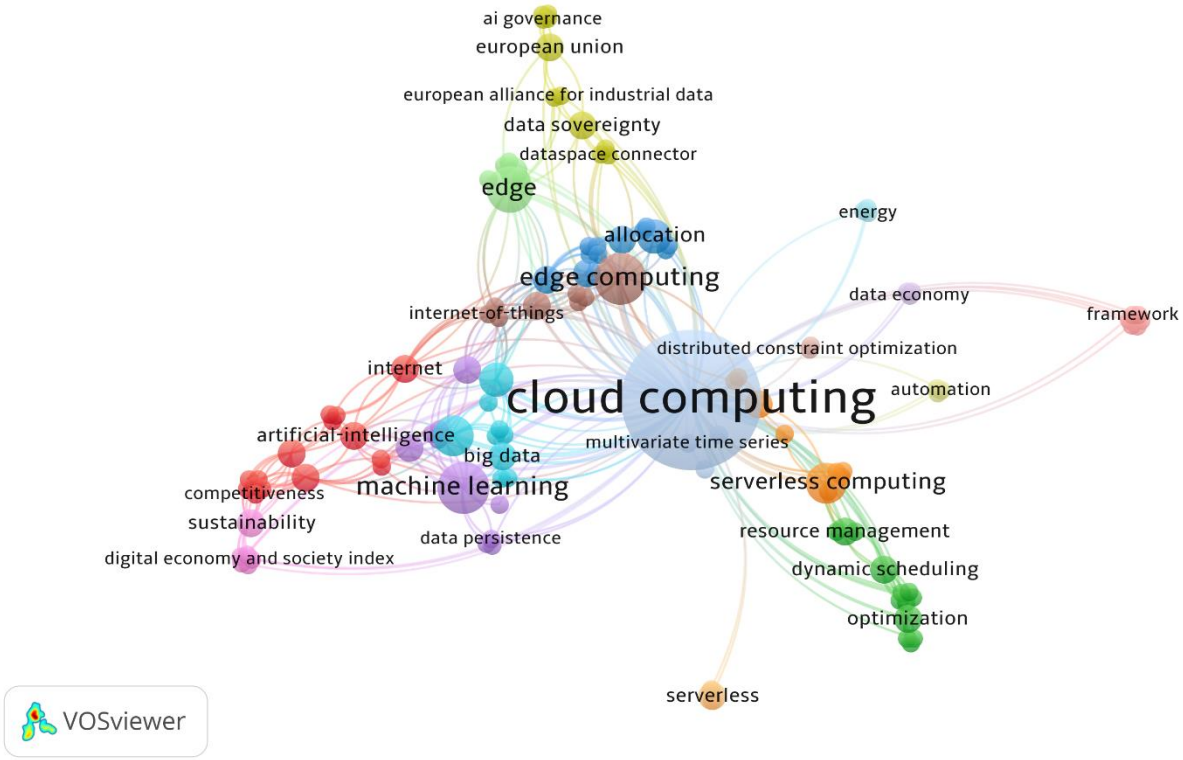


Figure 1: Keyword co-occurrence map illustrating cloud computing in the EU

Source: Author's creation

It connects with various technologies to create a robust ecosystem. For instance, edge computing tackles data processing closer to its source, while cloud computing manages the bigger picture in remote centers. Similarly, the Internet of Things(IoT) relies on the cloud to store the massive amount of data it collects (Rao et al. 2012). The processing power required for big data can be effectively harnessed through cloud computing. Even artificial intelligence depends on cloud resources for training and running complex models. These are just a few examples, highlighting how cloud computing intertwines with other advancements to shape the technological landscape.

2. DEFINITION AND CONCEPTS

(Buyya et al. 2019) highlighted that the subscription-based nature of cloud services offers flexibility and accessibility through a pay-as-you-go model. It enables various benefits, including shorter establishment times for start-ups, creating scalable global enterprise applications, improved cost-to-value ratios for scientific and high-performance computing applications, and novel invocation/execution models for pervasive and ubiquitous applications.

(Kumar Joshi, Rana, Professor- 2011) described the transformative nature of cloud computing, particularly in its redefinition of IT infrastructure. It emphasized how cloud computing offers a paradigm shift by providing virtually unlimited computing resources on demand, thereby obviating the need for organizations to make substantial upfront investments in hardware that may only be utilized during peak periods.

2.1. What is Cloud Computing?

Cloud computing is the on-demand delivery of computing services with pay-per-use pricing over the Internet without being restricted by location or infrastructure. It has become a popular approach for businesses, organizations, and individuals to access and utilize computing resources, as it offers greater convenience, scalability, and cost savings compared to traditional on-premises computing.

The definition by the European Expert Group (Schubert et al. 2010) stated that the cloud is “An elastic execution environment of resources involving multiple stakeholders and providing a metered service at multiple granularities for a specified level of quality (of service).” (Vaquero et al. 2008) defined “Clouds as a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms, and services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which the Infrastructure Provider offers guarantees utilizing customized SLAs.

Gartner experts (Plummer et al. 2008) defined cloud computing as “A style of computing where massively scalable, IT-enabled capabilities are provided ‘as a service’ to external customers using Internet technologies.” The term "cloud" encompasses virtual servers, distributed hosting, and shared resources accessible over the Internet. The expression by (Buyya, Yeo, Venugopal 2008) is that “Cloud is a type of parallel and distributed system consisting of a

collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service-level agreements established through negotiation between the service provider and consumers." Cloud computing eliminates the user requirement for provisioning and allows enterprises to start from small resources and increase them only when they need in service demand. Organizations are becoming increasingly experienced in the cloud, starting to migrate core business functions to cloud platforms (Avram 2014).

According to the globally accepted definition of cloud computing by the National Institute of Standards and Technology (NIST) is "A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell, Grance 2011).

The NIST definition of the cloud model also included the classification of essential characteristics and two different classes of clouds: those based on the service model and those based on the deployment model.

2.2. Cloud Characteristics

The classification of five essential characteristics of cloud computing is as follows:

On-demand self-service. With cloud computing, consumers can unilaterally provide computing services such as server time and network storage. They can access cloud computing resources without human interaction from service providers.

Broad network access. Cloud computing resources are available over the network and accessed through standard mechanisms by diverse client platforms such as mobile phones, tablets, laptops, and workstations.

Resource pooling. With resource pooling, multiple customers can dynamically share physical and virtual resources using a multi-tenant model while retaining privacy and security. Examples of resources are storage, processing, memory, and network bandwidth. The outcome of utilizing a pool-based model is that the physical computing resources are rendered "invisible" to consumers, as they typically do not have control or awareness of these resources' location, composition, and origins.

Rapid elasticity. Cloud services can be elastically provisioned and released, in some cases automatically, to scale up and down rapidly according to the business demand. From the customer's perspective, the provisioning capabilities often seem unlimited and can be accessed in any quantity at any time.

Measured service. In cloud systems, resource usage can be optimized by leveraging pay-per-use capabilities. It can be monitored, controlled, and reported, providing transparency for the provider and customer of the utilized service.

2.3. Cloud Computing Models

Cloud computing models refer to the various ways cloud computing services can be delivered and deployed to meet the needs of different organizations and individuals.

2.3.1. Service Models

Cloud computing service models refer to how cloud services can be accessed and utilized by users. The three main service models are SaaS, PaaS, and IaaS.

Software as a Service (SaaS). SaaS allows the customer to connect and utilize the provider's applications on a cloud infrastructure. It enables users who subscribe to pay-per-use models to access software or services in the cloud rather than being installed on their local device. Users of SaaS applications only need a thin client interface, such as a web browser, to access and utilize the cloud-hosted application. This minimizes the hardware requirements for end-users while facilitating centralized control, deployment, and maintenance of the software (Cusumano 2010).

Platform as a Service (PaaS). PaaS provides the customer with a complete cloud platform to develop, test, run, and deploy web applications. The customer is not responsible for managing or controlling the underlying cloud infrastructure, including network, servers, operating systems, storage, or individual application capabilities, except for limited user-specific configuration settings (Pahl 2015).

Infrastructure as a Service (IaaS). IaaS delivered computing, network, and storage resources to customers on demand via the internet, allowing for a pay-as-you-go basis. The customer does not manage and control the underlying cloud infrastructure but controls operating systems,

storage, and deployed applications while possibly having limited control over select networking components (Bhardwaj, Jain, Jain 2010).

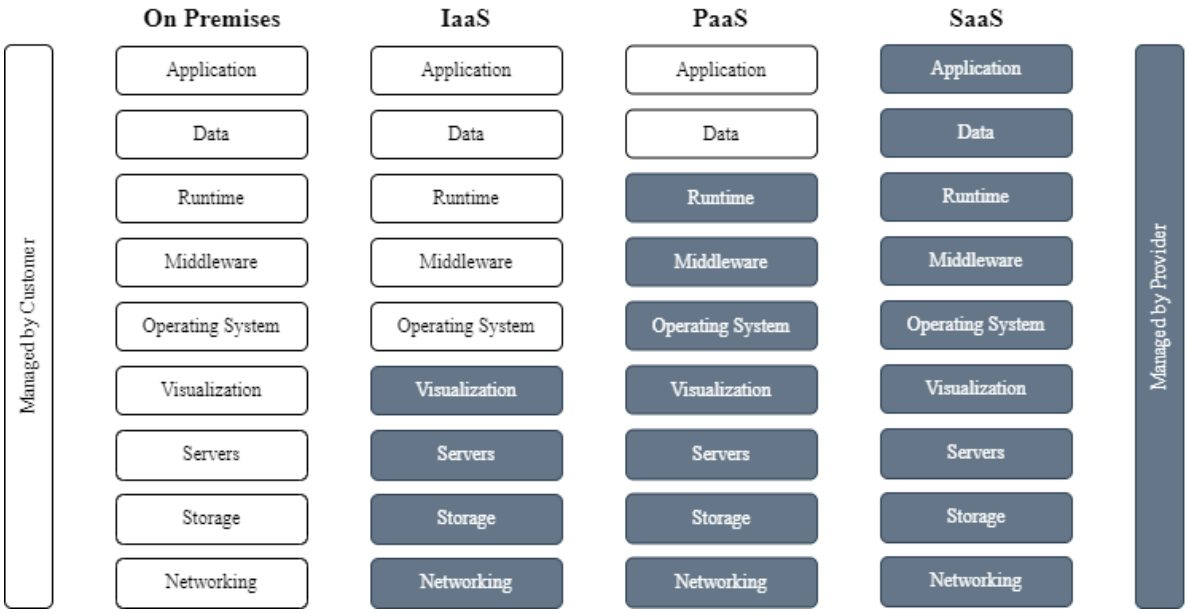


Figure 2: Cloud computing service models

Source: (Mell, France 2011)

2.3.2.Deployment Models

Cloud deployment models refer to how cloud computing resources and services are provisioned and made available to users. These models define how and where cloud infrastructure is deployed and managed. The four cloud deployment models are private cloud, public cloud, community cloud, and hybrid cloud.

Private Cloud. A private cloud is devoted to internal use by a single organization. It might be owned, managed, and operated by the organization itself, outsourced to a third-party provider, or some combination existing on or off premises (Grossman 2009).

Public Cloud. A cloud service provider owns the cloud infrastructure, which is accessible to the public or a large industry group for cloud services (Savu 2011).

Community Cloud. A community cloud falls between public and private clouds concerning the target set of consumers. It is similar to a private cloud, but the infrastructure and computational resources are exclusive to two or more organizations with standard privacy, security, and regulatory considerations rather than a single organization (Marinos, Briscoe 2009).

Hybrid Cloud. The cloud infrastructure combines two or more separate cloud infrastructures, such as private, community, or public clouds, that retain their identities. However, they are interconnected using standardized or proprietary technology that facilitates data and application portability, allowing for actions like cloud bursting for load balancing between clouds (Li et al. 2015).

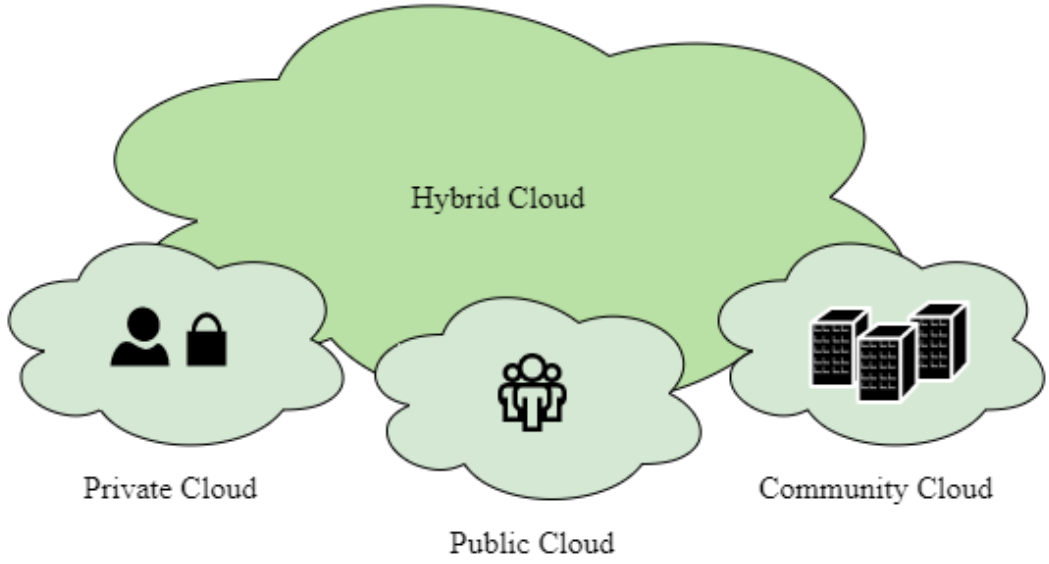


Figure 3: Cloud computing deployment models

Source: (Mell, France 2011)

2.4. Navigating Cloud Adoption: Benefits and Challenges

The subject of cloud computing is popular, making it a widely explored topic in research. The landscape of cloud computing is rich and varied, offering a multitude of benefits to explore and multifaceted challenges to overcome. Cloud computing offers high scalability, reliability, anytime, anywhere access, and pay-as-you-go concepts, leading to profit without maintaining the cost of data centers and technical staff (Bisong 2019). In the Nigerian construction industry, cloud computing offers benefits such as ubiquitous data storage, high situational awareness, team collaboration, compatibility with advanced production facilities, and improved project planning (Oke et al. 2023). Moreover, cloud computing offers benefits and significant cost savings, making it beneficial for Small and medium-sized Enterprises (SMEs) to improve efficiency, competitiveness, and productivity (Chatzithanasis, Michalakelis 2019).

Additionally, cloud computing benefits in education include cost-effectiveness for implementing hardware and software and affordable education quality (Ghazizadeh 2012).

Private clouds offer benefits like scale and virtualization with fewer drawbacks, while public clouds are unsuited for many business applications due to limitations in architecture and design (Hofmann, Woods 2010). Furthermore, cloud computing offers advantages such as scalability, online delivery of software and virtual hardware services, and flexibility, enabling organizations to omit the need to own, maintain, and update their software and hardware infrastructures (Sultan 2014).

From the cost-efficiency perspective, cloud computing eliminates the need for upfront infrastructure investment and reduces ongoing operational expenses (Beloglazov, Abawajy, Buyya 2012). Moreover, cloud computing offers significant cost savings and demonstrates high potential for improving energy efficiency under dynamic workload scenarios. Furthermore, optimization techniques for reducing resource consumption in cloud computing include various algorithms such as the firefly algorithm, whale optimization algorithm, and machine learning methods like deep neural networks (Jayaprakash et al. 2021).

In terms of scalability and flexibility, cloud platforms provide on-demand resource access, allowing organizations to rapidly scale computing power, storage, and other services to meet fluctuating workload demands (Malik, Khan, Srinivasan 2013). Additionally, cloud computing enables dynamic scaling of web applications in a virtualized environment, reducing infrastructure and management costs while handling sudden load surges (Chieu, Mohindra, Karve, Segal 2009). Optimization strategies for managing a federation of clouds can further reduce overall energy consumption, contributing to a rational and efficient adoption of the cloud computing paradigm (Bruneo, Longo, Puliafito 2011).

Accessibility and availability are also key benefits of cloud computing, providing ubiquitous access through mobile devices and applications, thereby improving the quality of education at an affordable cost (Ghazizadeh 2012). Cloud computing also offers increased availability, flexibility, and functionality, but also brings security and privacy issues such as secure remote storage and data sharing (Xiang, Di Martino, Wang, Li 2015). Regarding environmental sustainability, cloud computing can contribute to optimizing resource utilization, reducing energy consumption, and minimize carbon emissions (Radu 2017a). Green cloud computing has the potential to improve energy efficiency, reduce carbon footprints, and eliminate e-waste, making it environmentally friendly. Additionally, cloud computing technology improves the function of IoT, enhancing communication, collaboration, and data sharing benefits of both technologies (Stergiou, Psannis, Kim, Gupta 2018).

However, the journey towards cloud adoption is facing several challenges. Zhou, Cao, Dong, Vasilakos (2017) introduces a novel approach to privacy-preserving data aggregation in cloud-based IoT, addressing challenges in secure packet forwarding and efficient privacy preservation authentication. It provides insights into various security techniques and challenges in cloud computing, aiming to enhance data security and privacy protection for a trustworthy cloud environment (Sun, Zhang, Xiong, Zhu 2014).

Additionally, Rajeswari, Kalaiselvi (2017)presents a comprehensive survey on privacy preservation, data security, and storage security challenges in cloud computing, analyzing aspects such as data integrity, access control, and attribute-based encryption. Furthermore, it is discussed the data privacy threats, attacks, and solutions in mobile cloud computing, shedding light on ongoing trends and open research issues (Alnajrani, Norman, & Ahmed, 2020).

Organizational readiness and knowledge are crucial factors influencing cloud adoption, as cloud computing presents organizational changes, economic implications, and security challenges (Khajeh-Hosseini, Sommerville, Sriram 2010). Moreover, organizational readiness, except for competitor orientation and vendor pressure, significantly impacts the assimilation of cloud computing in organizations (Kim, Kim 2013). Cloud computing must address technology challenges to enable the future Internet of Services, including efficient management, collaboration, and improved security, reliability, and energy efficiency (Moreno-Vozmediano, Montero, Llorente 2013).

Morin, Aubert, Gateau (2012) stated that Service Level Agreement (SLA) management is pivotal in fortifying governance, risk mitigation, and compliance within cloud computing environments, effectively addressing security concerns and challenges. Moreover, SLAs play a crucial role in defining security levels and intricacy in cloud computing services, addressing challenges and enhancing overall cloud security (Ahmed et al. 2013). However, challenges persist in trust establishment, SLA management, and performance evaluation within cloud computing frameworks, necessitating an examination of existing models across various computing paradigms (Alhamad, Dillon, Chang 2011).

Kandukuri, Rakshit (2009) argued that there is a pressing need for standardized SLAs addressing diverse security issues to ensure customer trust and confidence in cloud services. Trust and vendor-related concerns further underscore the imperative of establishing secure and dependable cloud computing environments. Efforts are underway to identify and mitigate security, privacy, and trust issues through innovative solutions such as Trusted Third Party

frameworks leveraging cryptography and public key infrastructure (Sun et al. 2011) (Zissis, Lekkas 2012). The Trust Cloud framework also aims to instill accountability through technical and policy-based strategies, addressing critical challenges in fostering trust among cloud consumers (Ko et al. 2011).

Vendor lock-in poses a significant obstacle to the widespread adoption of cloud computing, underscoring concerns related to interoperability and portability (Opara-Martins, Sahandi, Tian 2014). Amidst technical challenges and complexities, cloud computing and virtualization technologies encounter hurdles in supporting emerging real-time applications and ensuring optimal user experiences (García-Valls, Cucinotta, Lu 2014). Innovative approaches are being explored to minimize technical complexities and align with evolving business trends and requirements (Menychtas et al. 2011). Kumar, Kumar Garg (2012) and (Scandurra et al. 2015) addressed that cost and financial concerns, system availability, and performance optimization remain crucial considerations in cloud migration strategies.

Challenges in data migration to the cloud require careful assessment and adherence to best practices to ensure secure and seamless transitions (Chauhan, Babar 2011) (Amin, Vadlamudi 2021). Governance and control frameworks are essential for enhancing security and service levels in the cloud era. Novel governance frameworks bridge the gap between control requirements, technical complexities, and business risks, fostering a secure and resilient cloud computing environment (*A New Cloud Computing Governance Framework* 2014). The transition to the cloud, while offering significant benefits, is not without its challenges. Organizations must carefully address these obstacles to ensure a successful and sustainable cloud adoption journey.

3. METHODOLOGY

Cloud services have become an essential part of the digital infrastructure in the European Union countries(Pedro R. Palos-Sanchez 2017). They play a crucial role in the EU's digital economy, supporting innovation, improving productivity, and driving economic growth across various sectors. However, using cloud services also presents challenges. The thesis aims to provide an overview of cloud adoption in the European Union, undertaking a comprehensive exploration of the benefits and challenges associated with cloud usage in selected member states.

3.1. Research Objectives

Aligned with the primary aim of this study, the thesis seeks to describe the state of Cloud Computing in the EU, preparing a model of drivers and challenges based on a thorough examination of available data and literature. Since 2014, Eurostat has been providing data about ICT usage, including cloud usage in enterprises. To compare the evolution of cloud computing in the EU, a comparison between 2014 and 2021 is conducted. To cover the research's purpose, two specific objectives have been formulated as follows:

- To conduct a comparative analysis of the current landscape of cloud computing within the European Union about the state of cloud computing in 2014, using the available data from Eurostat, focusing on adoption rates, growth rates, and spending patterns.
- To identify the primary drivers and challenges of cloud computing adoption within the selected member countries through a comprehensive synthesis of existing literature and data analysis.

3.2. Research Questions

To better understand cloud computing adoption across the European Union and accomplish the primary goal of this study, three research questions (RQ) were structured to guide the study.

- RQ1: What is the current state of Cloud Computing in the European Union's business landscape compared to 2014?
- RQ2: What influencing factors are examined in existing research papers focusing on adopting cloud computing technologies across various industries and organizational contexts within selected member states?

- RQ2.1: What are the benefits of adopting cloud computing solutions?
- RQ2.2: What are the main obstacles and difficulties they encounter?

These questions aim to explore the current scenario of cloud computing adoption, the reasons that drive businesses to adopt cloud solutions, and the obstacles member states face in this process.

3.3. Research Approach

The study initiated the area of interest by exploring existing literature and articles accessible online and at the university library. From this preliminary exploration, research questions were derived in alignment with the research aim. These questions led to the study being divided into two parts—the first segment aimed to address RQ1, focusing on cloud adoption by utilizing data from Eurostat. A systematic literature review was applied for research question 2 (RQ2) and related sub-requestions. It enabled a comprehensive examination of the advantages and challenges associated with cloud adoption within the selected countries. The process of the research was visually depicted in the following figure.

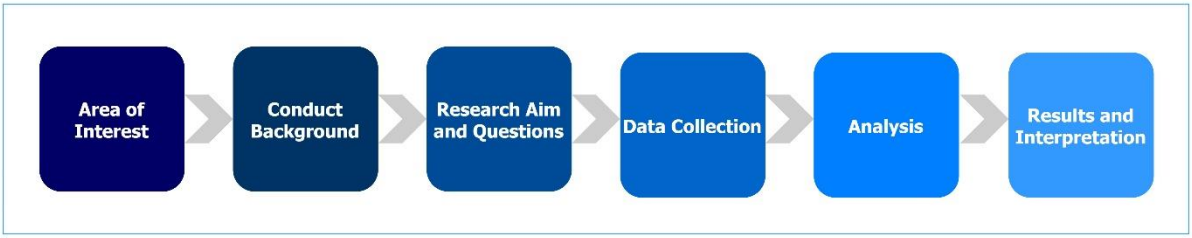


Figure 4: Research procedure

Source: Author's own creation

3.4. Concept of the Process

The process is mainly based on the time frame and enterprise size. Purchasing rates, growth rates, and spending patterns are examined to gain insight into the current cloud services landscape in the EU. Purchasing rates are evaluated according to the acquisition of cloud computing services used over the Internet. The growth rates are assessed by comparing the current landscape of Cloud Computing within the EU with the state of Cloud Computing in 2014. Spending patterns are determined according to buying cloud services based on Cloud service models as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

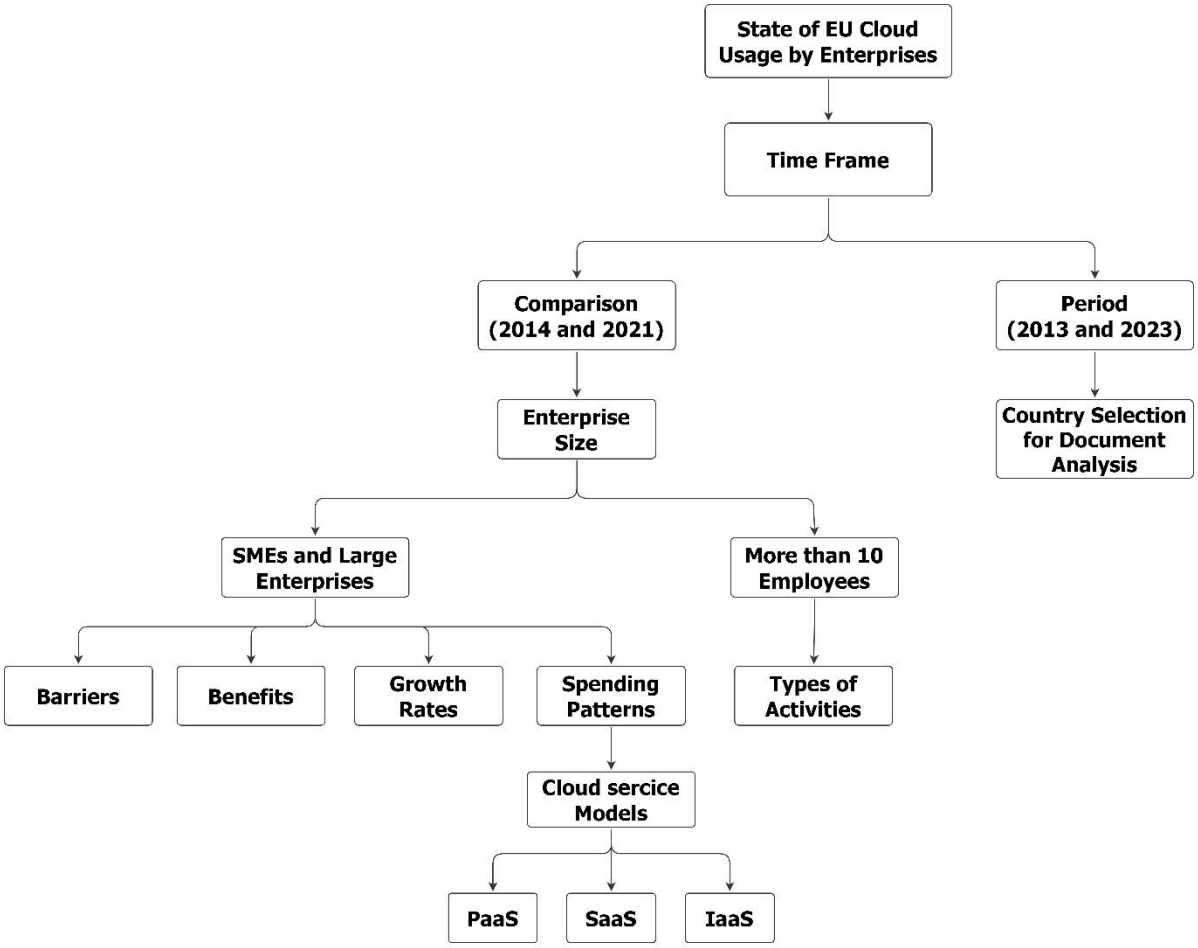


Figure 5: Concept of the process

Source: Author's own creation

3.5. Eurostat Data Analysis

3.5.1. Data Source

The European Union's Eurostat collects data on cloud computing usage through the "Community Survey on ICT usage and e-commerce in Enterprises (CIS)" program. This survey is conducted annually by National Statistical Institutes (NSIs) across EU member states. The survey aims to gather comprehensive information on enterprises' adoption and usage of information and communication technologies (ICT), including their utilization of cloud computing services.

The survey covers various aspects of cloud computing, such as types of cloud services used, frequency, intensity of usage, and factors influencing adoption, both at the individual and enterprise levels. The scope of this study is focused on examining the utilization of cloud

computing services within enterprises. The study utilizes data from the Eurostat survey titled "Cloud computing services by size class of enterprise (isoc_cicce_use)" within the Digital Economy and Society category (*Cloud computing - statistics on the use by enterprises - Statistics Explained* 2023).

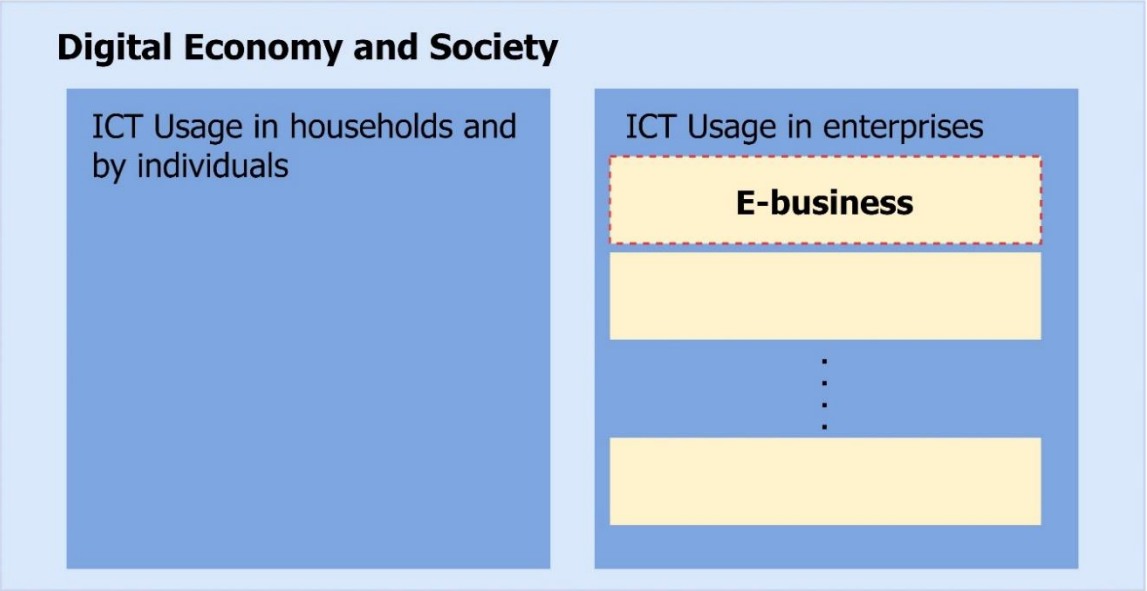


Figure 6: Data library

Source: (*Statistics | Eurostat* 2023)

3.5.2.Data Collection

This study followed the same procedure of collecting data by the paper named Cloud Computing Services–Emerging Trends During the Times of Pandemic (Kopáčková, Htoo 2023). Eurostat acquired the necessary data (*Statistics | Eurostat* 2023)in the MS Access database format in March 2023. The database consists of 14 tables and four queries. The primary focus was on the "DataWithAggregates" table, which includes all essential attributes.

Additionally, five reference tables, named "Activities," "Countries," "EntSizes," "Indicators," and "Years," were utilized to understand the data relationships and streamline data collection processes thoroughly. To compare cloud usage by enterprises in the EU, six attributes: Year, ExpCountry, ExpEntSize, ExpActivity, ExpIndicator, and Value are selected. For the "Year" attribute, two values, 2014 and 2021, were chosen, representing the oldest and newest years available in the database at the time of acquisition. This time frame was selected as the most suitable for conducting comparisons.

The study picked nine values for the “ExpCountry” attribute based on the country selection process. For the “ExpEntSize” attribute, it is decided on three attribute values: GE10(10 persons employed or more), 10-249(From 10 to 249 persons employed), and GE250(250 persons employed or more). Concerning the “ExpActivity” attribute, the paper selected ten attribute values (C, D_E, E, F, G, H, I, J, M, N). Lastly, the “ExpIndicator” attribute is chosen (E_CC, e_cc_bcost_hs, e_cc_bease_hs, e_cc_bflex_hs).

3.6. Document Analysis

In the second phase of the research, focusing on Research Question 2 (RQ2), the process is conducted through a comprehensive review of existing literature better to understand the current state of knowledge in Cloud Computing and to uncover any prevalent patterns and trends in this area. To provide a more focused description of the research, the findings from the systematic review were integrated with the initial phase of the process, which was predicated on analyzing available data. This integration allowed a more holistic approach to the research and provided a more comprehensive exploration of the research questions.

3.6.1. Country Selection

The European Union consists of 27 member states. Instead of including all these 27 states (EU country profiles | European Union), a targeted approach is focused on specific countries according to their cloud usage status. The selection of these countries is based on the EU survey on ICT usage and e-commerce in enterprises (ICT usage in enterprises, isoc_cicce_use) that has already been applied to the study. Utilizing this survey data, nine member states were chosen based on their respective rankings regarding cloud usage within the EU. From the ranked list of countries, three countries are selected from the highest rank, three from the middle, and three from the lowest rank.

3.6.2. Protocol

To review the literature systematically, the thesis follows the guidelines initiated by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. Following the PRISMA guidelines ensures transparent and comprehensive reporting of review methodologies, including search strategies, study selection criteria, and data extraction methods. (Moher et al., 2010).

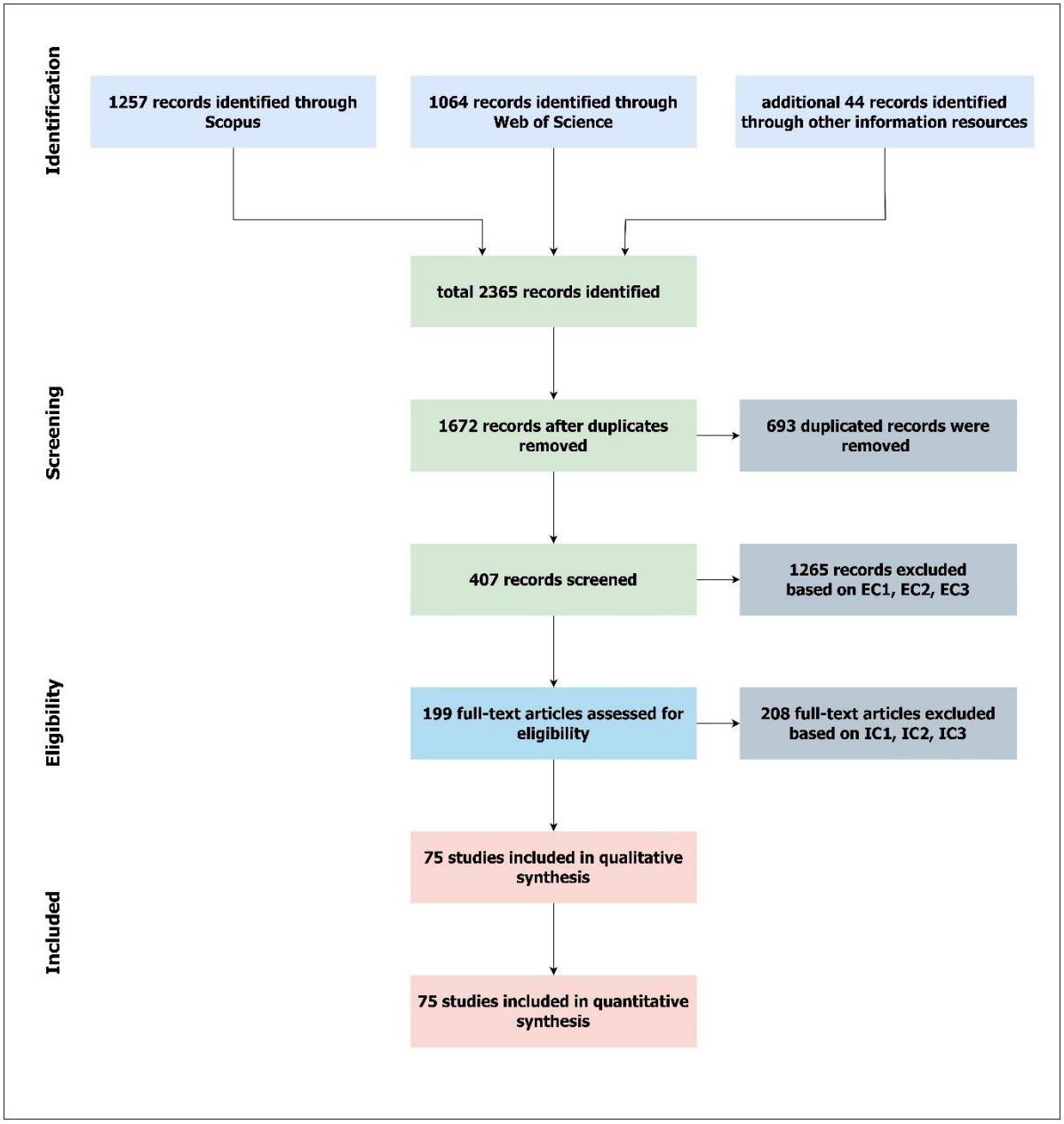


Figure 7: PRISMA flow diagram

Source: Author's own creation

3.6.3.Information Resources and Search Strategy

Scopus and Web of Science were selected as the primary information sources due to their extensive coverage of scholarly articles and journals. Additional searches were conducted on Google Scholar, the European Commission Digital Library, ENISA, and CIF to expand the literature review and gather more insights. The search period was limited to publications from 2009 to 2023, ensuring that the recent and relevant studies were included. The search used the

"Title, Abstract, Keywords" search form to retrieve relevant literature within the specified parameters.

The search strategy employed a combination of search terms to capture various aspects of cloud computing adoption within the context of the European Union. To be more specific, the search terms used included certain keywords such as “cloud computing,” "cloud adoption," "drivers," "challenges," "benefits," "risks," and "factors" in conjunction with Boolean operators, “AND” and “OR” to refine search results. The terms "EU" and "selected countries" were included to focus the search on specific geographic contexts. In the European Commission Digital Library, a specific search strategy was created, employing content type filters such as "Report/Study," the topic "Cloud Computing," and a time frame ranging from 2013 to 2023.

3.6.4.Eligibility Criteria

Following the PRISMA statement, inclusion and exclusion criteria were established to guarantee the relevance and quality of studies. The Inclusion Criteria (IC) and Exclusion Criteria (EC) were specified as follows:

IC1: Includes studies specifically addressed cloud adoption within the context of the selected EU countries.

IC2: Includes studies examining both drivers and challenges of cloud adoption within focused countries.

IC3: This includes studies examining at least cloud adoption drivers or challenges within focused countries.

EC1: Excludes studies not written in English to ensure consistency and accessibility for analysis.

EC2: Excludes studies not conducted on cloud computing or cloud adoption.

EC3: Exclude studies that do not concentrate on the selected countries.

3.6.5.Process of selecting and screening documents

A thorough review of 2365 studies was conducted through the initial search process. This resulted in 1257 documents from Scopus, 1064 documents from Web of Science, and 44 from other sources. 693 duplicates were removed using Rstudio to ensure the integrity of the review

process. The identified studies 1672 were subjected to predefined inclusion and exclusion criteria to be eligible for further review. The process emphasized evaluating the titles and abstracts of the studies to determine their alignment with the scope of cloud computing within the European Union. 1265 studies that did not explicitly address this specific area of interest were excluded from further consideration. Furthermore, 208 studies were removed based on inclusion criteria. Following this screening process, 75 documents were identified as meeting the criteria for full-text screening, indicating their potential relevance to the study objectives.

4. RESULTS

Cloud computing is a transformative technology that provides scalable and flexible computing resources over the internet. It is reshaping the IT landscape and influencing business models and societal practices. This section presents the research findings on adopting cloud computing within the EU using data from Eurostat. Eurostat is a valuable resource for gaining insights into various aspects of EU economies and societies, providing high-quality statistics and data on Europe.

This study explores the level of cloud adoption across EU member states by examining key indicators such as usage patterns, deployment models, and challenges associated with adoption. By analyzing Eurostat data, the study aims to provide a detailed understanding of the factors driving cloud adoption and the obstacles existing among different regions and sectors within the EU.

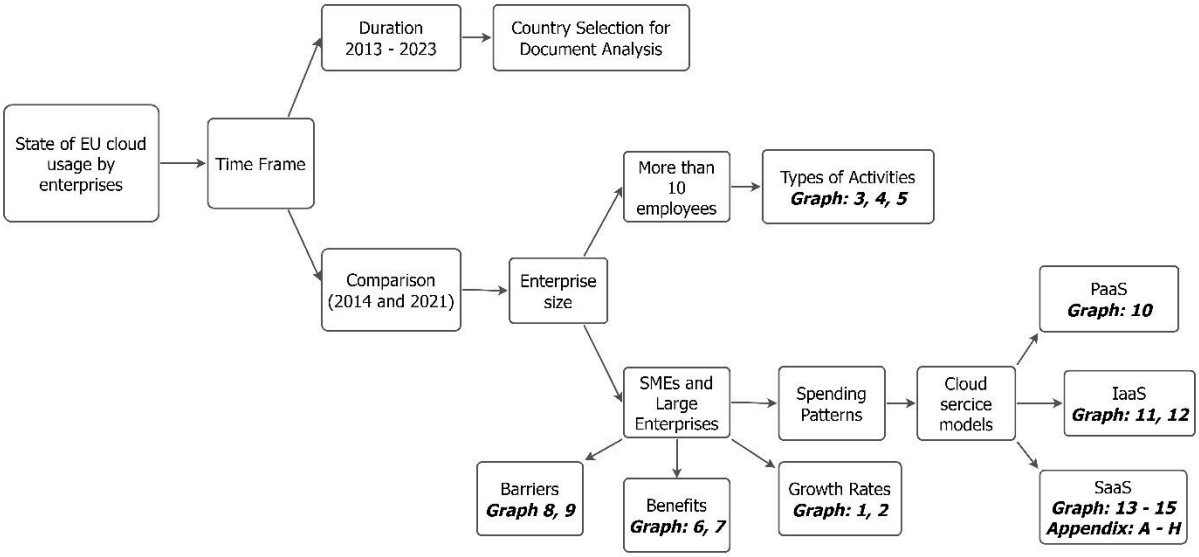


Figure 8: Map of the result

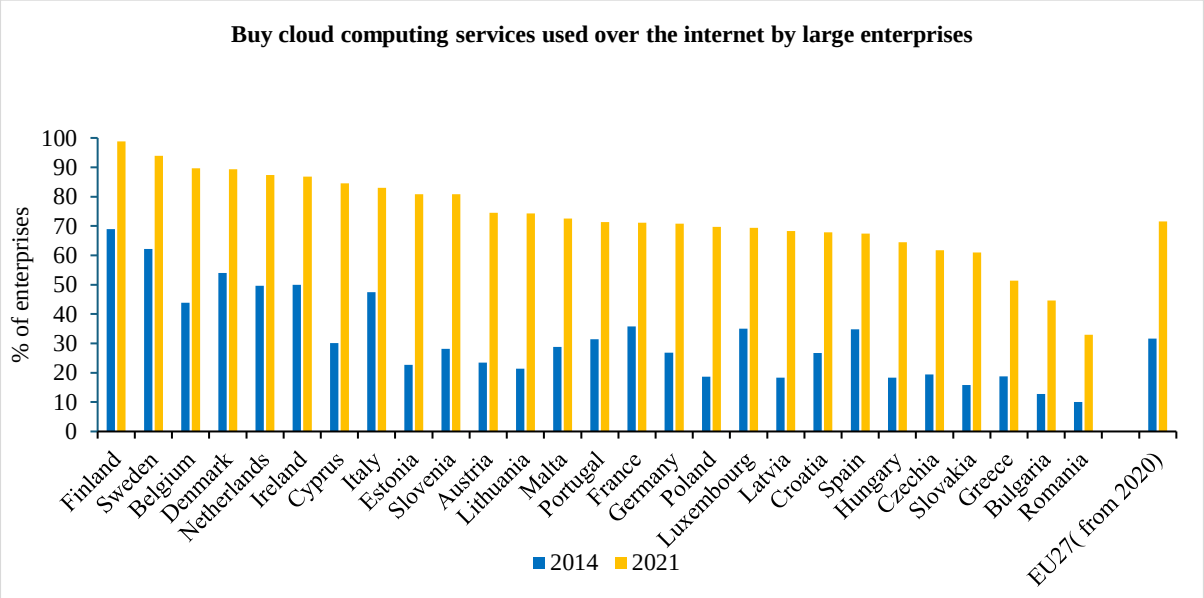
Source: Author's own creation

4.1. Variations in Cloud Adoption

4.1.1. Gwroth Rates

Graphs 1 and 2 compare the adoption rates of cloud computing services in large enterprises with more than 250 employees and SMEs (Small and Medium-sized Enterprises) across various European countries in 2014 and 2021. The data shows significant increases in adoption

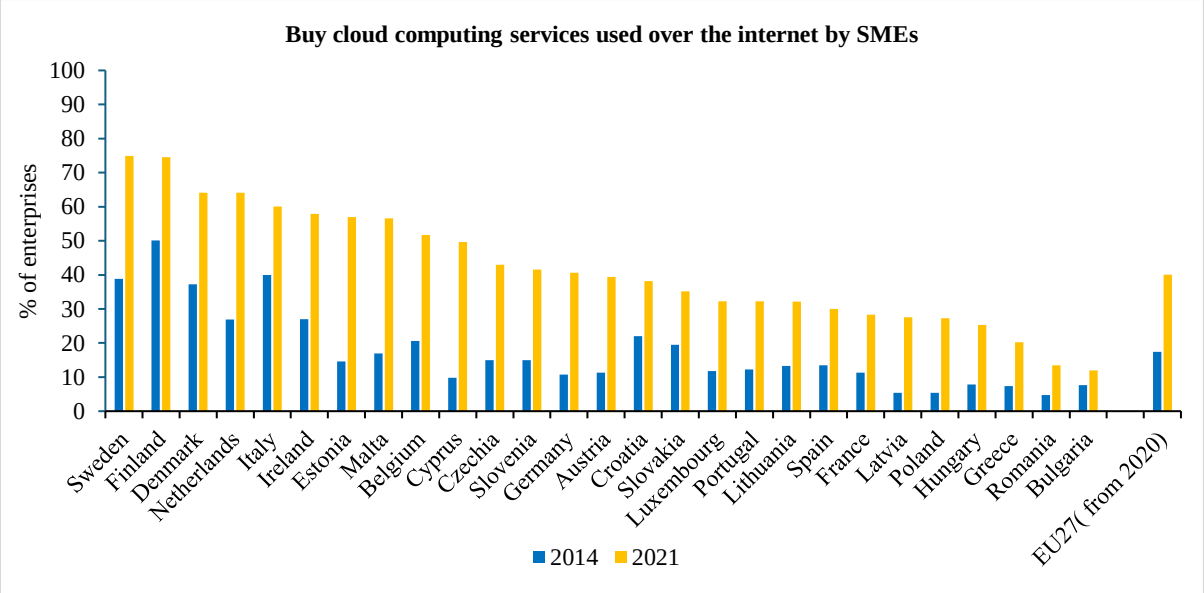
rates for both large enterprises and SMEs in most countries. Austria saw a significant rise in cloud adoption among large enterprises, increasing from 23.5% in 2014 to 74.5% in 2021. This indicates a growing trend towards adopting cloud technologies over time.



Graph 1: Growth Rates of large enterprises

Source: Author's own creation

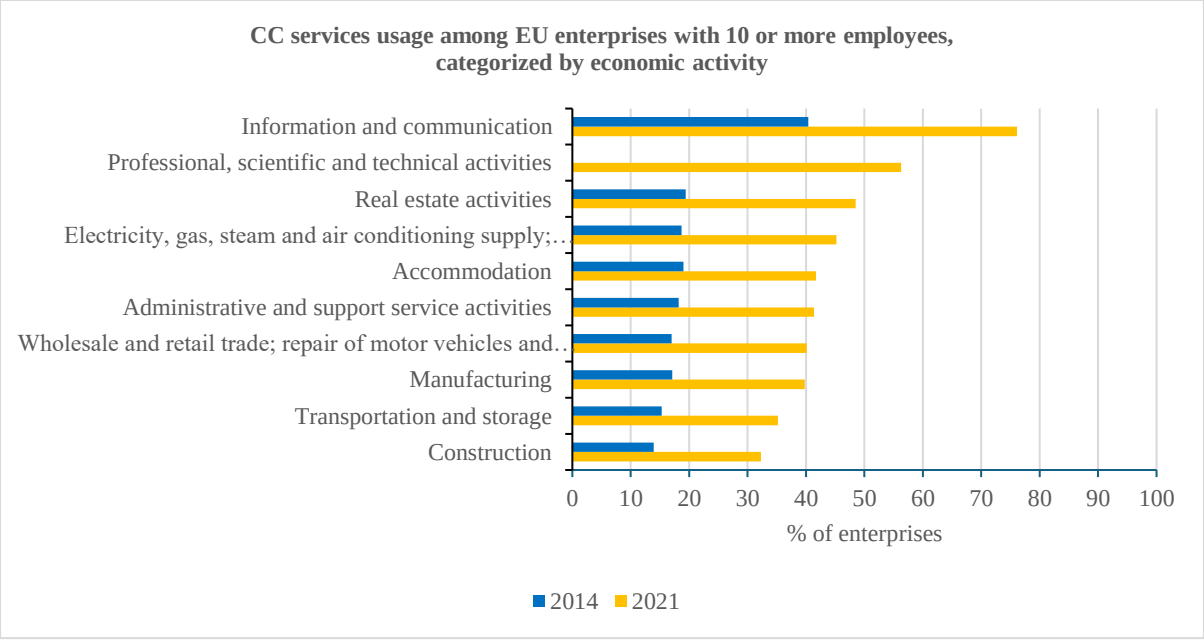
SME adoption also experienced growth, climbing from 11.3% to 39.4% during the same period. It indicates that European SMEs have lower adoption rates for cloud computing than large enterprises. However, countries like Belgium, Denmark, and Sweden, where both large enterprises and SMEs show high adoption rates, indicate a robust cloud computing culture across businesses of all sizes. Meanwhile, countries like Bulgaria and Romania have lower adoption rates. These findings indicate the increasing importance of cloud computing across businesses of all sizes in Europe while highlighting variations in adoption rates between countries and business sizes.



Graph 2: Growth rates of SMEs

Source: Author's own creation

4.1.2. Types of Activities: Cloud Adoption Across Industries



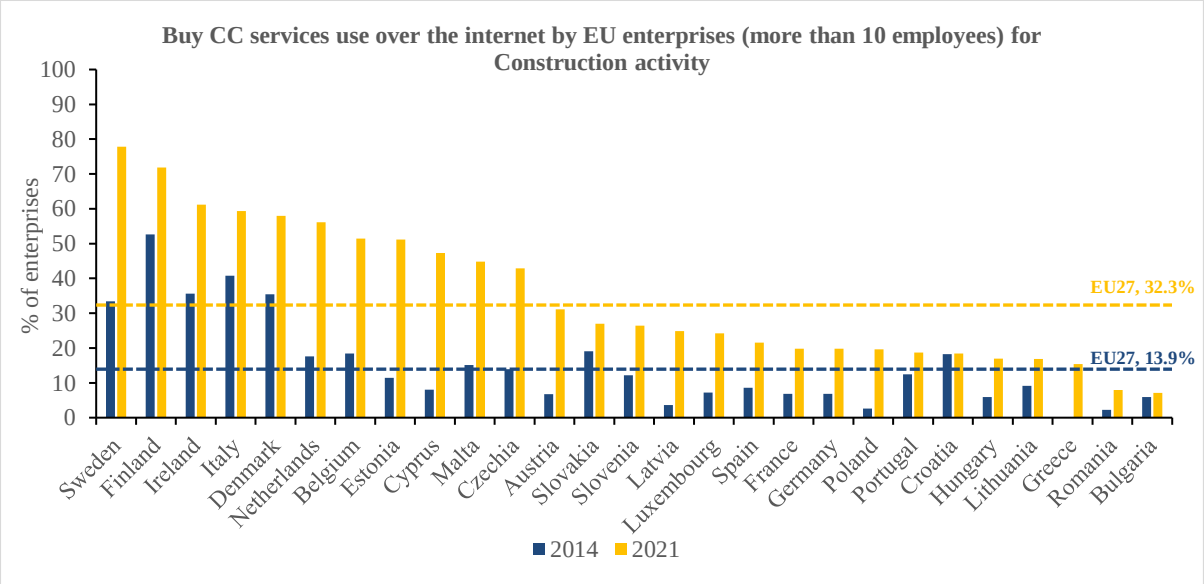
Graph 3: Purchasing rates by activities

Source: Author's own creation

The data depicted in Graph 3 displays the adoption rates of cloud computing services in various industries between 2014 and 2021. During this period, the adoption rates have increased across all industries, indicating that businesses rely more on cloud technologies. Industries such as Construction, Transportation, Storage, and Manufacturing witnessed significant growth in

adoption rates, with increases from 13.9% to 32.3%, 15.3% to 35.2%, and 17.1% to 39.8%, respectively. Similarly, sectors like Wholesale and Retail Trade, Administrative and Support Service Activities, and Accommodation have also experienced notable increases in adoption rates. The Information and Communication industry witnessed the most impressive increase, surging from 40.4% in 2014 to 76.1% in 2021, proving that cloud computing plays a crucial role. These findings demonstrate the diverse patterns of cloud adoption across different sectors, highlighting the importance of cloud technologies in modern business operations and organizational strategies. It also indicates that different industries exhibit varying levels of adoption of cloud computing services, and industries with higher technological intensity may exhibit higher adoption rates compared to industries with lower technological intensity.

4.1.2.1. Cloud Adoption in the Construction Sector



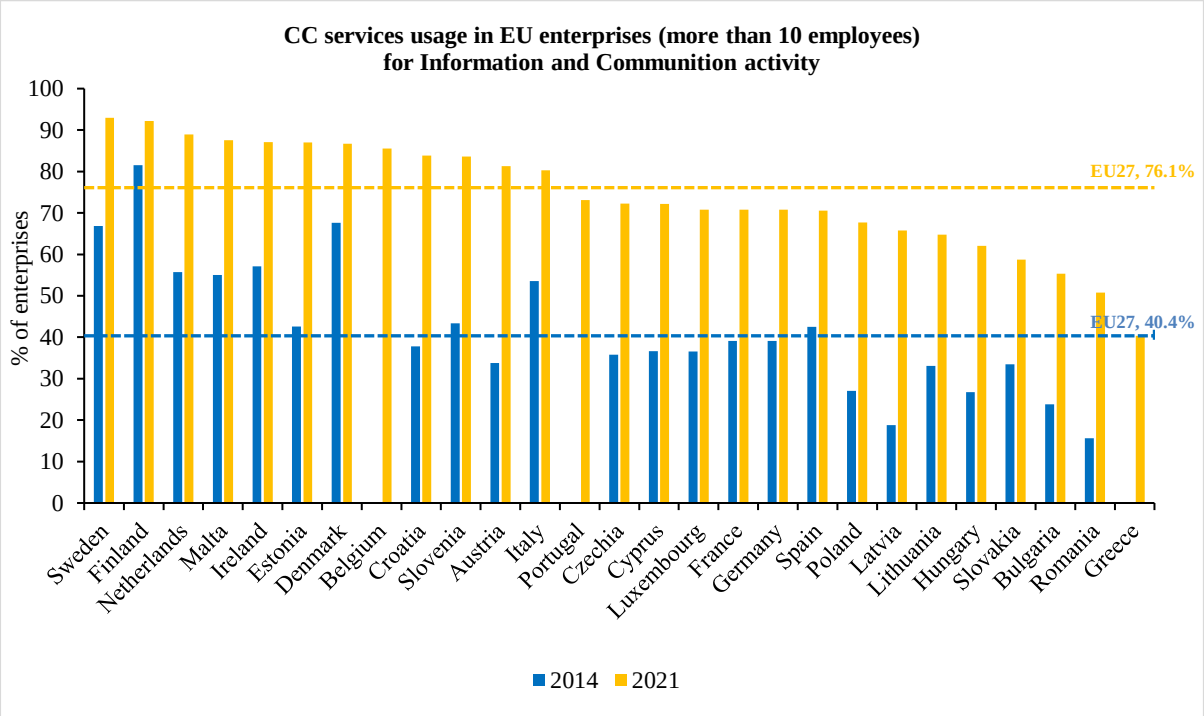
Graph 4: Purchasing rates by construction enterprises

Source: Author's own creation

The data presented in Graph 4 showcases the adoption rates of cloud computing services by construction companies in EU countries with at least 10 employees in 2014 and 2021. It reveals that many EU countries have witnessed a significant increase in CC adoption rates during this period, indicating the growing importance of cloud technologies in the construction sector. In Sweden, adoption rates surged significantly from 33.4% in 2014 to 77.8% in 2021, significantly shifting towards cloud-based solutions. The adoption rates in Finland, Ireland, and Italy also grew considerably during this period. However, there are notable differences in adoption rates among EU countries, with some countries, such as Romania and Bulgaria, showing lower

adoption rates than others. These findings highlight the changing landscape of cloud adoption within the construction sector across the EU.

4.1.2.2. Cloud Adoption in the Information and Communication Sector



Graph 5: Purchasing rates are based on information and communication activity

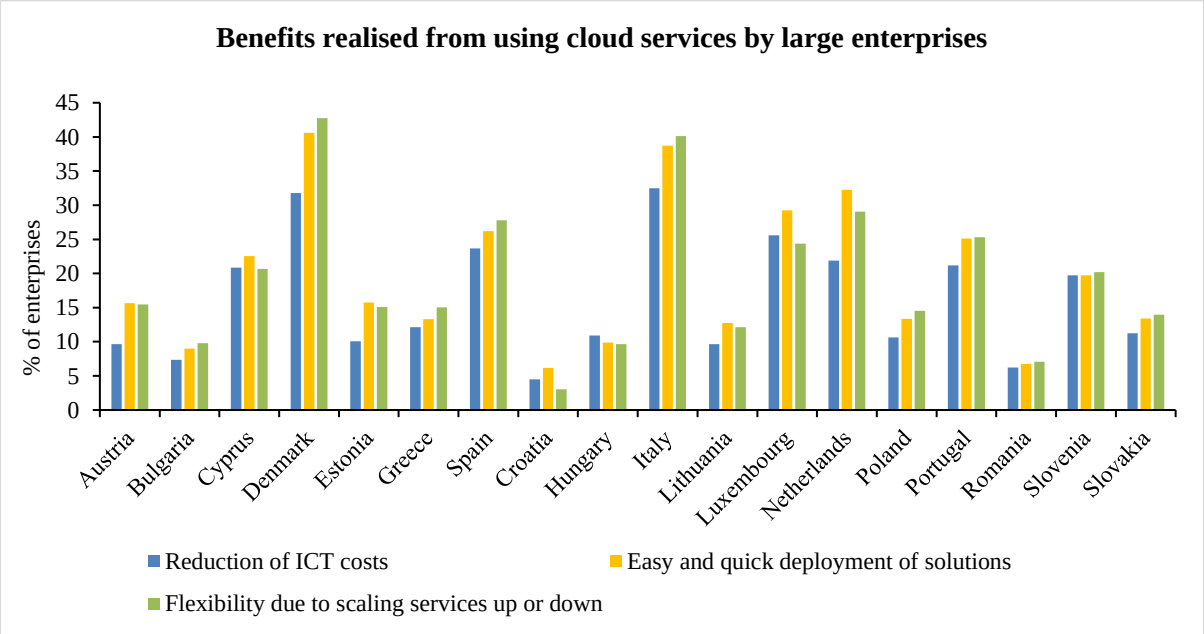
Source: Author's own creation

The data presented in Graph 5 outlines the utilization of cloud computing services by enterprises in EU countries with over ten employees, focusing on the Information and Communication sector, from 2014 to 2021. The data shows a significant increase in cloud computing adoption rates across many EU nations during this period, indicating a growing reliance on cloud technologies within the region's business landscape. For instance, Sweden experienced a substantial rise from 66.9% in 2014 to 92.9% in 2021, reflecting a notable shift towards cloud-based solutions. Similarly, Finland, the Netherlands, Malta, and Ireland also witnessed substantial increases in adoption rates, indicating a trend towards cloud adoption among EU enterprises. However, variations exist among EU member states, with some countries, such as Romania, Bulgaria, and Greece, exhibiting lower adoption rates than others. Overall, the data underscores the evolving role of cloud computing in European business operations, particularly within the Information and Communication sector, highlighting the importance of cloud technologies in modern organizational strategies and operations.

4.1.3. Benefits: Factors Motivating Cloud Adoption

Graphs 6 and 7 display the advantages of cloud computing services in different European countries. These benefits are grouped into three primary categories: reduced ICT expenses, rapid and effortless implementation of solutions, and the capacity to adjust services according to scaling requirements. Austria has shown significant reductions in ICT costs and substantial improvements in solution deployment and flexibility. Denmark has also made remarkable advancements in all three aspects, with notable cost reductions and impressive flexibility in scaling services.

Another country that stands out is Cyprus, which has exhibited substantial cost reductions and efficient solution deployment. Conversely, Croatia indicates comparatively lower benefits across all categories, with minimal reductions in ICT costs and limited advancements in solution deployment and flexibility. Romania follows a similar trend, showing modest gains in all three aspects. Overall, the data underscores the widespread adoption and varying degrees of success in leveraging cloud computing services across European nations, highlighting the potential for significant cost savings, streamlined solution deployment, and enhanced operational flexibility.



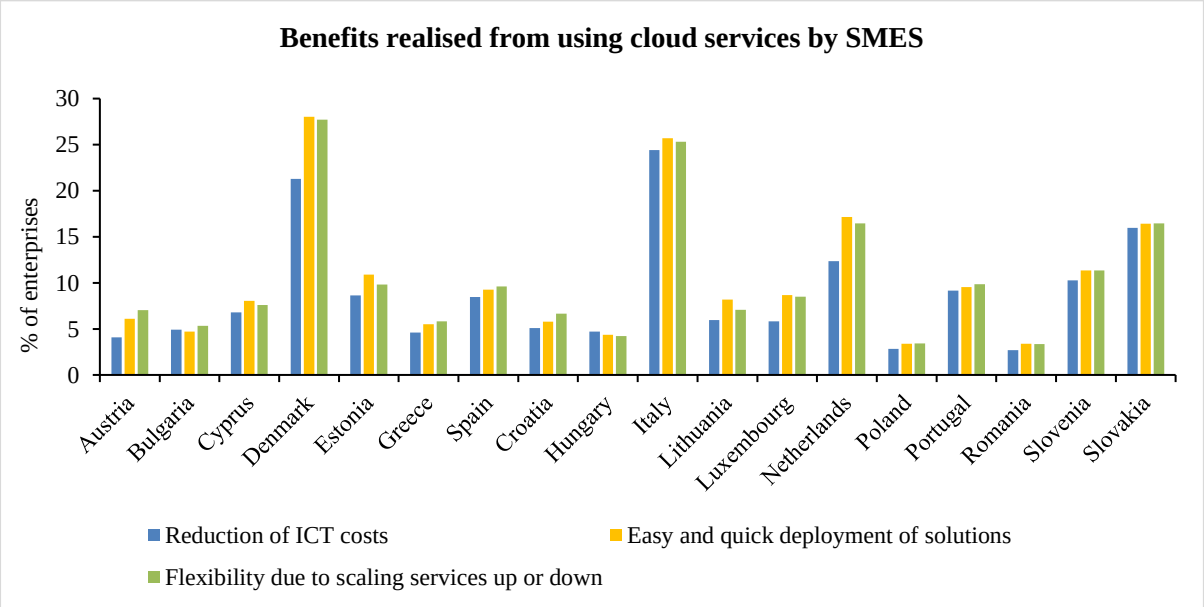
Graph 6: Benefits realized from large enterprises using cloud services

Source: Author's own creation

The provided data (Graph: 6) outlines the utilization of cloud computing services by SMEs across various EU countries, focusing on three key metrics: reduction of ICT costs, ease and speed of solution deployment, and flexibility in scaling services.

Denmark emerges as a leader in cloud adoption among SMEs, with significant reductions in ICT costs and exceptional agility in solution deployment and service scaling. Italy also demonstrates strong performance across all metrics, particularly notable in cost reduction and solution deployment. Luxembourg showcases notable benefits for SMEs, with considerable reductions in ICT costs and impressive flexibility. Similarly, Slovenia exhibits significant advantages in all three aspects, highlighting SMEs' robust adoption of cloud computing.

Conversely, Poland and Romania display comparatively lower levels of cloud adoption among SMEs, with modest benefits in ICT cost reduction and solution deployment and limited flexibility in scaling services. Overall, the data underscores the varying degrees of cloud adoption and corresponding benefits realized by SMEs across EU countries, emphasizing the importance of cloud computing in enhancing operational efficiency and competitiveness for smaller businesses.



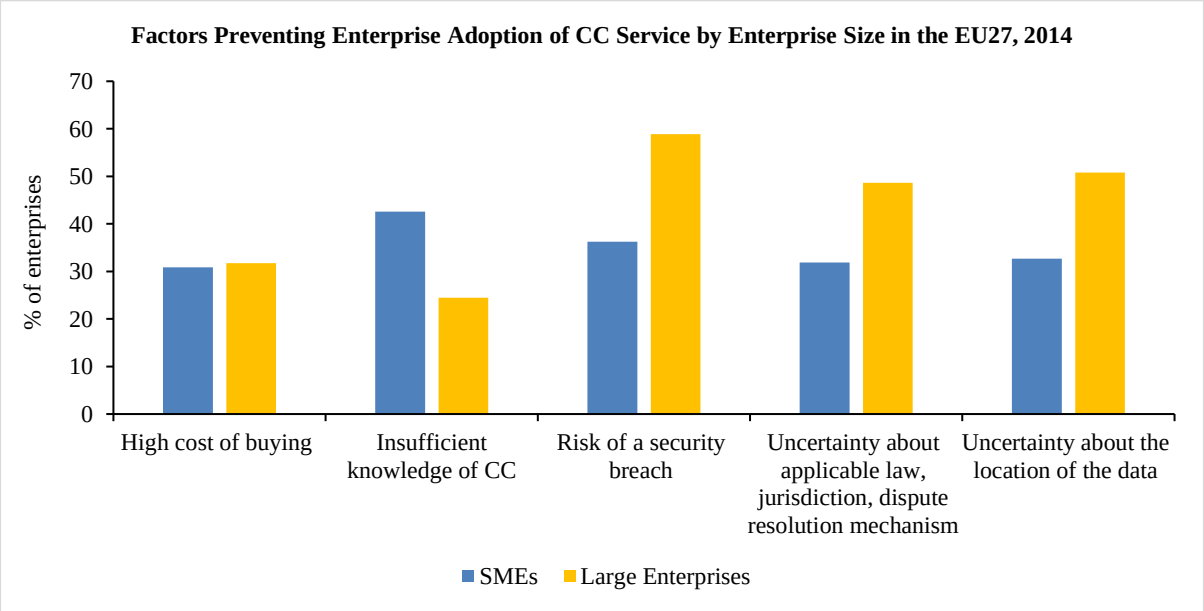
Graph 7: Benefits realized from SMEs using cloud services

Source: Author's own creation

4.1.4. Barriers: Factors Preventing Cloud Adoption

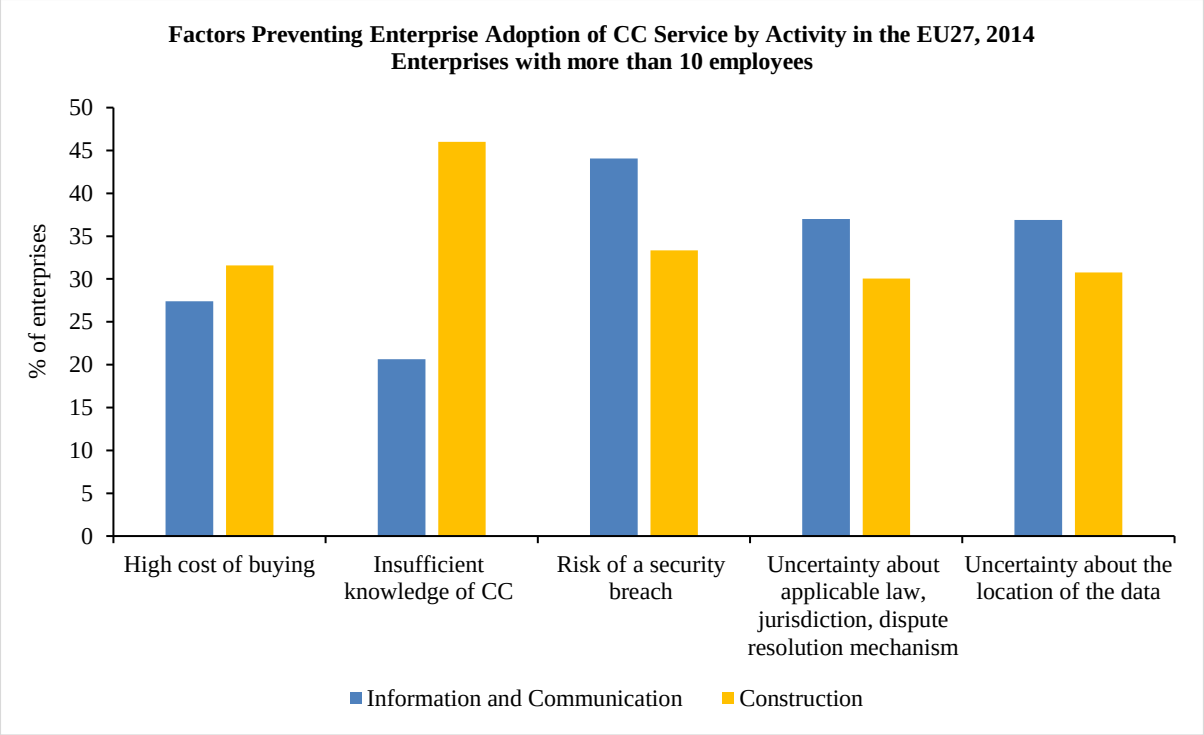
The barriers preventing enterprises in the EU from buying cloud services are depicted in Graphs 8 and 9. It focused on enterprise size, differentiating between SMEs and large enterprises. The chart illustrates the overall percentages of various factors hindering cloud adoption among SMEs and large enterprises in the EU27. Notably, the high cost of purchasing cloud services was cited as a significant deterrent, with SMEs reporting 30.9%, while large enterprises reported a slightly higher rate of 31.8%.

Insufficient knowledge of CC emerged as another prominent obstacle, with a notably higher percentage among SMEs at 42.6 compared to 24.5 among large enterprises. Concerns regarding the risk of security breaches were prevalent across both categories, though more pronounced among large enterprises, registering at 58.9% compared to 36.3% for SMEs. One key finding is that SMEs perceive insufficient knowledge of the cloud as a more significant barrier than large enterprises. This suggests that SMEs may face challenges understanding and implementing CC solutions due to limited resources or expertise. On the other hand, large enterprises appear to prioritize concerns about the risk of security breaches, indicating a greater emphasis on safeguarding sensitive data and information.



Graph 8: Factors preventing enterprise cloud service adoption by enterprise size in the EU27, 2014

Source: Author's own creation



Graph 9: Factors preventing enterprise cloud service adoption by activity in the EU27, 2014

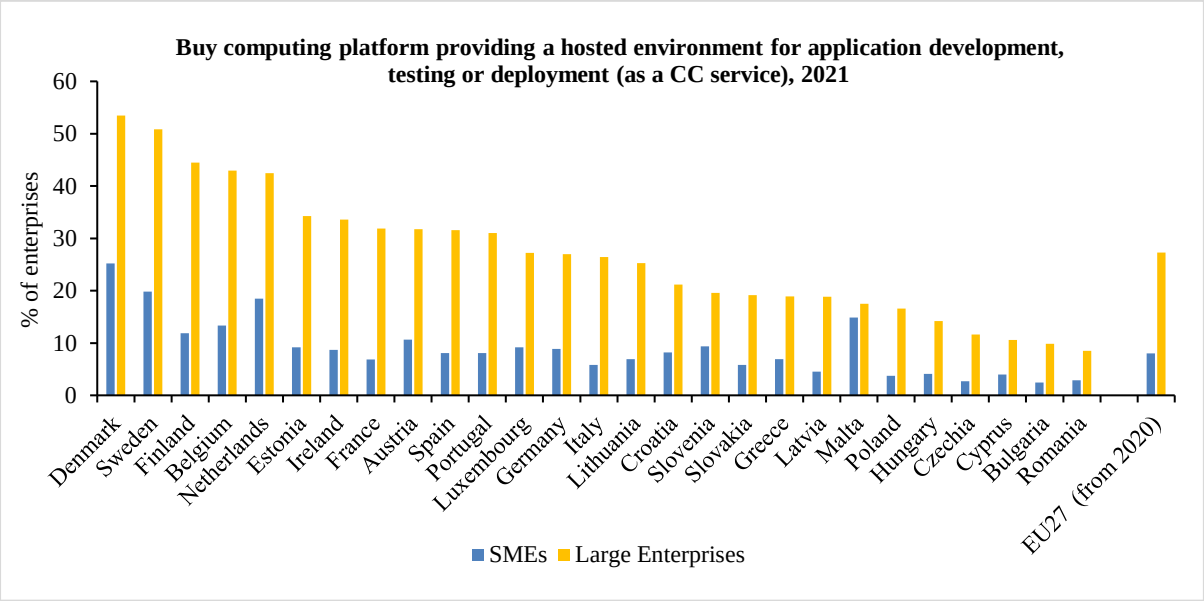
Source: Author's own creation

The factors preventing the purchase of cloud services varied between the Information and Communication activities and Construction activities described in Figure 8. Among enterprises with more than ten employees, the high cost of purchasing cloud services was cited as a significant barrier, with 27.4% of enterprises in the Information and Communication sector and 31.6% in the Construction sector.

A significant indication is that insufficient knowledge of cloud computing emerged as a massive barrier for the construction sector, where 46% of enterprises reported it as a deterrent compared to 20.64% in the Information and Communication sector. Conversely, the risk of a security breach was perceived as a more considerable concern in the Information and Communication sector, with 44.06% of enterprises highlighting it as a barrier. In comparison, only 33.35% in the Construction sector expressed similar concerns. Additionally, uncertainties surrounding applicable laws, jurisdiction, dispute resolution mechanisms, and data location were identified as significant barriers in both sectors with slightly different proportions. These findings highlight enterprises' challenges in adopting cloud services across different sectors and underscore the importance of sector-specific approaches in addressing these barriers.

4.1.5. Spending Patterns

4.1.5.1. Platform as a Service



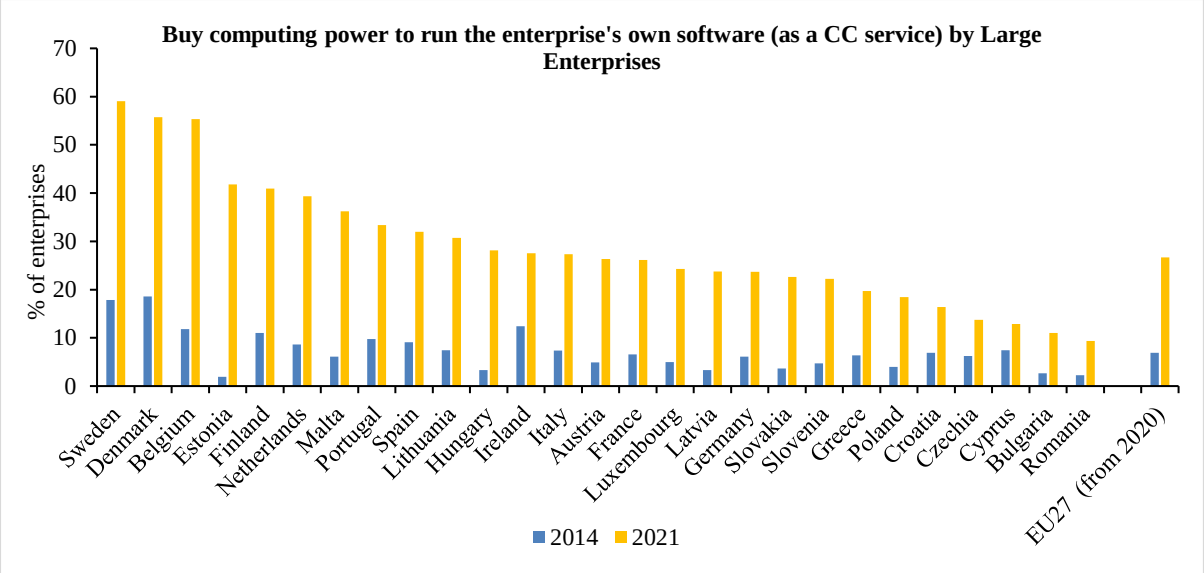
Graph 10: Purchasing PaaS

Source: Author's own creation

The adoption rates of CC platforms to host environments for application development among SMEs and large enterprises across various European countries in 2021 are depicted in Graph 10. SMEs and large enterprises in Denmark demonstrate a relatively higher adoption rate than other countries, with 25.2% in SMEs and 53.5% in large enterprises, respectively. Notably, Sweden and Finland also show substantial adoption rates among SMEs and large enterprises, indicating a positive trend towards cloud computing integration in these countries. Conversely, Romania and Bulgaria have the lowest adoption rates across SMEs and large enterprises, suggesting potential barriers to cloud adoption in these nations. SMEs' adoption of cloud technology in Malta ranks fourth among all EU countries.

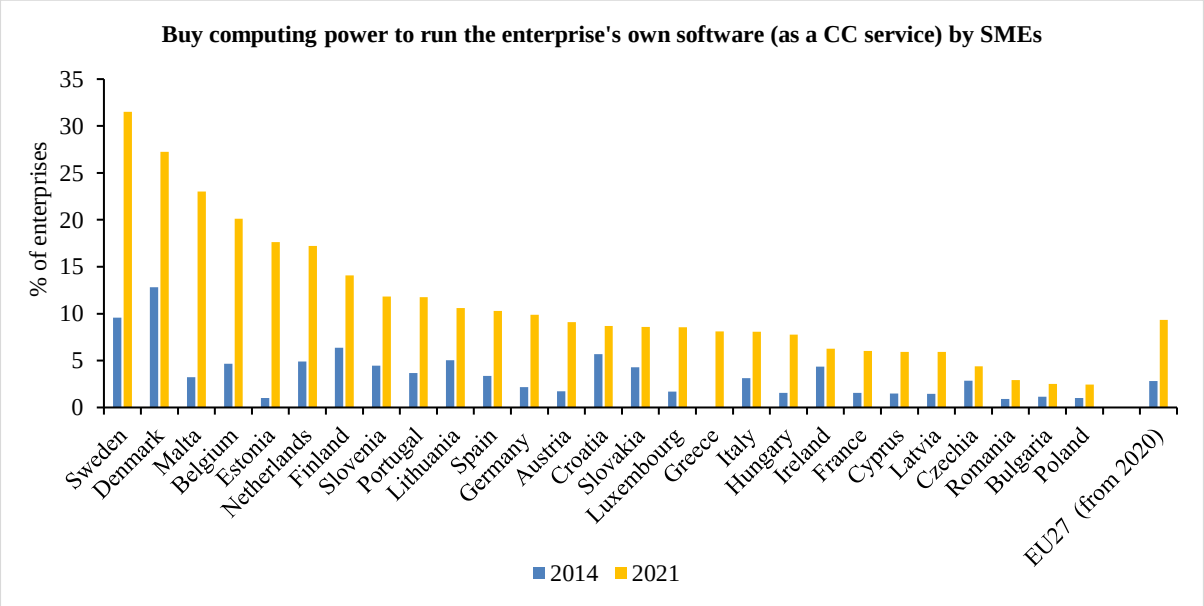
4.1.5.2. Infrastructure as a Service

The comparison between SMEs and large enterprises in terms of buying computing power to run the enterprise's software as a service across European countries for 2014 and 2021 is depicted in Graphs 11 and 12.



Graph 11: IaaS in large enterprises

Source: Author's own creation



Graph 12: IaaS in SMEs

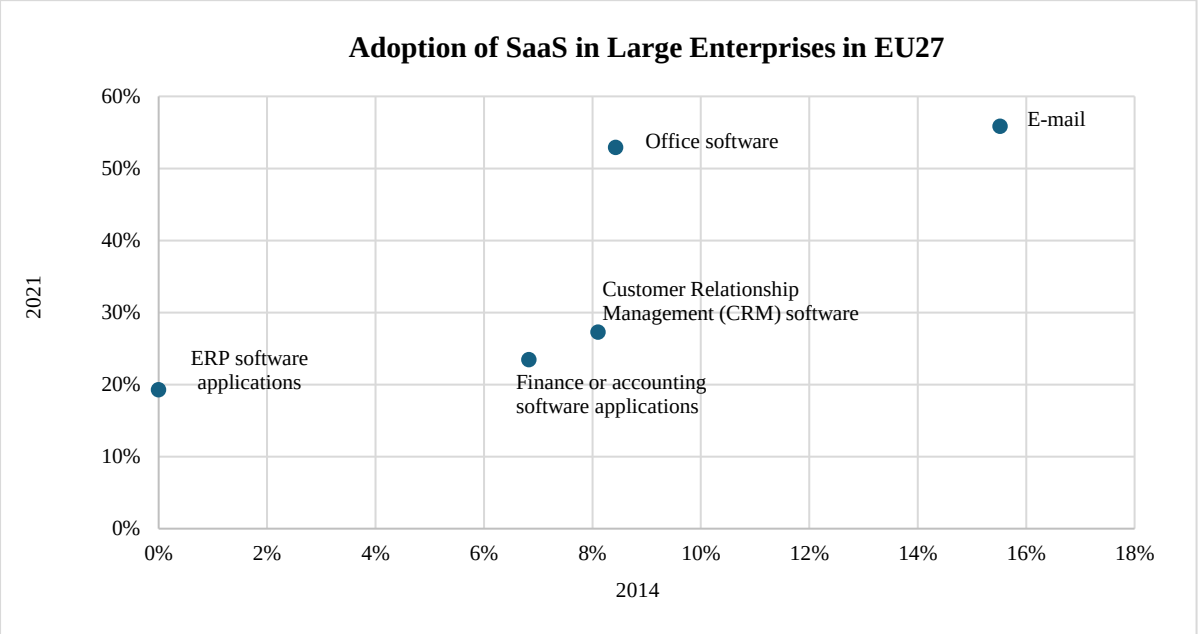
Source: Author's own creation

Among SMEs, Sweden and Denmark consistently demonstrate relatively higher adoption rates in both 2014 and 2021, with Sweden showing significant growth from 9.6% to 31.5% and Denmark from 12.8% to 27.3%. Conversely, countries like Malta and Belgium exhibit substantial increases in adoption rates over the same period, indicating a notable shift towards CC services among SMEs. Similarly, large enterprises in Sweden and Denmark also show remarkable growth, with adoption rates soaring from 17.8% to 59% and 18.6% to 55.8%,

respectively. Notably, countries such as Estonia and Finland witness considerable increases in adoption rates among large enterprises, reflecting a broader trend of CC service adoption across different enterprise sizes. Overall, the data highlights a significant surge in cloud service adoption among SMEs and large enterprises across various EU countries, underscoring the increasing reliance on cloud technologies to power enterprise software and operations.

4.1.5.3. Adoption of Software as a Service

The data provided by Graphs 13 and 14 illustrates the adoption of Software as a Service (SaaS) cloud solutions by large enterprises and SMEs across the EU27. The focus lies on various software applications, including Customer Relationship Management (CRM), Email, Enterprise Resource Planning (ERP), Finance or accounting, and Office software.

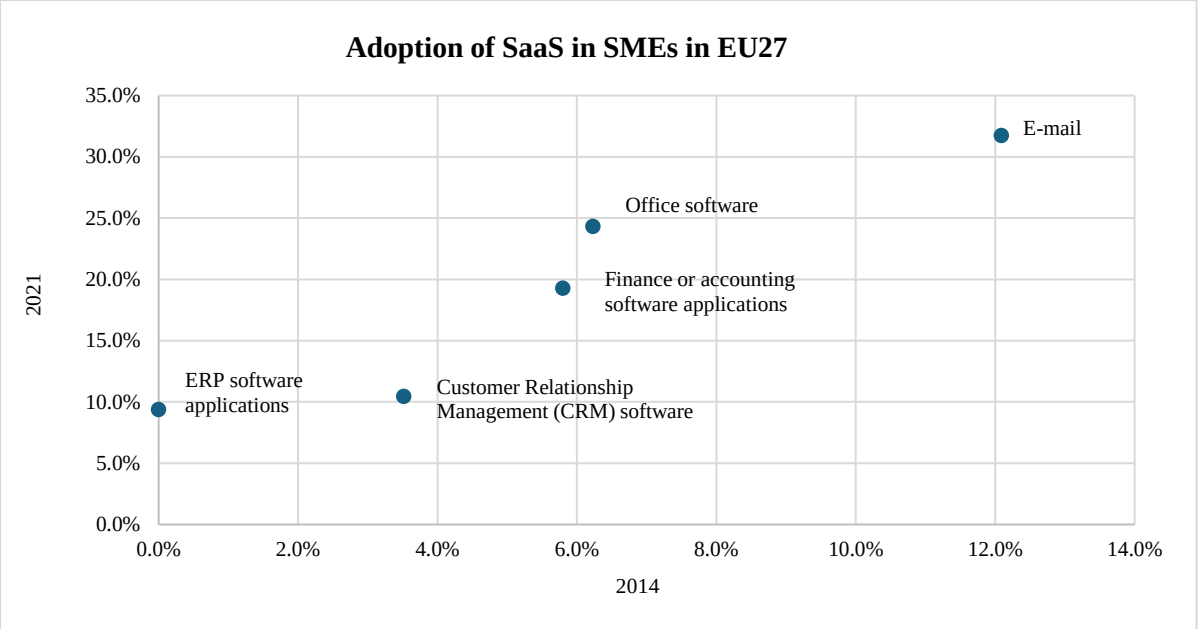


Graph 13: SaaS usage among large enterprises, EU27

Source: Author's own creation

In 2021, large enterprises showed a significant increase in the usage of SaaS solutions, with Email services (55.9%) and Office software (52.9%) being the most popular. Large enterprises also widely used CRM software (27.3%) and Finance or Accounting software applications (23.4%). However, ERP software applications had a slightly lower adoption rate of 19.3%, which was still significant. Comparatively, in 2014, adoption rates of SaaS solutions among large enterprises were notably lower across all categories. Email services (15.5%) and Office software (8.4%) had the highest adoption rates, followed by CRM software (8.1%) and Finance or accounting software applications (6.8%). The usage of ERP software applications had not

been described for 2014. Overall, the data indicates a substantial increase in the adoption of SaaS cloud services among large enterprises within the EU, signifying a growing reliance on cloud-based solutions for critical business operations.



Graph 14: SaaS usage among SMEs, EU27

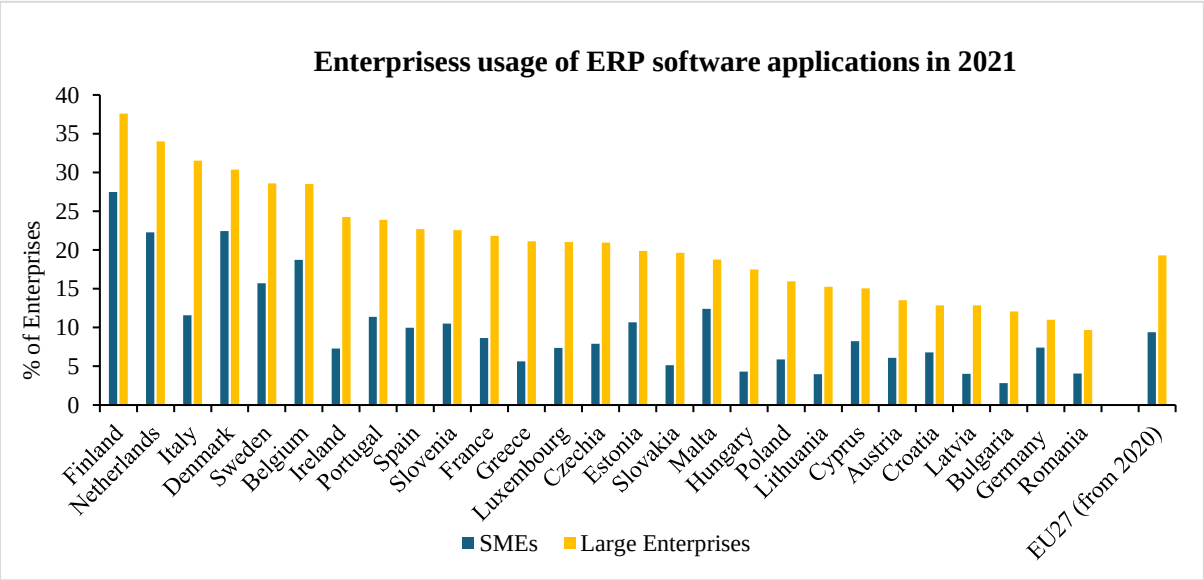
Source: Author's own creation

SMEs in the EU27 region showed a significant interest in SaaS solutions. Among the popular SaaS solutions, Email services were adopted by 31.7% of SMEs, followed by Office software at 24.3%. Finance or accounting software applications and CRM software also gained considerable attention, with adoption rates of 19.3% and 10.5%, respectively. However, ERP software applications had a lower adoption rate of 9.37%. Comparatively, in 2014, adoption rates were notably lower across all categories. SMEs showed less inclination towards SaaS solutions, with Email services (12.1%) and Office software (6.2%) recording the highest adoption rates. CRM software (3.5%) and Finance or accounting software applications (5.8%) also saw moderate adoption, while ERP software applications usage was not described. There is a growing trend among European SMEs to adopt SaaS cloud services for software applications, indicating a shift towards more efficient and scalable business solutions.

Adoption of Cloud-based ERP software among Large Enterprises and SMEs

In 2021, it was observed that several large enterprises across Europe have increasingly adopted cloud-based ERP software solutions as shown in Graph 15. Finland emerged as the leader with the highest adoption rate of 37.6%, followed by countries such as the Netherlands, Italy,

Denmark, and Sweden. Even countries like Germany, Romania, and Bulgaria, with slightly lower adoption rates, witnessed the growing significance of cloud-based ERP solutions. SMEs across Europe also demonstrated varying levels of adoption of cloud-based ERP software. Finland led the way with a 27.5% adoption rate, followed by Denmark and the Netherlands. Countries such as Belgium, Sweden, and Malta also showed significant uptake of cloud ERP among SMEs, indicating that smaller businesses increasingly recognize the benefits of cloud technology. However, adoption rates in Bulgaria, Romania, and Lithuania remained relatively low.



Graph 15: Enterprises' usage of ERP software

Source: Author's own creation

Adoption of Cloud-based CRM software among Large Enterprises and SMEs

According to the survey depicted in Appendix A, large enterprises Finland and Sweden demonstrated significant growth in SaaS CRM adoption from 2014 to 2021. Finland increased from 22.9% to 55.7%, and Sweden increased from 15% to 51.9%. This indicates that major regional corporations are increasingly dependent on cloud-based CRM solutions. Other countries, such as Italy, Belgium, and Denmark, also experienced notable growth in SaaS CRM adoption, indicating a broader trend toward leveraging cloud-based CRM platforms to manage customer relationships more effectively. Conversely, some countries started from lower adoption rates in 2014 but exhibited considerable growth by 2021, underscoring the increasing recognition of the benefits of SaaS CRM solutions among large enterprises. The data indicates that large European enterprises are increasingly adopting cloud-based CRM solutions.

Among different countries for CRM software adoption rates in SMEs described in Appendix B, Sweden's SMEs had the highest rate of CRM software adoption among the countries surveyed, increasing from 10% in 2014 to 28% in 2021. Similarly, Finland saw growth, with adoption rates increasing from 14% to 30% throughout the same period. These gains indicate an increasing emphasis on good customer relationship management in Sweden and Finland. However, certain nations, such as Romania and Bulgaria, began from a lower base in 2014 and experienced more development through 2021. Overall, the results show that CRM software is becoming more widely recognized and used across SMEs in surveyed countries, demonstrating a deliberate focus on improving customer interaction and driving corporate growth.

Adoption of Email among Large Enterprises and SMEs

Between 2014 and 2021, the use of email in large enterprises throughout Europe saw a significant uptick as shown in Appendix C. Notably, Finland saw the highest growth rate, with a jump from 30.1% to 88.9% adoption. Sweden, Italy, and Belgium also experienced substantial increases in email usage. Cyprus, Ireland, and Denmark demonstrated significant jumps in email usage rates, suggesting a widespread trend towards email as a primary communication tool in business operations. However, there were variations in adoption rates across countries, with some, such as Romania and Bulgaria, showing comparatively lower rates despite improvements.

SMEs depicted in Appendix D have seen a significant increase in the usage of email as they have shifted towards digital communication and collaboration. Sweden led this charge with a substantial increase from 21.8% to 65.1%, followed closely by Finland, Estonia, and the Netherlands, all of which witnessed notable upticks in email adoption rates within their SME sectors. Denmark, Italy, and Malta also showed considerable improvements, highlighting the importance of email as a fundamental tool for SMEs in conducting business operations. However, there were variations across countries, with some, like Romania and Bulgaria, displaying comparatively lower rates of email adoption among SMEs, indicating potential areas for further digitalization efforts. Overall, the data underscores the increasing reliance of SMEs on email as a key communication platform, which enables efficient interaction and information exchange in an evolving business landscape.

Adoption of Finance or Accounting software among Large Enterprises and SMEs

The utilization of finance or accounting software among large enterprises in Europe, shown in Appendix E, experienced significant growth from 2014 to 2021, reflecting a broader trend

toward digitalization and automation of financial processes. Sweden emerged as a leader in this regard, with an increase from 13.8% to 56.1%, followed closely by Finland, Italy, and Belgium, all showing substantial improvements in adopting finance or accounting software within their large enterprises. Other countries, such as Ireland, the Netherlands, and Malta, also demonstrated noteworthy increases, underlining the importance of these software solutions in optimizing financial management and reporting. Despite the overall positive trend, there were variations across countries, with some, like Slovenia and Bulgaria, showing comparatively lower adoption rates. This data highlights the growing recognition among large enterprises of the benefits of finance or accounting software in enhancing efficiency, accuracy, and compliance in financial operations, thereby contributing to improved decision-making and business performance.

From 2014 to 2021, Appendix F showed that there was a noteworthy surge in finance and accounting software use among SMEs throughout the EU. This suggests that more SMEs recognize the significance of digital tools when managing financial processes. Sweden saw the highest increase, jumping from 14.7% to 55.0%. Finland, Estonia, and the Netherlands also experienced substantial growth in finance and accounting software adoption. Denmark, Italy, and Ireland showed significant improvements as well. However, there were disparities among countries, with some, such as Bulgaria and Romania, exhibiting lower adoption rates. This data underscores the mounting awareness among SMEs of the benefits of finance and accounting software.

Adoption of Office software among Large Enterprises and SMEs

The data collected from 2014 to 2021 presended in Appendex G indicates a significant increase in office software usage among large enterprises in Europe. This reflects the widespread acknowledgment of the value of software in enhancing efficiency and productivity. Finland emerged as the leader in this regard, with a remarkable surge from 22.2% to 87.0%. Sweden, Italy, and Belgium followed closely, experiencing significant growth in the implementation of office software within their large enterprises. Other countries, such as Cyprus, Ireland, and Denmark, also showed noteworthy increases, highlighting the growing reliance of large enterprises on digital solutions for office productivity. However, there were variations across countries, with some countries like Romania and Bulgaria displaying comparatively lower adoption rates.

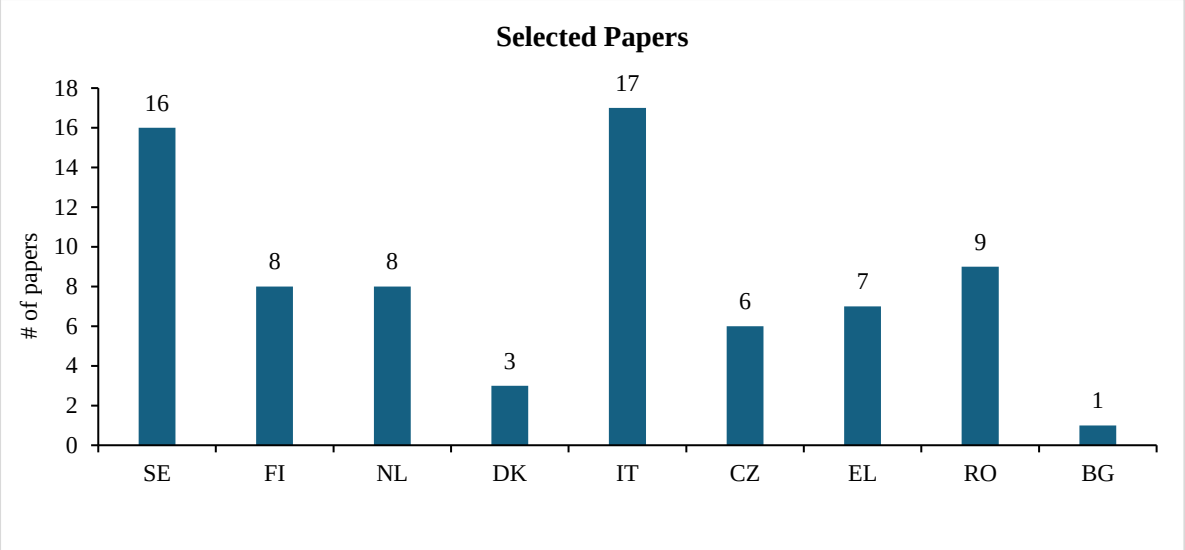
Between 2014 and 2021, there was a significant increase in the use of office software among SMEs in the EU, indicating the growing importance of digital tools in enhancing productivity and collaboration as depicted in Appendix H. Sweden saw the most remarkable growth, with adoption rates rising from 12.4% to 52.9%, followed closely by Finland, Estonia, and the Netherlands, with all three countries experiencing substantial growth in office software implementation within their SME sectors. Denmark, Ireland, and Malta also showed considerable improvements, highlighting the increasing reliance of SMEs on digital solutions for office productivity. However, there were variations across countries, with some countries, such as Bulgaria and Romania, displaying relatively lower adoption rates.

4.2. Cloud Insights

Based on the Eurostat data analysis results, nine countries were chosen for document analysis according to their ranks in cloud usage within the EU27. Sweden, Finland, and Denmark were chosen as the top countries in CC adoption within the European Union (EU), with the highest usage levels. In addition to these countries, the analysis also included the Netherlands, Italy, and Czechia, which had moderate usage levels, and Greece, Romania, and Bulgaria, which had lower usage levels, to represent a diverse range of adoption rates. This approach offers essential perspectives on EU cloud implementation opportunities and obstacles.

4.2.1. Selected Papers for Cloud Adoption

During the document analysis using the PRISMA framework, 75 papers were selected for review, as shown in Graph 16. Different countries contributed these papers, with Italy (IT) having the highest number of papers, totaling 17, followed by Sweden (SE) with 16 papers. Finland (FI) and the Netherlands (NL) each had 8 papers selected for analysis. Denmark (DK) contributed 3 papers, while Czechia (CZ) and Greece (EL) provided 6 and 7 papers, respectively. Romania (RO) had 9 papers included in the analysis, while Bulgaria (BG) had the lowest representation with only 1 paper. This distribution highlights the diverse geographical origins of the research included in the document analysis, reflecting a broad spectrum of contributions from multiple countries within the scope of the PRISMA review.

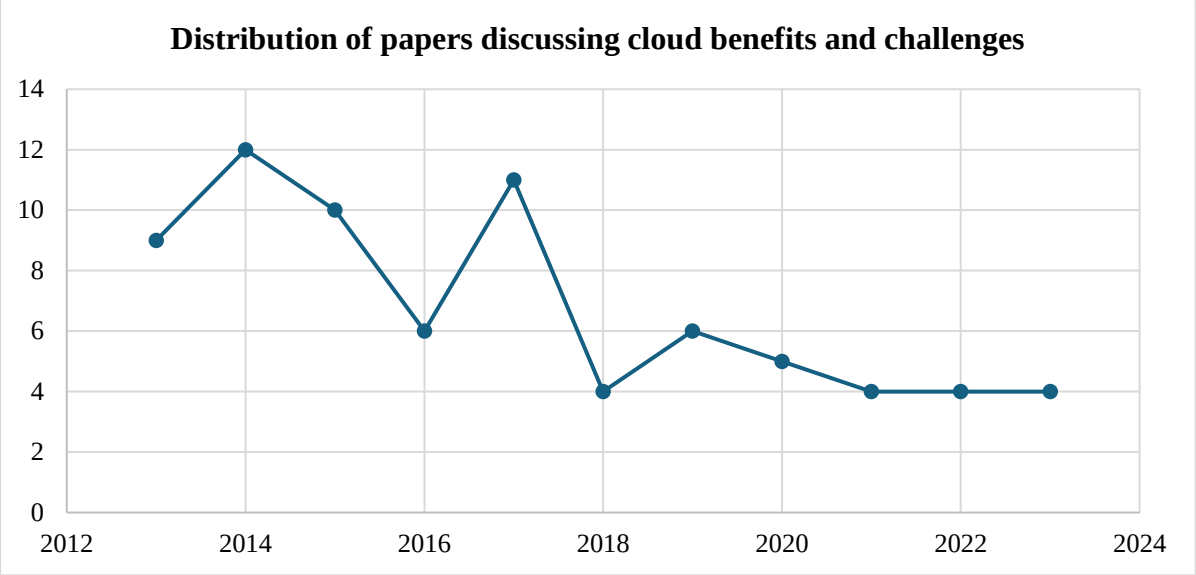


Graph 16: Selected papers

Source: Author's own creation

4.2.2. Paper Contributions

The number of papers discussing the benefits and challenges of CC varied over the years, as shown by the provided data. In 2014, the highest number of papers, 12 in total, were contributed, indicating a significant focus on understanding and exploring the potential advantages and obstacles associated with CC during that period. Subsequent years also saw substantial contributions, with 2013 and 2017 accounting for 9 and 11 papers, respectively. However, fewer papers were published in later years, with 2018, 2020, and 2021 each yielding only 4 papers. These fluctuations in paper distribution may reflect changes in research interests, technological advancements, and emerging trends within the field of cloud computing. During the years 2014 and 2015, CC was already becoming a popular trend. Research emphasized its significance in providing IT services and its potential impact on various industries. In 2014, a study discussed the framework of the cloud environment, different cloud models, current technologies, and trends in the cloud space.

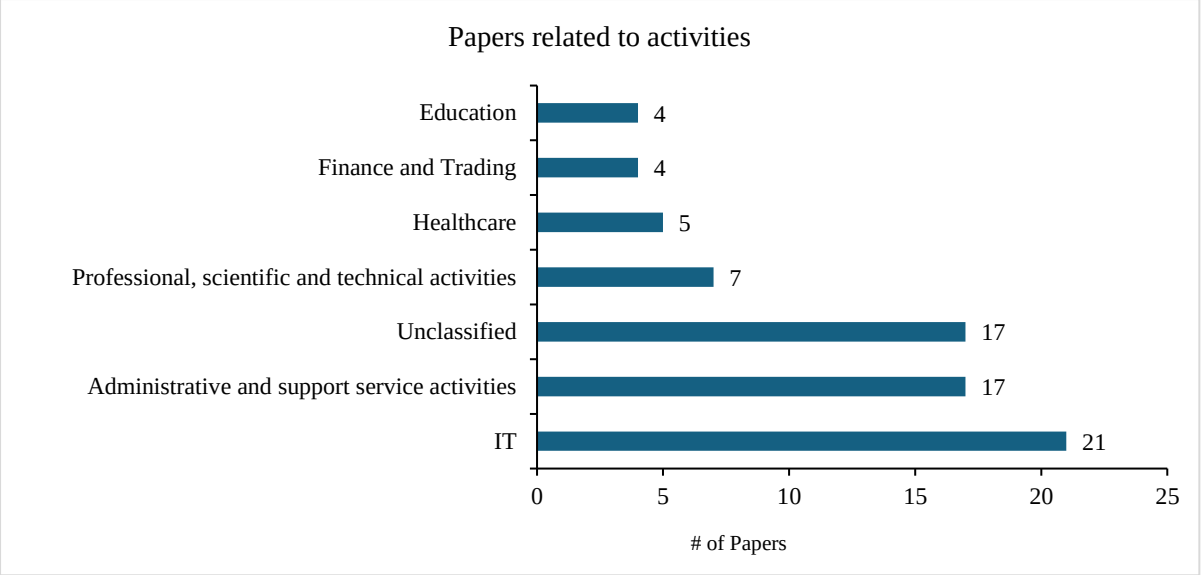


Graph 17: Distribution of papers discussing cloud benefits and challenges between 2013 and 2023

Source: Author's own creation

The distribution of paper contributions across various activities in the context of cloud adoption in the EU provides insights into the focus areas and interests of researchers in this field is shown in Appendix I . The highest number of papers, totaling 21, were dedicated to IT-related activities, indicating a substantial emphasis on the technical aspects and implementation of cloud technologies within the information technology sector. Additionally, administrative and support service activities, represented by 16 papers, highlight the importance of addressing operational and organizational challenges associated with cloud adoption.

Professional, scientific, and technical activities, along with healthcare, each contributed 11 and 5 papers, respectively, underscoring the relevance of cloud technologies in various professional domains and their potential impact on healthcare service delivery. Finally, finance, trading, and education had 4 papers dedicated to understanding the implications of cloud adoption within these sectors, indicating a growing interest in leveraging cloud solutions to enhance operational efficiency and innovation.



Graph 18: Paper contribution related to activities

Source: Author's own creation

4.2.3. Benefits

Through a comprehensive search, as depicted in Appendix J, nine key benefits emerged from selected research papers by applying the Ground Theory. These benefits include Communication, Collaboration, Data Sharing Accessibility and Availability, Cost Reduction, Scalability and Flexibility, Environmental Friendliness, Management and Optimization, Security and Support User Experience, and Business Opportunities.

Communication, collaboration, and data sharing

Cloud computing enables enhanced communication, collaboration, and remote learning opportunities, fostering collaboration across multiple organizations. It simplifies data storage, management, and sharing, ensuring data availability and facilitating the sharing of learning materials among professionals. Moreover, it enables federated storage, reduces data duplication, improves data access efficiency, and provides ample storage space. It allows easy access to stored data, promotes information sharing, and grants authorized employees access to stored information, enhancing overall data accessibility and collaboration.

Accessibility and Availability

It refers to the seamless access and availability of recorded data for analysis, post-processing procedures, and integration across various systems. This encompasses providing instant data access, enabling users to retrieve information promptly for their needs. Moreover, it involves

access from any location, removing restrictions on the type of device connected to the internet, and ensuring data can be accessed efficiently regardless of the user's location or device.

Cost Reduction

It encompasses various aspects that lead to lower total costs, increased cost-effectiveness, and potential for significant savings. It involves minimizing maintenance, upgrade, and startup costs, ensuring predictable costs, and significantly reducing overall expenses while enhancing services. CC offers the potential for reduced investment in hardware and software, thereby lowering financial constraints and increasing operational efficiency. Additionally, cost reduction in CC can lead to decreased ICT employees, as tasks are streamlined and automated, contributing to overall efficiency and cost-effectiveness in managing IT resources.

Scalability and Flexibility

It refers to the system's ability to adapt and expand according to changing demands and requirements. It involves the scalability and strategic flexibility of cloud-based deployment, services, and resource utilization, allowing for efficient allocation and utilization of computational resources based on demand. This scalability and flexibility enable interactive analysis, parallelization of computing activities, and real-time processing, optimizing the overall efficiency of the computing system through on-demand computing allocation. Additionally, it facilitates customization, real-time monitoring, and analysis, enhancing the system's agility, interoperability, and efficiency in distributing computational tasks. The flexibility and scalability of cloud-based deployment support the evolution in ICT delivery and offer the potential for higher profitability through strategies like high-frequency trading (HFT), ease of implementation, and entry into new markets and sectors, showcasing the adaptability and efficiency of CC solutions.

Environmentally Friendly

Environmentally friendly refers to products, services, practices, or technologies with minimal negative environmental impact. These solutions are designed to reduce energy consumption, minimize waste generation, lower carbon emissions, and promote sustainability.

Management and Optimization

It includes features that enhance monitoring, resource utilization, and operational efficiency. It enables enhanced monitoring and management for service delivery optimization, resource

monitoring, and business continuity, improving operational management and infrastructure efficiency. Cloud services reduce the demand for internal competency, increase resource utilization and productivity, and streamline business processes, ultimately enhancing efficiency and competitiveness. Additionally, CC facilitates rapid deployment, time-saving, and centralized management of multiple infrastructures, promoting efficiency, reliability, and automation of data processes. It also provides real-time data analysis capabilities, increased speed in trading, and the potential for reducing the number of applications, leading to productivity improvements and simplifying business processes. Cloud solutions support business processes, offer new opportunities, enhance functionality, and enable centralized monitoring, ensuring efficient use of ICT resources and increased productivity across various operations.

Security and Support

It enhances data security, adequate IT support, and overall system reliability. It ensures enhanced data security by enforcing security measures across multiple cloud environments, disaster recovery capabilities, and secure data communication. This benefit includes features like increased user confidence through trust-building measures, automatic updates and new versions of programs, online technical support, and the elimination of system failure risks. By providing a robust security framework, reliable IT support, and proactive measures to mitigate risks, cloud services offer a secure and well-supported environment for data management and operations, ultimately enhancing overall system resilience and user satisfaction.

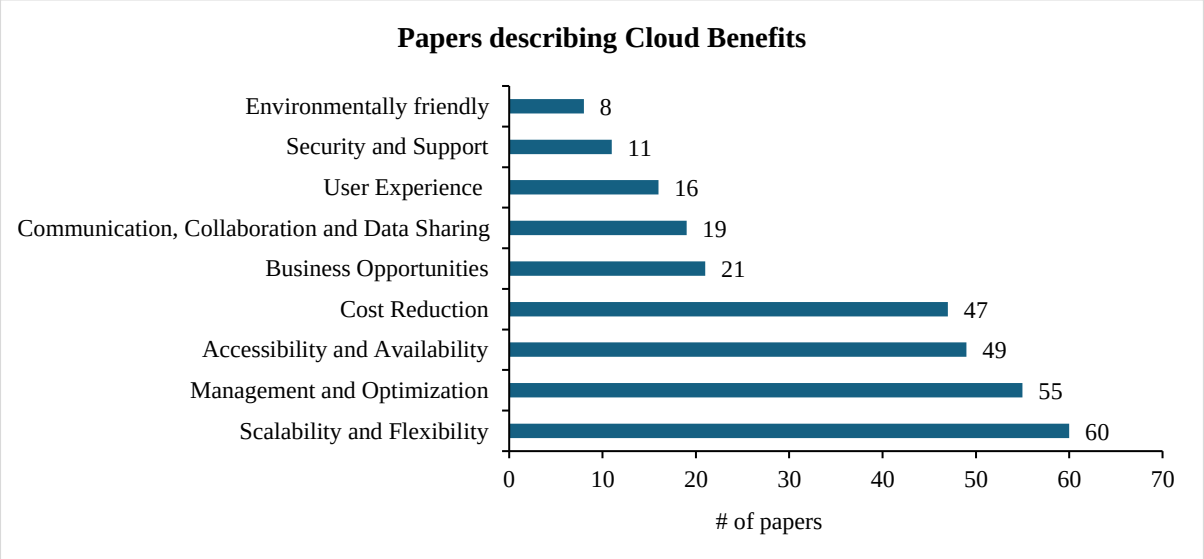
User Interface

It involves providing an improved user experience through more attractive services, a user-friendly web interface for accessing synchronized data, and executing post-processing operations. Cloud services eliminate the need for installation and maintenance, offering ready-to-use functionality and data migration tools that enhance users' perceived ease of use and usefulness. Additionally, CC increases citizens' engagement by providing improved services and a user-friendly interface, ultimately streamlining processes, reducing the need for internal competence, and ensuring a seamless and efficient user experience.

Business Opportunities

These opportunities include faster time to market, providing competitive advantages, and creating strategic opportunities for innovation. CC offers increased opportunities for innovation

and rapid innovation, supporting business processes, simplifying growth periods, and enabling quality improvement. Moreover, it facilitates market expansion, increases market potential, and allows entry into new markets and sectors, enhancing the organization's competitive edge and relative advantage. Cloud services also provide learning opportunities, access to venture capital, and the ability for SMEs to exploit business opportunities across national borders, ultimately leading to a more significant number of customers and an enhanced market potential for organizations embracing cloud technologies. Table 1 depicts which papers described specific benefits.



Graph 19: Papers describing cloud benefits

Source: Author's own creation

The papers describing the mentioned benefits processed by Appendix K are shown in Graph 19. One significant advantage is scalability and flexibility, acknowledged in 60 papers, enabling executives to adapt quickly to changing market conditions and deploy new services efficiently. Management and optimization, cited in 55 papers, empower middle managers to streamline workflows and make informed decisions using advanced analytics tools. Accessibility and availability, highlighted in 49 papers, provide frontline managers remote access to essential business applications, fostering flexibility and responsiveness.

Additionally, cloud solutions contribute to cost reduction, recognized in 47 papers, by eliminating the need for large upfront investments in IT infrastructure. Furthermore, cloud technologies open up new business opportunities, as mentioned in 21 papers, enabling

organizations to innovate and stay competitive in the market. Communication, collaboration, and data sharing, emphasized in 19 papers, facilitate seamless teamwork across teams regardless of geographical location. Moreover, cloud-based user experiences, as noted in 16 papers, enhance operational staff productivity by providing intuitive and efficient tools. Security and support, acknowledged in 11 papers, ensure the protection of sensitive data and assist in managing cloud environments. Finally, CC is environmentally friendly, recognized in 8 papers, as it reduces the carbon footprint associated with traditional on-premises IT infrastructure.

Figure 9 categorizes cloud advantages into three planning levels to better understand and leverage these benefits: Strategic, Managerial, and Operational (Organizational Planning in 3 levels:Strategic, Tactical, Operational). Each level encompasses distinct aspects of cloud adoption and offers unique opportunities for organizations to enhance their business operations and achieve their strategic objectives. Strategic decision-making involves high-level, long-term choices that impact the overall direction and objectives of the organization. This includes decisions around defining the company's mission and vision, determining competitive strategy, allocating resources, and making major structural changes. The managerial level is concerned with implementing strategic decisions within specific departments or functional areas of an organization (Morris et al. 2016). The operational level involves executing day-to-day activities and tasks within an organization (Trad, Kalpic 2013).

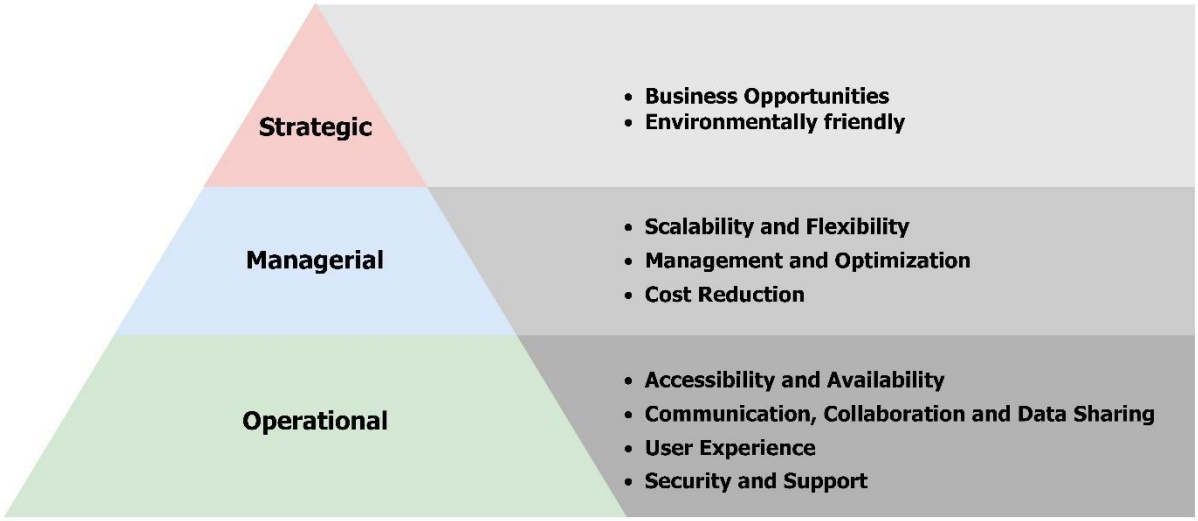


Figure 9: Cloud computing benefits hierarchical

Source: Author's own creation

At the Strategic level, the primary benefit highlighted is the creation of new business opportunities. Cloud computing can open new avenues for businesses to explore and expand

(Zied Milian, de Mesquita Spinola, de Paula Pessoa 2015). Organizations can leverage cloud technologies to innovate their products or services, enter new markets, and stay competitive in today's dynamic business environment (Xue, Xin 2016). Cloud computing can reduce the carbon footprint (Singh, Mishra, Ali, Shukla, Shankar 2015) by minimizing hardware usage. Organizations can reduce energy consumption, lower emissions, and contribute to sustainability efforts by migrating to cloud-based infrastructure (Xu, Buyya 2020).

The Managerial level lists three key benefits:

1. Cost Reduction: Refers to the potential savings in IT costs due to the pay-as-you-go model typically offered by cloud service providers. Organizations can achieve cost savings by avoiding upfront investments in hardware, reducing maintenance expenses, and optimizing resource usage.
2. Management and Optimization: Cloud computing allows for better resource management and process optimization. Organizations can streamline IT operations, automate workflows, and improve efficiency by leveraging cloud-based management tools and analytics.
3. Scalability and Flexibility: Cloud services can be easily scaled up or down based on business needs and offer flexibility regarding software and infrastructure. Organizations can quickly adapt to changing demands, handle peak workloads efficiently, and innovate more rapidly.

At the Operational level, the benefits include:

1. Accessibility and Availability: Cloud services can be accessed anytime, anywhere, ensuring high availability. Organizations can provide seamless access to applications and data for employees, customers, and partners, increasing productivity and customer satisfaction.
2. Communication, Collaboration, and Data Sharing: Cloud computing enhances collaboration by allowing easy sharing and access to data. Organizations can foster teamwork, improve communication, and accelerate decision-making by leveraging cloud-based collaboration tools and shared data repositories.
3. Improved User Experience: Cloud computing often provides user-friendly interfaces and seamless experiences. Organizations can enhance user satisfaction, engagement, and retention by delivering intuitive and responsive applications, services, and digital experiences.

4. Security and Support: Indicates that cloud providers typically offer robust security measures and round-the-clock support services. Organizations can ensure their data and applications' confidentiality, integrity, and availability by leveraging cloud security features and accessing expert support resources.

Cloud computing provides various benefits to different management levels, ultimately leading to increased agility, efficiency, and competitiveness for the organization as a whole.

4.2.4. Obstacles – Challenges and Barriers

Through a systematic analysis of existing literature and empirical evidence, nine distinct challenges emerge, encapsulating the complexities and impediments inherent in cloud adoption initiatives. These challenges are Data Privacy and Security, Organizational Readiness and Knowledge, SLA Issues, Trust and Vendor Related Issues, Technical Challenges and Complexity, Cost and Financial Concerns, System availability and Performance, Data Migration and Handling, and Governance and Control as shown in Appendix L.

Data Privacy and Security

This challenge encompasses the confidentiality, integrity, and privacy of stored data. It involves navigating complex regulatory requirements and uncertainties surrounding data location, which can result in potential security breaches, data loss, and account hijacking. Additionally, it includes identity theft risks, adapting to new attack strategies, designing secure applications, safeguarding against malicious attacks, maintaining system integrity, preventing data leakage, addressing shared vulnerabilities, and dealing with social engineering tactics. This obstacle also includes data privacy and protection, physical security (Chandrasegaran et al., 2017), lost or stolen backups, compromise of security logs, infrastructural, economic, legal, and organizational cultural barriers, security and compatibility issues, and overall data security and privacy concerns. Therefore, compliance with regulations and transparency about data location is essential to ensure overall data security and privacy.

Organizational Readiness and Knowledge

This cloud obstacle includes challenges related to the competence and preparedness required for cloud adoption within organizations (Yang et al., 2019). It involves issues such as a lack of IT expertise, difficulties determining total ownership and benefits realization costs, the need for updated guidelines, and a centralized approach to cloud services consumption. Additionally, it involves challenges such as resistance from business stakeholders, unclear benefits

realization, difficulty maintaining currency, infrastructure readiness, lack of experts, and the requirement for extensive analysis for appropriate cloud deployment (Suganya, Sasipraba 2022). It highlights the lack of readiness in some European countries for cloud adoption and the absence of support or training from cloud service providers (Yang et al., 2019)

SLA Issues

It is related to Service Level Agreement (SLA) specifications and reliability within cloud computing, including difficulties in effectively implementing SLAs (Dawson et al., 2023), concerns about the complexity of SLAs leading to trust issues, and challenges associated with ensuring the reliability and fulfillment of SLA specifications. Furthermore, it involves issues such as missing features or services in SLAs, which can impact the quality and performance of cloud services. Addressing these obstacles is critical to ensuring that cloud service providers and consumers have transparent, reliable, and trustworthy agreements that meet the required service levels and expectations.

Trust and Vendor Issues

It covers various concerns about trust, security, and quality when dealing with cloud service providers. These concerns include worries about providers' reliability, potential risks of identity theft, and concerns about the complexity of trust and interoperability of services. Additionally, it involves compliance with regulations, legal requirements, data privacy laws, and issues related to reliability, system availability, and downtime. Other challenges within this obstacle include vendor dependency, the need for trust-building measures, risks of isolation from cloud providers, and the lack of support or training from service providers.

Technical Challenges and Complexity

This covers a range of issues related to the technical aspects of cloud computing. These challenges include dependability, network provisioning, monitoring, and the complexity of integrating with existing applications and systems. Additionally, technical weaknesses and obstacles to implementation, quality of network communication, bandwidth, and connection speed, lack of interoperability between systems, complexity of measurement and resource overhead, integration challenges with diverse operating systems and hardware platforms, lack of standards, customization limitations, migration complexity, network dependency, and the continuously evolving nature of cloud services contribute to the technical challenges and complexity in cloud computing.

Cost and Financial Concerns

It relates to various challenges related to the financial aspects of cloud computing, including uncertainties surrounding the payment model and concerns about costs, financial burdens, and limitations in achieving cost savings, especially for small and medium-sized companies. Additionally, it involves challenges in cost management, economic value considerations, and potential uncertainties or concerns regarding cost savings when transitioning existing IT structures to cloud computing.

System Availability and Performance

It encompasses various challenges related to cloud services' availability, reliability, and performance concerning performance variability, service availability breaches, system downtime, outlier execution times, potential variability in cloud service performance, and the need to ensure continuous execution and availability of functionalities for services. Additionally, it involves issues such as data availability concerns, dependability, ensuring Quality of Service (quality of service), network performance variability, natural disaster recovery, reporting and support for storage provisioning errors, and addressing slow response times.

Data Migration and Handling

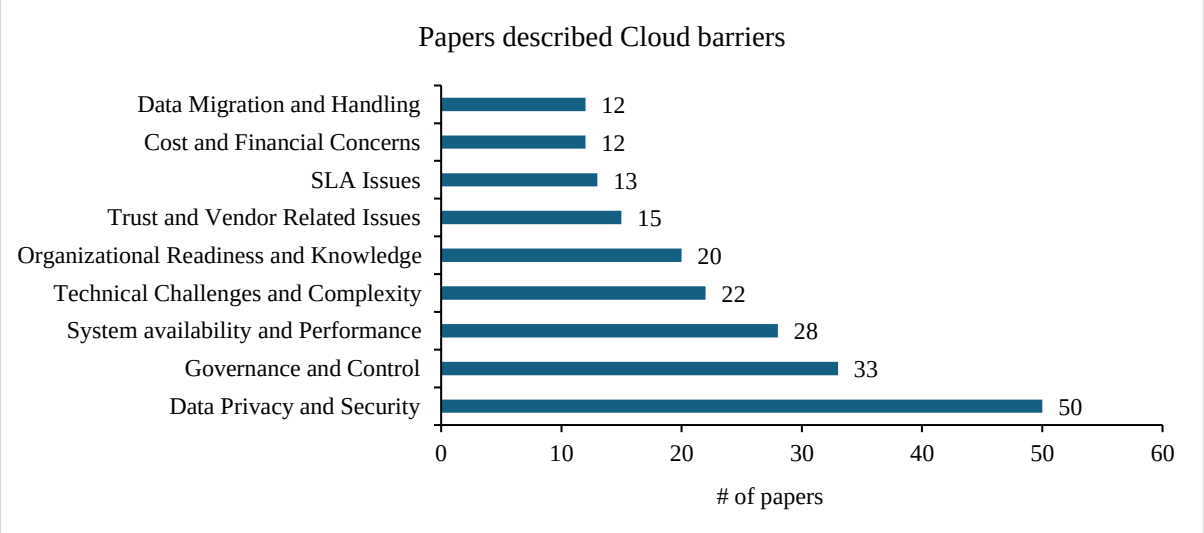
This is related to efficiently managing data storage, migration, deletion, and handling within CC environments. This obstacle involves complexities associated with migration processes, including integration with diverse operating systems, ensuring seamless data transfer, and addressing the handling of large volumes of data. Challenges such as data storage optimization, secure and efficient data migration, proper data deletion practices, and managing vast amounts of data pose significant hurdles that must be carefully addressed to ensure data integrity, security, and efficiency in cloud environments.

Governance and Control

It includes challenges related to the loss of governance and control over IT resources, uncertainties regarding data center location and service availability, dependence on service providers, and risks associated with changes in jurisdiction and liability obligations. This obstacle also includes concerns about auditors and government agencies not fully supporting cloud computing, data ownership issues, lack of control over data processing and maintenance, and the need to adapt governance models to address legal, contractual, and regulatory

limitations. Additionally, it involves challenges such as the risk of controlling information, decreased control over systems when transitioning to the cloud, lack of cloud-specific criteria in auditing tools, and the necessity for better legislation, consolidation, and standardization to enhance governance and control in cloud environments.

Table 2 provides detailed information about the papers that described cloud challenges and barriers. Organizations encounter various obstacles when adopting cloud computing, as highlighted in numerous research papers, as shown in Graph 20. Data privacy and security, cited in 50 papers, are the most among these challenges, indicating a pervasive concern regarding protecting sensitive information in the cloud environment. As noted in 33 papers, governance and control pose another significant hurdle, emphasizing the need for effective management and security measures to safeguard infrastructure and data. Ensuring system availability and performance, acknowledged in 28 papers, remains critical to maintaining uninterrupted operations and meeting service level expectations. Technical challenges and complexity, mentioned in 22 papers, arise from integrating cloud services with existing systems and managing the intricacies of the cloud environment effectively depicted in Appendix M.



Graph 20: Papers describing cloud obstacles

Source: Author's own creation

Additionally, organizational readiness and knowledge, recognized in 20 papers, underscore the importance of equipping users with the necessary skills and processes to adopt cloud services successfully. Trust and vendor-related issues, highlighted in 15 papers, include concerns about the provider's reputation, reliability, and potential for vendor lock-in, which may impact decision-making. Service level agreement (SLA) issues, noted in 13 papers, may arise if

providers struggle to meet agreed-upon performance metrics, leading to user dissatisfaction. Finally, cost and financial concerns, as well as data migration and handling challenges, each cited in 12 papers, further contribute to the complexities associated with cloud adoption. Addressing these obstacles requires a comprehensive approach, encompassing robust security measures, effective governance frameworks, technical expertise, organizational preparedness, and strategic vendor partnerships to unlock the full potential of cloud computing while mitigating risks and ensuring success.

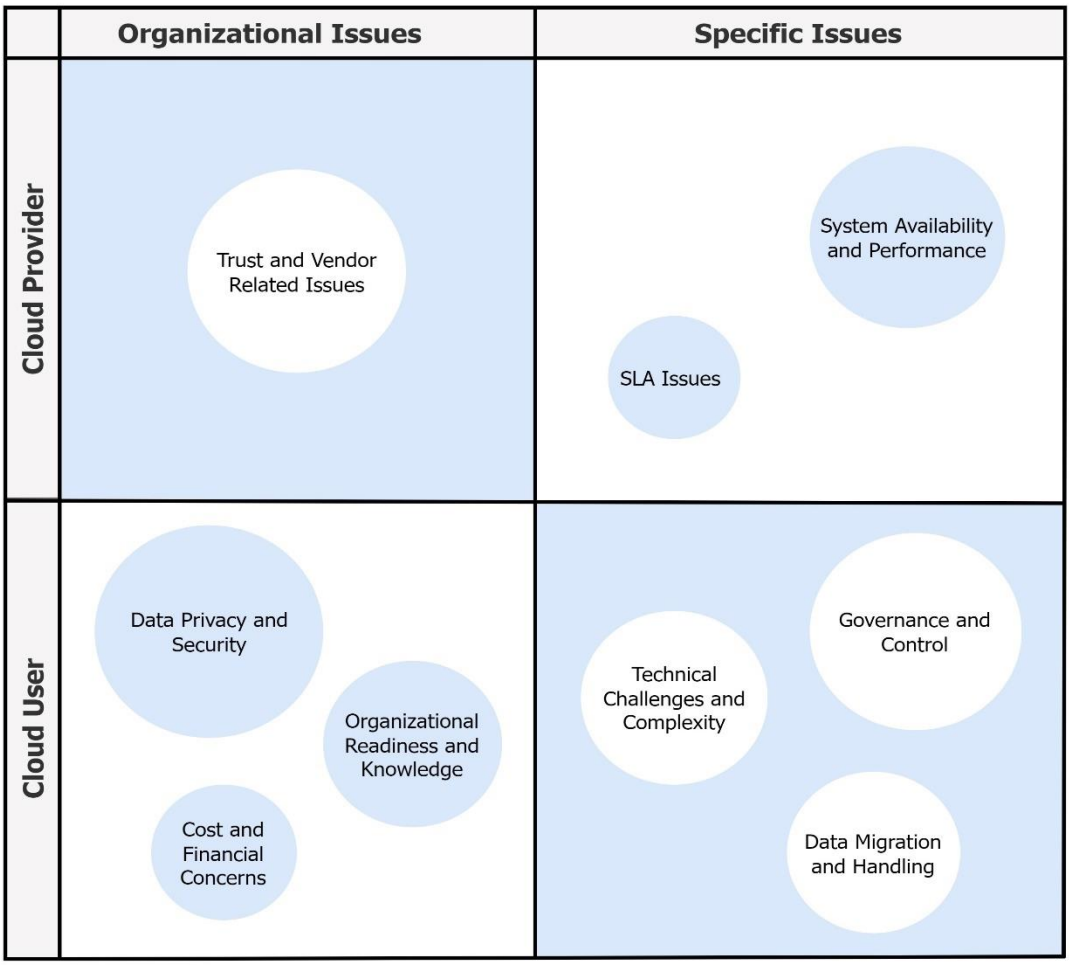


Figure 10: Cloud computing stakeholder-issues map

Source: Author's own creation

Figure 10 provides an overview of organizational and specific cloud provider and user issues. Cloud providers face an organizational issue that impacts their ability to deliver reliable and secure services. It includes trust and vendor-related concerns, encompassing worries about the provider's reputation, track record, and the potential for vendor lock-in. Service Level

Agreement (SLA) issues may arise as a specific issue if the provider struggles to meet the agreed-upon performance metrics and service levels, leading to user dissatisfaction. System availability and performance are also critical, as users rely on the provider to maintain uptime and consistent service performance to ensure uninterrupted operations.

Cloud users encounter organizational challenges regarding their readiness and knowledge in adopting cloud services. This includes having the necessary skills and processes to leverage cloud technologies within their organization effectively. Data migration and handling present additional hurdles, as users must navigate the complexities of migrating data to the cloud while ensuring proper management and security. Users also face specific issues, such as technical challenges and complexity that arise from integrating cloud services with existing systems and managing the overall cloud environment effectively. Additionally, cost and financial concerns are prevalent, as users must manage and control the expenses associated with cloud services to ensure they remain within budgetary constraints and deliver value to the organization.

5. DISCUSSION

This study investigated the landscape of cloud adoption within the EU, focusing on both the benefits and challenges that organizations experience. The research employed a mixed methods approach, integrating quantitative data analysis with qualitative document analysis using the PRISMA framework. Through this comprehensive methodology, several key findings emerged, providing insights into the intricate dynamics surrounding cloud adoption in the EU.

5.1. Evaluation of Cloud Adoption in the EU

The landscape of CC adoption across European countries and business sizes from 2014 to 2021 was analyzed based on the available data provided by Eurostat. Significant growth in cloud adoption among large enterprises and SMEs, signaling a shift towards embracing cloud technologies as a standard practice.

The diverse patterns of cloud adoption across various industries were found. Industries with higher technological intensity, such as Information and Communication, show remarkable increases in adoption rates, underscoring the pivotal role of cloud computing in driving digital transformation. However, even sectors traditionally less associated with technology, such as Construction and Transportation, are experiencing notable growth in cloud adoption, indicating the pervasive influence of cloud technologies across diverse sectors. These findings highlight the importance of understanding industry-specific adoption patterns and tailoring strategies to suit each sector's unique needs and challenges. Flexibility due to scaling up and down was the primary motivation to adopt Clouds for large enterprises and SMEs.

Insufficient knowledge of cloud computing was identified as a significant barrier for SMEs in adopting cloud technology. SMEs often lack the know-how and understanding of the benefits that cloud computing can offer, which slows down their adoption process (Parthasarathy, Kumar 2016). The discrepancy in concerns between SMEs and large enterprises regarding cloud computing can be attributed to resource limitations hindering SMEs' ability to invest in understanding CC technology, while larger enterprises prioritize security due to their scale and potentially higher stakes.

The concerns of SMEs regarding poor consistency and inadequate accessibility of cloud services may also obstruct the adoption of cloud computing (Kumar, Samalia, Verma 2017). This is further supported by the finding that SMEs often face informational and marketing

barriers to internationalization (Hosseini et al. 2019). Moreover, due to the past staff shortages and costs, SMEs had limitations in engaging in technical innovation (Kamarudin et al. Aziz, Kamarudin, Wahab 2022). On the other hand, addressing enterprise security concerns has emerged as the biggest challenge for the adoption of Software as a Service (SaaS) applications in the cloud (Alghamdi 2021). One of the top security concerns of enterprises is the physical location of the data being stored in the cloud, especially if they are located in another country (Bisong, M. Rahman 2011).

The benefits and barriers described in Eurostat data did not cover all countries. This was the main motivation for conducting a systematic literature review to explore the detailed factors influencing cloud adoption in selected EU countries. Nine benefits and obstacles were discovered based on literature reviews using the PRISMA statement. The results from document analysis also indicated that scalability and flexibility were the most frequently described benefits, while data security and privacy concerns were the most commonly mentioned challenges in the literature.

5.2. Recommendations

Based on the analysis of CC adoption trends and the identified benefits and barriers, several recommendations can be made to support organizations in their cloud adoption journey:

Invest in Education and Training

Due to the importance of having enough knowledge to overcome the challenges of cloud adoption, it is recommended that organizations, particularly SMEs, prioritize education and training programs. These programs can help improve the understanding of CC concepts, benefits, and best practices, enabling employees to make informed decisions and utilize cloud technologies effectively (Tehrani, Shirazi 2014).

Enhance Data Security Measures

Addressing data security and privacy concerns is crucial for building trust and confidence in cloud technologies. Organizations should invest in robust data security measures, such as encryption, access controls, and regular security audits, to protect sensitive information stored in the cloud. Compliance with relevant data protection regulations, such as the General Data Protection Regulation (GDPR) in the EU, should also be ensured (Duncan 2018).

Tailor Strategies to Industry Needs

Organizations should consider the specific requirements and challenges of the industry in which they operate to effectively adopt cloud computing. This may involve customizing cloud solutions to meet each sector's unique demands and aligning their adoption efforts with industry trends and regulations. It is important to recognize that different industries have diverse cloud adoption patterns; therefore, a tailored approach is needed for successful implementation (Xu 2012).

5.3. Limitations

The mixed methods approach in research enhances the depth of analysis by combining qualitative and quantitative methods. However, each method has its limitations. Quantitative data analysis, while providing statistical rigor, may overlook nuanced qualitative insights (Dawadi, Shrestha, Giri 2021). On the other hand, a qualitative method could be influenced by researcher subjectivity and interpretation bias (Hussein et al. 2014). Furthermore, as seen in some studies, reliance on secondary data sources may restrict the ability to capture real-time or context-specific nuances (Zhang et al. 2020) (Melchiorre et al. 2021).

Scope Restriction

The search results appear to focus primarily on specific aspects of cloud computing adoption, such as barriers, benefits, and adoption factors. This narrow scope may overlook relevant evidence from other perspectives or methodologies that could provide a more comprehensive understanding of the topic (Brereton et al. 2007).

5.4. Future Research Direction

5.4.1. Security and Privacy in Multi-cloud Environments

With the increasing adoption of multi-cloud architectures, there is a need to examine the security and privacy implications of distributing workloads across multiple cloud providers. Multi-cloud environments offer flexibility, scalability, and resource optimization but introduce challenges related to security and privacy (Mahajan, Khandelwal, K 2020). Encryption plays a crucial role in protecting data confidentiality and integrity in multi-cloud scenarios (M, Sasipraba 2022). Identity management is essential for securely orchestrating user identities across different cloud services (Pillai, Polimetla 2024). Secure multi-party computation

(SMPC) enables interactive calculations while preserving data privacy among parties in cloud environments (Rajab et al. 2024).

5.4.2.Sustainability and Green Cloud Computing

Sustainability is becoming increasingly important in the field of cloud computing. Many initiatives are aimed at minimizing the environmental impact of cloud computing and are gaining momentum. Cloud providers are focusing on energy efficiency by utilizing advanced technologies such as virtualization and resource pooling to optimize energy consumption within their data centers. The trend of using renewable energy sources to power these facilities is also on the rise, which reduces reliance on fossil fuels and mitigates greenhouse gas emissions (Mehta et al. 2021).

Cloud computing reduces the need for individual organizations to maintain and upgrade on-premises hardware, leading to decreased e-waste generation(Kumar, Holuszko, Espinosa 2017) (Rene et al. 2021). Cloud providers manage and dispose of hardware at the end of its lifecycle, often through recycling and refurbishment programs. Strategic data center locations near renewable energy sources (Depoorter, Oró, Salom 2015)further contribute to sustainability efforts by minimizing energy transmission losses.

Through green certifications and adherence to environmental standards, cloud providers demonstrate their commitment to responsible practices, promoting transparency and accountability in their operations (Radu 2017). Moreover, the scalability and flexibility offered by cloud services enable organizations to optimize their workloads for energy efficiency, dynamically adjusting resource allocation based on demand. By embracing green cloud computing, businesses not only reduce their carbon footprint but also drive innovation and collaboration in sustainable solutions, contributing to global efforts in combating climate change.

CONCLUSION

This thesis explores the benefits and challenges of cloud adoption in the European Union. A comprehensive understanding of the subject has been attained through a combination of quantitative research, utilizing Eurostat data, and qualitative methods employing the PRISMA method for document analysis.

The quantitative analysis provided valuable insights into the current state of cloud adoption across the EU member states, offering statistical evidence to support the growth rates and spending patterns based on the enterprise size and time frame. This data-driven approach has clearly identified the current state of Cloud Computing in the European Union's business landscape compared to 2014.

The benefits and barriers described in Eurostat data did not cover all countries. This was the main motivation for conducting the quantitative findings and the qualitative analysis through the PRISMA method to provide a nuanced understanding of the benefits and challenges inherent in cloud adoption. It provided to explore the detailed factors influencing cloud adoption in selected EU countries. Nine benefits and obstacles were discovered based on the document analysis. The results indicated that scalability and flexibility were the most frequently described benefits, while data security and privacy concerns were the most commonly mentioned challenges in the literature.

This research underscores the multifaceted nature of cloud adoption within the EU context. It highlights the importance of considering quantitative and qualitative perspectives to holistically understand the subject. Moving forward, the insights derived from this research can inform policymakers, businesses, and stakeholders in navigating the opportunities and challenges presented by cloud adoption, ultimately contributing to the advancement of digital transformation in the European Union.

REFERENCES

1. 25 Amazing Cloud Adoption Statistics [2023]: Cloud Migration, Computing, And More - Zippia, 2023. Online. Available from: https://www.zippia.com/advice/cloud-adoption-statistics/ [Accessed 27 April 2024].
2. A New Cloud Computing Governance Framework, 2014. In: *Proceedings of the 4th International Conference on Cloud Computing and Services Science*. SCITEPRESS - Science and Technology Publications. p. 671–678. ISBN 978-989-758-019-2. DOI 10.5220/0004970706710678.
3. AARESTRUP, Frank M, ALBEYATTI, Abdullah, ARMITAGE, W John, AUFFRAY, Charles, AUGELLO, Luca, BALLING, Rudi, BENHABILES, Nora, BERTOLINI, Guido, BJAALIE, Jan G and BLACK, Michaela, 2020. Towards a European health research and innovation cloud (HRIC). *Genome medicine*. 2020. Vol. 12, p. 1–14.
4. AHMED BUTT, Muheet, ZAMAN, Majid, NAYAK, Deveeshree, MUHEET AHMED BUTT, Er, MAJID ZAMAN, Er and THEMAZI, Dana AL, 2013. *EMPOWERING CLOUD SECURITY THROUGH SLA*. Online. Available from: www.jgrcs.info
5. ALGHAMDI, Mohammed I., 2021. Cloud Computing Mechanism for Security. *International Journal of Cryptocurrency Research*. 12 May 2021. Vol. 1, no. 1, p. 81. DOI 10.51483/IJCCR.1.1.2021.81-89.
6. ALHAMAD, Mohammed, DILLON, Tharam and CHANG, Elizabeth, 2011. A Survey on SLA and Performance Measurement in Cloud Computing. In: . p. 469–477.
7. AMAZON, E, 2009. Amazon elastic compute cloud. *Retrieved Feb*. 2009. Vol. 10.
8. AMIN, Ruhul and VADLAMUDI, Siddhartha, 2021. Opportunities and Challenges of Data Migration in Cloud. *Engineering International*. 25 April 2021. Vol. 9, no. 1, p. 41–50. DOI 10.18034/ei.v9i1.529.
9. ARMBRUST, Michael, FOX, Armando, GRIFFITH, Rean, JOSEPH, Anthony D, KATZ, Randy H, KONWINSKI, Andrew, LEE, Gunho, PATTERSON, David A, RABKIN, Ariel and STOICA, Ion, 2009. *Above the clouds: A berkeley view of cloud computing*. Technical Report UCB/EECS-2009-28, EECS Department, University of California ….
10. ASHRAF, Imran, 2014. An overview of service models of cloud computing. *International Journal of Multidisciplinary and Current Research*. 2014. Vol. 2, no. 1, p. 779–783.

11. AVRAM, Maricela-Georgiana, 2014. Advantages and challenges of adopting cloud computing from an enterprise perspective. *Procedia Technology*. 2014. Vol. 12, p. 529–534.
12. BAYRAMUSTA, Merve and NASIR, V. Aslihan, 2016. A fad or future of IT?: A comprehensive literature review on the cloud computing research. *International Journal of Information Management*. 1 August 2016. Vol. 36, no. 4, p. 635–644. DOI 10.1016/J.IJINFOMGT.2016.04.006.
13. BELOGLAZOV, Anton, ABAWAJY, Jemal and BUYYA, Rajkumar, 2012. Energy-aware resource allocation heuristics for efficient management of data centers for Cloud computing. *Future Generation Computer Systems*. May 2012. Vol. 28, no. 5, p. 755–768. DOI 10.1016/j.future.2011.04.017.
14. BHARDWAJ, Sushil, JAIN, Leena and JAIN, Sandeep, 2010. *CLOUD COMPUTING: A STUDY OF INFRASTRUCTURE AS A SERVICE (IAAS)*.
15. BISONG, Anthony and M. RAHMAN, Syed Shawon, 2011. An Overview Of The Security Concerns In Enterprise Cloud Computing. *International Journal of Network Security & Its Applications*. 28 January 2011. Vol. 3, no. 1, p. 30–45. DOI 10.5121/ijnsa.2011.3103.
16. BISONG, Ekaba, 2019. What Is Cloud Computing? *Cloud Technologies*. Online. 2019. Available from: https://api.semanticscholar.org/CorpusID:985150
17. BRERETON, Pearl, KITCHENHAM, Barbara A, BUDGEN, David, TURNER, Mark and KHALIL, Mohamed, 2007. Lessons from applying the systematic literature review process within the software engineering domain. *Journal of systems and software*. 2007. Vol. 80, no. 4, p. 571–583.
18. BROWN, Cecelia Wright and NYARKO, Kofi, 2013. Software as a service (SaaS). In: *Cloud Computing Service and Deployment Models: Layers and Management*. IGI Global. p. 50–69.
19. BRUNEO, Dario, LONGO, Francesco and PULIAFITO, Antonio, 2011. Evaluating energy consumption in a Cloud infrastructure. In: *2011 IEEE International Symposium on a World of Wireless, Mobile and Multimedia Networks*. IEEE. June 2011. p. 1–6. ISBN 978-1-4577-0352-2. DOI 10.1109/WoWMoM.2011.5986479.
20. BUYYA, Rajkumar, SRIRAMA, Satish Narayana, CASALE, Giuliano, CALHEIROS, Rodrigo, SIMMHAN, Yogesh, VARGHESE, Blesson, GELENBE, Erol, JAVADI, Bahman, VAQUERO, Luis Miguel, NETTO, Marco A. S., TOOSI, Adel Nadjaran, RODRIGUEZ, Maria Alejandra, LLORENTE, Ignacio M., VIMERCATI, Sabrina De

Capitani Di, SAMARATI, Pierangela, MILOJICIC, Dejan, VARELA, Carlos, BAHSOON, Rami, ASSUNCAO, Marcos Dias De, RANA, Omer, ZHOU, Wanlei, JIN, Hai, GENTZSCH, Wolfgang, ZOMAYA, Albert Y. and SHEN, Haiying, 2019. A Manifesto for Future Generation Cloud Computing. *ACM Computing Surveys*. 30 September 2019. Vol. 51, no. 5, p. 1–38. DOI 10.1145/3241737.

21. BUYYA, Rajkumar, YEO, Chee Shin, VENUGOPAL, Srikumar, BROBERG, James and BRANDIC, Ivona, 2009. Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. *Future Generation Computer Systems*. June 2009. Vol. 25, no. 6, p. 599–616. DOI 10.1016/j.future.2008.12.001.
22. BUYYA, Rajkumar, YEO, Chee Shin and VENUGOPAL, Srikumar, 2008. Market-oriented cloud computing: Vision, hype, and reality for delivering its services as computing utilities. In: *2008 10th IEEE international conference on high performance computing and communications*. Ieee. 2008. p. 5–13. ISBN 0769533523.
23. CHAN, Joseph On-Piu, 2020. Digital transformation in the era of big data and cloud computing. *Int. J. Intell. Inf. Syst*. 2020. Vol. 9, no. 3, p. 16.
24. CHATZITHANASIS, Georgios and MICHALAKELIS, Christos, 2019. The Benefits of Cloud Computing. In: *Cloud Security*. IGI Global. p. 1333–1345.
25. CHAUHAN, Muhammad Aufeef and BABAR, Muhammad Ali, 2011. Migrating Service-Oriented System to Cloud Computing: An Experience Report. In: *2011 IEEE 4th International Conference on Cloud Computing*. IEEE. July 2011. p. 404–411. ISBN 978-1-4577-0836-7. DOI 10.1109/CLOUD.2011.46.
26. CHIEU, Trieu C., MOHINDRA, Ajay, KARVE, Alexei A. and SEGAL, Alla, 2009. Dynamic Scaling of Web Applications in a Virtualized Cloud Computing Environment. In: *2009 IEEE International Conference on e-Business Engineering*. IEEE. 2009. p. 281–286. ISBN 978-0-7695-3842-6. DOI 10.1109/ICEBE.2009.45.
27. CHURAKOVA, Inna, MIKHRAMOVA, Ramilja and GIELEN, Ir F, 2010. Software as a service: Study and analysis of saas business model and innovation ecosystems. *Universiteit Gent*. 2010. Vol. 103.
28. Cloud computing - statistics on the use by enterprises - Statistics Explained, 2023. . Online. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Cloud_computing_-_statistics_on_the_use_by_enterprises&stable=1 [Accessed 11 February 2024].

29. CUSUMANO, Michael, 2010. Cloud computing and SaaS as new computing platforms. *Communications of the ACM*. April 2010. Vol. 53, no. 4, p. 27–29. DOI 10.1145/1721654.1721667.
30. DAWADI, Saraswati, SHRESTHA, Sagun and GIRI, Ram A, 2021. Mixed-methods research: A discussion on its types, challenges, and criticisms. *Journal of Practical Studies in Education*. 2021. Vol. 2, no. 2, p. 25–36.
31. DEPOORTER, Victor, ORÓ, Eduard and SALOM, Jaume, 2015. The location as an energy efficiency and renewable energy supply measure for data centres in Europe. *Applied Energy*. February 2015. Vol. 140, p. 338–349. DOI 10.1016/j.apenergy.2014.11.067.
32. DUNCAN, Bob, 2018. Can eu general data protection regulation compliance be achieved when using cloud computing? *Cloud computing*. 2018. P. 1–6.
33. ETRO, Federico, 2009. The economic impact of cloud computing on business creation, employment and output in Europe. *Review of Business and Economics*. 2009. Vol. 54, no. 2, p. 179–208.
34. EU country profiles | European Union, [no date]. . Online. Available from: https://european-union.europa.eu/principles-countries-history/eu-countries_en [Accessed 29 April 2024].
35. GARCÍA-VALLS, Marisol, CUCINOTTA, Tommaso and LU, Chenyang, 2014. Challenges in real-time virtualization and predictable cloud computing. *Journal of Systems Architecture*. October 2014. Vol. 60, no. 9, p. 726–740. DOI 10.1016/j.sysarc.2014.07.004.
36. Gartner Says Cloud Will Become a Business Necessity by 2028, 2023. . Online. Available from: https://www.gartner.com/en/newsroom/press-releases/2023-11-29-gartner-says-cloud-will-become-a-business-necessity-by-2028 [Accessed 27 April 2024].
37. GHAZIZADEH, Aida, 2012. Cloud Computing Benefits and Architecture in E-Learning. In: *2012 IEEE Seventh International Conference on Wireless, Mobile and Ubiquitous Technology in Education*. IEEE. March 2012. p. 199–201. ISBN 978-1-4673-0884-7. DOI 10.1109/WMUTE.2012.46.
38. GROSSMAN, R.L., 2009. The Case for Cloud Computing. *IT Professional*. March 2009. Vol. 11, no. 2, p. 23–27. DOI 10.1109/MITP.2009.40.
39. HEILIG, Leonard, 2014. A View on Cloud Computing from above the Clouds. *Computer*. October 2014. Vol. 47, no. 10, p. 8–8. DOI 10.1109/MC.2014.271.

40. HOFMANN, Paul and WOODS, Dan, 2010. Cloud Computing: The Limits of Public Clouds for Business Applications. *IEEE Internet Computing*. November 2010. Vol. 14, no. 6, p. 90–93. DOI 10.1109/MIC.2010.136.
41. HOSSEINI, Sahab, FALLON, Grahame, WEERAKKODY, Vishanth and SIVARAJAH, Uthayasankar, 2019. Cloud computing utilization and mitigation of informational and marketing barriers of the SMEs from the emerging markets: Evidence from Iran and Turkey. *International Journal of Information Management*. June 2019. Vol. 46, p. 54–69. DOI 10.1016/j.ijinfomgt.2018.11.011.
42. HUNADY, Ján, PISÁR, Peter, VUGEC, Dalia Suša and BACH, Mirjana Pejic, 2022. Digital Transformation in European Union: North is leading, and South is lagging behind. *International Journal of Information Systems and Project Management*. 2022. Vol. 10, no. 4, p. 58–81.
43. HUSSEIN, Mohamed El, HIRST, Sandra, SALYERS, Vince and OSUJI, Joseph, 2014. Using grounded theory as a method of inquiry: Advantages and disadvantages. . 2014.
44. IDC Says European Public Cloud Spending Will Reach $142 Billion This Year, Defying Budget Cuts Amid an Economic Downturn, 2023. . Online. Available from: https://www.idc.com/getdoc.jsp?containerId=prEUR151144823 [Accessed 27 April 2024].
45. JANY SHABU, Dr. S.L., REFONAA, Dr. J., C NAIR, Ms. Manju, VELVIZHI, Ms. R. and CHERUKULLAPURATH MANA, Dr. Suja, 2023. *Navigating The Cloudscape: A Comprehensive Guide To Cloud Computing*. Jupiter Publications Consortium. ISBN 9789391303679.
46. JAYAPRAKASH, Stanly, NAGARAJAN, Manikanda Devarajan, PRADO, Rocío Pérez de, SUBRAMANIAN, Sugumaran and DIVAKARACHARI, Parameshachari Bidare, 2021. A Systematic Review of Energy Management Strategies for Resource Allocation in the Cloud: Clustering, Optimization and Machine Learning. *Energies*. 27 August 2021. Vol. 14, no. 17, p. 5322. DOI 10.3390/en14175322.
47. KAMARUDIN, Shafinah, AHMAD KHALILI, Ahmad Hidayat, ABD. AZIZ, Zakry Fitri, KAMARUDIN, Khairul Anuar and WAHAB, Amelia Natasya Abdul, 2022. Exploring of Potential of Cloud Computing for Small and Medium Enterprises. *Indonesian Journal of Information Systems*. 26 February 2022. Vol. 4, no. 2. DOI 10.24002/ijis.v4i2.5487.
48. KANDUKURI, Balachandra Reddy, V., Ramakrishna Paturi and RAKSHIT, Atanu, 2009. Cloud Security Issues. In: *2009 IEEE International Conference on Services*

Computing. IEEE. 2009. p. 517–520. ISBN 978-1-4244-5183-8. DOI 10.1109/SCC.2009.84.

49. KAUR, Pawandeep, KAUR, Simranpreet and MADHURI, H, 2020. Analysing key aspects of Network virtualisation in cloud computing: NaaS. In: . Online. 2020. Available from: https://api.semanticscholar.org/CorpusID:219630814
50. KHAJEH-HOSSEINI, Ali, SOMMERVILLE, Ian and SRIRAM, Ilango, 2010. *Research Challenges for Enterprise Cloud Computing*. Online. Available from: http://aws.amazon.com/economics/
51. KIM, Sanghyun and KIM, Geuna, 2013. An Empirical Study on Factors Influencing the Assimilation and Expected Benefits of Cloud Computing and the Moderating Effect of Organizational Readiness. *Korean Management Science Review*. 31 July 2013. Vol. 30, no. 2, p. 63–77. DOI 10.7737/KMSR.2013.30.2.063.
52. KO, Ryan K.L., JAGADPRAMANA, Peter, MOWBRAY, Miranda, PEARSON, Siani, KIRCHBERG, Markus, LIANG, Qianhui and LEE, Bu Sung, 2011. TrustCloud: A Framework for Accountability and Trust in Cloud Computing. In: *2011 IEEE World Congress on Services*. IEEE. July 2011. p. 584–588. ISBN 978-1-4577-0879-4. DOI 10.1109/SERVICES.2011.91.
53. KOPÁČKOVÁ, Hana and HTOO, Sann Thawdar, 2023. Cloud Computing Services – Emerging Trends During the Times of Pandemic. In: *2023 18th Iberian Conference on Information Systems and Technologies (CISTI)*. IEEE. 20 June 2023. p. 1–6. ISBN 978-989-33-4792-8. DOI 10.23919/CISTI58278.2023.10212064.
54. KSHETRI, Nir and MURUGESAN, San, 2013. Cloud computing and EU data privacy regulations. *Computer*. 2013. Vol. 46, no. 03, p. 86–89.
55. KU, Cheng-Yuan and CHIU, Yu-Siang, 2013. A Novel Infrastructure for Data Sanitization in Cloud Computing (Research Paper). In: . Online. 2013. Available from: https://api.semanticscholar.org/CorpusID:112904150
56. KUMAR, Amit, HOLUSZKO, Maria and ESPINOSA, Denise Crocce Romano, 2017. E-waste: An overview on generation, collection, legislation and recycling practices. *Resources, Conservation and Recycling*. July 2017. Vol. 122, p. 32–42. DOI 10.1016/j.resconrec.2017.01.018.
57. KUMAR, Devesh, SAMALIA, Harsh Vardhan and VERMA, Piyush, 2017. Exploring suitability of cloud computing for small and medium-sized enterprises in India. *Journal of Small Business and Enterprise Development*. 30 October 2017. Vol. 24, no. 4, p. 814–832. DOI 10.1108/JSBED-01-2017-0002.

58. KUMAR JOSHI, Pramod, RANA, Sadhana and PROFESSOR-, Asst, 2011. *CCIS 169 - Era of Cloud Computing*.
59. KUMAR, Vikas and KUMAR GARG, Kavindra, 2012. Migration of Services to the Cloud Environment: Challenges and Best Practices. *International Journal of Computer Applications*. 20 October 2012. Vol. 55, no. 1, p. 1–6. DOI 10.5120/8716-7105.
60. LI, Jin, LI, Yan Kit, CHEN, Xiaofeng, LEE, Patrick P.C. and LOU, Wenjing, 2015. A Hybrid Cloud Approach for Secure Authorized Deduplication. *IEEE Transactions on Parallel and Distributed Systems*. 1 May 2015. Vol. 26, no. 5, p. 1206–1216. DOI 10.1109/TPDS.2014.2318320.
61. LIN, Angela and CHEN, Nan-Chou, 2012. Cloud computing as an innovation: Percepetion, attitude, and adoption. *International Journal of Information Management*. December 2012. Vol. 32, no. 6, p. 533–540. DOI 10.1016/j.ijinfomgt.2012.04.001.
62. M, Suganya and SASIPRABA, T., 2022. Security and Privacy-Efficient Encryption Algorithm for Cloud Data Using Genetic Prime Crossover Technique. In: *2022 1st International Conference on Computational Science and Technology (ICCST)*. IEEE. 9 November 2022. p. 992–997. ISBN 978-1-6654-7655-3. DOI 10.1109/ICCST55948.2022.10040375.
63. MAHAJAN, Shubham, KHANDELWAL, Somya and K, Muskan, 2020. Security and Privacy in Multi-Cloud Environments. *International Journal of Psychosocial Rehabilitation*. Online. 2020. Available from: https://api.semanticscholar.org/CorpusID:267517396
64. MALIK, Saif U. R., KHAN, Samee U. and SRINIVASAN, Sudarshan K., 2013. Modeling and Analysis of State-of-the-art VM-based Cloud Management Platforms. *IEEE Transactions on Cloud Computing*. January 2013. Vol. 1, no. 1, p. 1–1. DOI 10.1109/TCC.2013.3.
65. MANVI, Sunilkumar S and SHYAM, Gopal Krishna, 2014. Resource management for Infrastructure as a Service (IaaS) in cloud computing: A survey. *Journal of network and computer applications*. 2014. Vol. 41, p. 424–440.
66. MARINOS, Alexandros and BRISCOE, Gerard, 2009. Community Cloud Computing. In: . p. 472–484.
67. MEHTA, Jai A., K.NANAVATI, Pankti and K. MEHTA, Vishant, 2021. A SURVEY ON GREEN CLOUD COMPUTING. *International Journal of Engineering Applied Sciences and Technology*. 1 May 2021. Vol. 6, no. 1. DOI 10.33564/IJEAST.2021.v06i01.067.

68. MELCHIORRE, Maria Gabriella, QUATTRINI, Sabrina, LAMURA, Giovanni and SOCCI, Marco, 2021. A Mixed-Methods Analysis of Care Arrangements of Older People with Limited Physical Abilities Living Alone in Italy. *International Journal of Environmental Research and Public Health*. 9 December 2021. Vol. 18, no. 24, p. 12996. DOI 10.3390/ijerph182412996.
69. MELL, P M and GRANCE, T, 2011. *The NIST definition of cloud computing*. Gaithersburg, MD.
70. MENYCHTAS, Andreas, KOUSIOURIS, George, KYRIAZIS, Dimosthenis and VARVARIGOU, Theodora, 2011. Minimizing Technical Complexities in Emerging Cloud Computing Platforms. In: . p. 603–610.
71. MILOŠEVIĆ, Nela, DOBROTA, Marina and RAKOČEVIĆ, Slađana Barjaktarović, 2018. Digital economy in Europe: Evaluation of countries' performances. *Zbornik Radova Ekonomski Fakultet u Rijeka*. 2018. Vol. 36, no. 2, p. 861–880.
72. MORENO-VOZMEDIANO, Rafael, MONTERO, Ruben S. and LLORENTE, Ignacio M., 2013. Key Challenges in Cloud Computing: Enabling the Future Internet of Services. *IEEE Internet Computing*. July 2013. Vol. 17, no. 4, p. 18–25. DOI 10.1109/MIC.2012.69.
73. MORIN, Jean-Henry, AUBERT, Jocelyn and GATEAU, Benjamin, 2012. Towards Cloud Computing SLA Risk Management: Issues and Challenges. In: *2012 45th Hawaii International Conference on System Sciences*. IEEE. January 2012. p. 5509–5514. ISBN 978-1-4577-1925-7. DOI 10.1109/HICSS.2012.602.
74. MORRIS, Darin, VON ROSING, Mark, VON SCHEEL, Henrik and PRESTON, Thomas, 2016. *U.S. Department of Defense Evidence based decision making Leading Practice Case story on Applying measurement, reporting and decision making to run a Government agency "like a business."*
75. NGUYEN DUC, Anh and CHIRUMAMILLA, Aparna, 2019. Identifying Security Risks of Digital Transformation - An Engineering Perspective. In: . p. 677–688.
76. OKE, Ayodeji Emmanuel, KINEBER, Ahmed Farouk, AL-BUKHARI, Ibraheem, FAMAKIN, Ibukun and KINGSLEY, Chukwuma, 2023. Exploring the benefits of cloud computing for sustainable construction in Nigeria. *Journal of Engineering, Design and Technology*. 4 July 2023. Vol. 21, no. 4, p. 973–990. DOI 10.1108/JEDT-04-2021-0189.

77. OPARA, C M, 2019. Cloud computing in Amazon Web Services, Microsoft Windows Azure, Google App Engine and IBM cloud platforms: A comparative study. *Diss. Near East University*. 2019.
78. OPARA-MARTINS, Justice, SAHANDI, Reza and TIAN, Feng, 2014. Critical review of vendor lock-in and its impact on adoption of cloud computing. In: *International Conference on Information Society (i-Society 2014)*. IEEE. November 2014. p. 92–97. ISBN 978-1-9083-2038-4. DOI 10.1109/i-Society.2014.7009018.
79. Organizational Planning in 3 levels Strategic, Tactical, Operational, [no date]. . Online. Available from: https://www.futurecioclub.com/blog/organizational-planning-and-execution-in-three-levels-strategic-tactical-operational [Accessed 26 April 2024].
80. PAHL, Claus, 2015. Containerization and the PaaS Cloud. *IEEE Cloud Computing*. May 2015. Vol. 2, no. 3, p. 24–31. DOI 10.1109/MCC.2015.51.
81. PALOS-SANCHEZ, Pedro R, 2017. Drivers and barriers of the cloud computing in SMEs: the position of the European union. *UNIE Business Research*. 2017. Vol. 6, no. 2, p. 116–132.
82. PALOS-SANCHEZ, Pedro R., 2017. Drivers and Barriers of the Cloud Computing in SMEs: the Position of the European Union. *Harvard Deusto Business Research*. 25 October 2017. Vol. 6, no. 2, p. 116–132. DOI 10.3926/hdbr.125.
83. PARTHASARATHY, Vidhyalakshmi and KUMAR, Vikas, 2016. Determinants of cloud computing adoption by SMEs. *International Journal of Business Information Systems*. 30 May 2016. Vol. 22, p. 375–395. DOI 10.1504/IJBIS.2016.076878.
84. PARVIAINEN, Päivi, TIHINEN, Maarit, KÄÄRIÄINEN, Jukka and TEPPOLA, Susanna, 2017. Tackling the digitalization challenge: how to benefit from digitalization in practice. *International journal of information systems and project management*. 2017. Vol. 5, no. 1, p. 63–77.
85. PILLAI, Sanjaikanth E Vadakkethil Somanathan and POLIMETLA, Kiran, 2024. Enhancing Network Privacy through Secure Multi-Party Computation in Cloud Environments. In: *2024 International Conference on Integrated Circuits and Communication Systems (ICICACS)*. IEEE. 23 February 2024. p. 1–6. ISBN 979-8-3503-1755-8. DOI 10.1109/ICICACS60521.2024.10498662.
86. PLUMMER, Daryl C, BITTMAN, Thomas J, AUSTIN, Tom, CEARLEY, David W and SMITH, David Mitchell, 2008. Cloud computing: Defining and describing an emerging phenomenon. *Gartner, June*. 2008. Vol. 17, p. 1–9.

87. RADU, Laura-Diana, 2017a. Green Cloud Computing: A Literature Survey. *Symmetry*. 30 November 2017. Vol. 9, no. 12, p. 295. DOI 10.3390/sym9120295.
88. RADU, Laura-Diana, 2017b. Green Cloud Computing: A Literature Survey. *Symmetry*. 30 November 2017. Vol. 9, no. 12, p. 295. DOI 10.3390/sym9120295.
89. RAJAB ASAAD, Renas and R. M. ZEEBAREE, Subhi, 2024. Enhancing Security and Privacy in Distributed Cloud Environments: A Review of Protocols and Mechanisms. *Academic Journal of Nawroz University*. 31 March 2024. Vol. 13, no. 1, p. 476–488. DOI 10.25007/ajnu.v13n1a2010.
90. RAJESWARI, S. and KALAISELVI, R., 2017. Survey of data and storage security in cloud computing. In: *2017 IEEE International Conference on Circuits and Systems (ICCS)*. IEEE. December 2017. p. 76–81. ISBN 978-1-5090-6480-9. DOI 10.1109/ICCS1.2017.8325966.
91. RAJU NARZARY, Rinku Basumatary, Deepak Hajoary, 2023. Mapping the Evolving Landscape of Cloud Computing Research: A Bibliometric Analysis. *Dandao Xuebao/Journal of Ballistics*. 21 December 2023. Vol. 35, no. 2, p. 44–58. DOI 10.52783/dxjb.v35.115.
92. RAO, B B Prahlada, SALUIA, Paval, SHARMA, Neetu, MITTAL, Ankit and SHARMA, Shivay Veer, 2012. Cloud computing for Internet of Things & sensing based applications. In: *2012 Sixth International Conference on Sensing Technology (ICST)*. IEEE. 2012. p. 374–380. ISBN 1467322482.
93. RENE, Eldon R., SETHURAJAN, Manivannan, KUMAR PONNUSAMY, Vinoth, KUMAR, Gopalakrishnan, BAO DUNG, Thi Ngoc, BRINDHADEVI, Kathirvel and PUGAZHENDHI, Arivalagan, 2021. Electronic waste generation, recycling and resource recovery: Technological perspectives and trends. *Journal of Hazardous Materials*. August 2021. Vol. 416, p. 125664. DOI 10.1016/j.jhazmat.2021.125664.
94. SAVU, Laura, 2011. Cloud Computing: Deployment Models, Delivery Models, Risks and Research Challenges. In: *2011 International Conference on Computer and Management (CAMAN)*. IEEE. May 2011. p. 1–4. ISBN 978-1-4244-9282-4. DOI 10.1109/CAMAN.2011.5778816.
95. SCANDURRA, Patrizia, PSAILA, Giuseppe, CAPILLA, Rafael and MIRANDOLA, Raffaela, 2015. Challenges and assessment in migrating IT legacy applications to the cloud. In: *2015 IEEE 9th International Symposium on the Maintenance and Evolution of Service-Oriented and Cloud-Based Environments (MESOCA)*. IEEE. 2 October 2015. p. 7–14. ISBN 978-1-4673-7935-9. DOI 10.1109/MESOCA.2015.7328120.

96. SCHUBERT, Lutz, JEFFERY, Keith, NEIDECKER-LUTZ, Burkhard, BAROT, Prashant, BEHR, Francis, BOSCH, Peter and BRANDIC, Ivona, 2010. The future of cloud computing-opportunities for european cloud computing beyond 2010. . 2010.
97. SIDERSKA, Julia, 2020. Robotic Process Automation—a driver of digital transformation? *Engineering Management in Production and Services*. 2020. Vol. 12, no. 2, p. 21–31.
98. SINGLA, Neeraj, CHAHAT, NISHA and HARNOOR, 2022. A Review Paper on Cloud Computing. In: *2022 2nd International Conference on Innovative Sustainable Computational Technologies (CISCT)*. IEEE. 23 December 2022. p. 1–4. ISBN 978-1-6654-7416-0. DOI 10.1109/CISCT55310.2022.10046572.
99. SRINIVASAN, S and SRINIVASAN, S, 2014. Cloud computing evolution. *Cloud Computing Basics*. 2014. P. 1–16.
100. Statistics | Eurostat, 2023. . Online. Available from: https://ec.europa.eu/eurostat/databrowser/view/isoc_cicce_use/default/bar?lang=en [Accessed 15 April 2024].
101. STERGIOU, Christos, PSANNIS, Kostas E., KIM, Byung-Gyu and GUPTA, Brij, 2018. Secure integration of IoT and Cloud Computing. *Future Generation Computer Systems*. January 2018. Vol. 78, p. 964–975. DOI 10.1016/j.future.2016.11.031.
102. SULTAN, Nabil, 2014. Making use of cloud computing for healthcare provision: Opportunities and challenges. *International Journal of Information Management*. April 2014. Vol. 34, no. 2, p. 177–184. DOI 10.1016/j.ijinfomgt.2013.12.011.
103. SUN, Dawei, CHANG, Guiran, SUN, Lina and WANG, Xingwei, 2011. Surveying and Analyzing Security, Privacy and Trust Issues in Cloud Computing Environments. *Procedia Engineering*. 2011. Vol. 15, p. 2852–2856. DOI 10.1016/j.proeng.2011.08.537.
104. SUN, Yunchuan, ZHANG, Junsheng, XIONG, Yongping and ZHU, Guangyu, 2014. Data Security and Privacy in Cloud Computing. *International Journal of Distributed Sensor Networks*. 1 July 2014. Vol. 10, no. 7, p. 190903. DOI 10.1155/2014/190903.
105. TEHRANI, Shima Ramezani and SHIRAZI, Farid, 2014. Factors Influencing the Adoption of Cloud Computing by Small and Medium Size Enterprises (SMEs). In: . p. 631–642.
106. TOADER, Liviu, PARASCHIV, Dorel, DINU, Vasile, MANEA, Daniela and MIHAI, Mihaela, 2023. The effects of private sector companies' research and development investments on the adoption of cloud computing services in the European Union. *E+M*

Ekonomie a Management. June 2023. Vol. 26, no. 2, p. 189–202. DOI 10.15240/tul/001/2023-2-012.

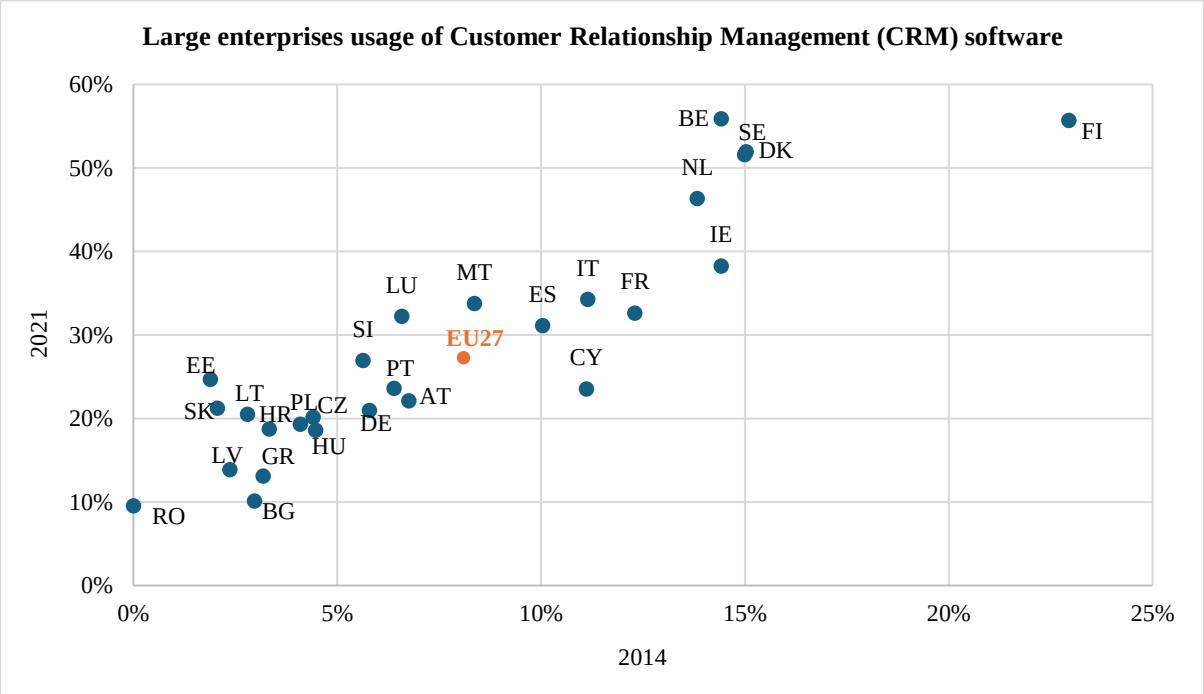
107. TRAD, Antoine and KALPIC, Damir, 2013. The Selection and Training Framework (STF) for managers in (e-)business innovation transformation projects the business Transformation Manager's profile. In: *Proceedings of the International Conference on Information Technology Interfaces, ITI*. 2013. p. 117–122. ISBN 9789537138301. DOI 10.2498/iti.2013.0551.
108. VAN ARK, Bart, 2016. The productivity paradox of the new digital economy. *International Productivity Monitor*. 2016. Vol. 31, p. 3–18.
109. VAQUERO, Luis M, RODERO-MERINO, Luis, CACERES, Juan and LINDNER, Maik, 2008. *A break in the clouds: towards a cloud definition*. 2008. ACM New York, NY, USA. ISBN 0146-4833.
110. XIANG, Yang, DI MARTINO, Beniamino, WANG, Guilin and LI, Jin, 2015. Cloud Computing: Security, Privacy and Practice. *Future Generation Computer Systems*. November 2015. Vol. 52, p. 59–60. DOI 10.1016/j.future.2015.06.007.
111. XU, Xun, 2012. From cloud computing to cloud manufacturing. *Robotics and computer-integrated manufacturing*. 2012. Vol. 28, no. 1, p. 75–86.
112. XUE, Colin Ting Si and XIN, Felicia Tiong Wee, 2016. Benefits and Challenges of the Adoption of Cloud Computing in Business. *International Journal on Cloud Computing: Services and Architecture*. 30 December 2016. Vol. 6, no. 6, p. 01–15. DOI 10.5121/ijccsa.2016.6601.
113. ZHANG, Yang, WANG, Huaimin, WU, Yiwen, HU, Dongyang and WANG, Tao, 2020. GitHub's milestone tool: A mixed-methods analysis on its use. *Journal of Software: Evolution and Process*. 20 April 2020. Vol. 32, no. 4. DOI 10.1002/smr.2229.
114. ZHOU, Jun, CAO, Zhenfu, DONG, Xiaolei and VASILAKOS, Athanasios V., 2017. Security and Privacy for Cloud-Based IoT: Challenges. *IEEE Communications Magazine*. January 2017. Vol. 55, no. 1, p. 26–33. DOI 10.1109/MCOM.2017.1600363CM.
115. ZIED MILIAN, Eduardo, DE MESQUITA SPINOLA, Mauro and DE PAULA PESSOA, Marcelo Schneck, 2015. Opportunities for strategic alignment of IT to business with the adoption of cloud computing: Case studies in large organizations. In: *2015 Portland International Conference on Management of Engineering and*

Technology (PICMET). IEEE. August 2015. p. 64–74. ISBN 978-1-8908-4331-1. DOI 10.1109/PICMET.2015.7273067.

116. ZISSIS, Dimitrios and LEKKAS, Dimitrios, 2012. Addressing cloud computing security issues. *Future Generation Computer Systems*. March 2012. Vol. 28, no. 3, p. 583–592. DOI 10.1016/j.future.2010.12.006.
117. ZUKA, Edgars Brekis–Kristine Rozite–Rita, 2014. META-ANALYSIS OF ADVANTAGES AND CONCERNS OF CLOUD COMPUTING IN SMALL COMPANIES. 2014.

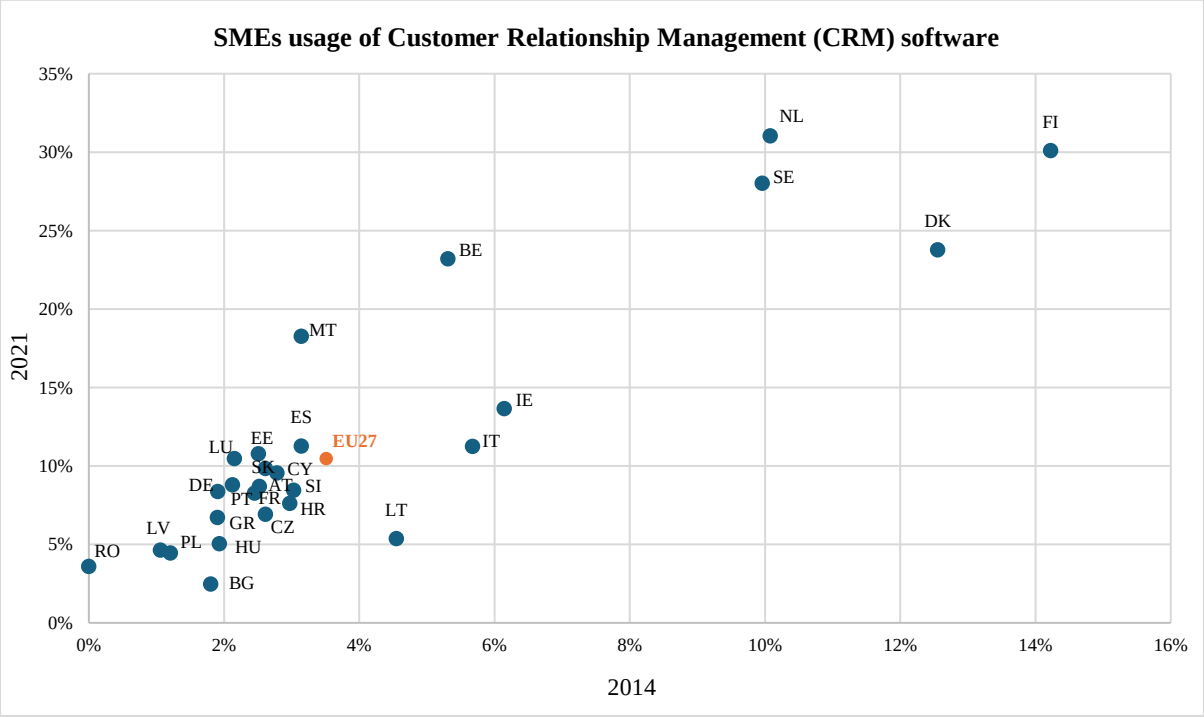
APPENDIX

Appendix A: Comparison of Large enterprises' usage of CRM for 2014 and 2021



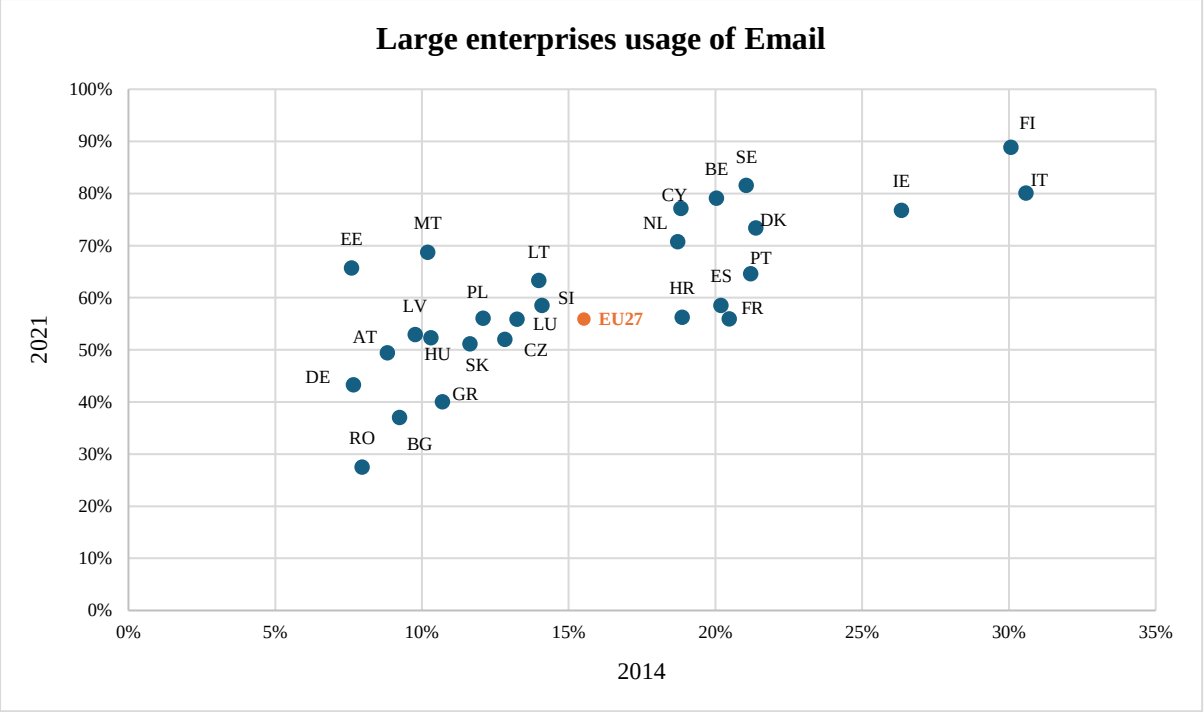
Source: Author's own creation

Appendix B: Comparison of SMEs' usage of CRM for 2014 and 2021



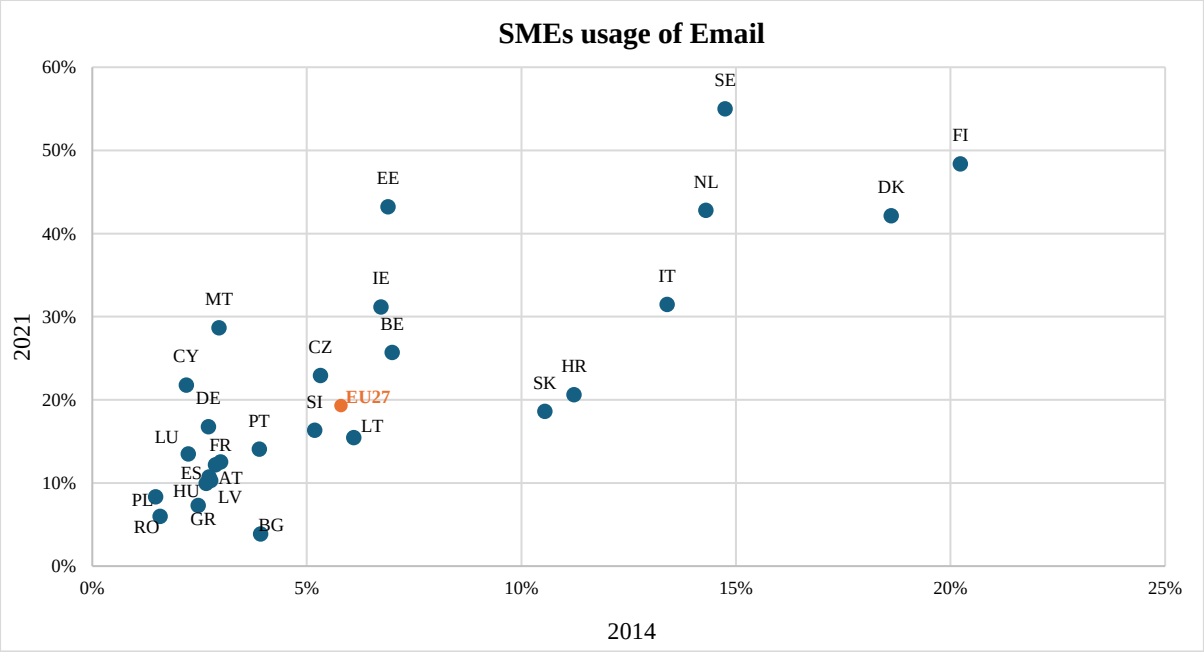
Source: Author's own creation

Appendix C: Comparison of Large enterprises' usage of Email for 2014 and 2021



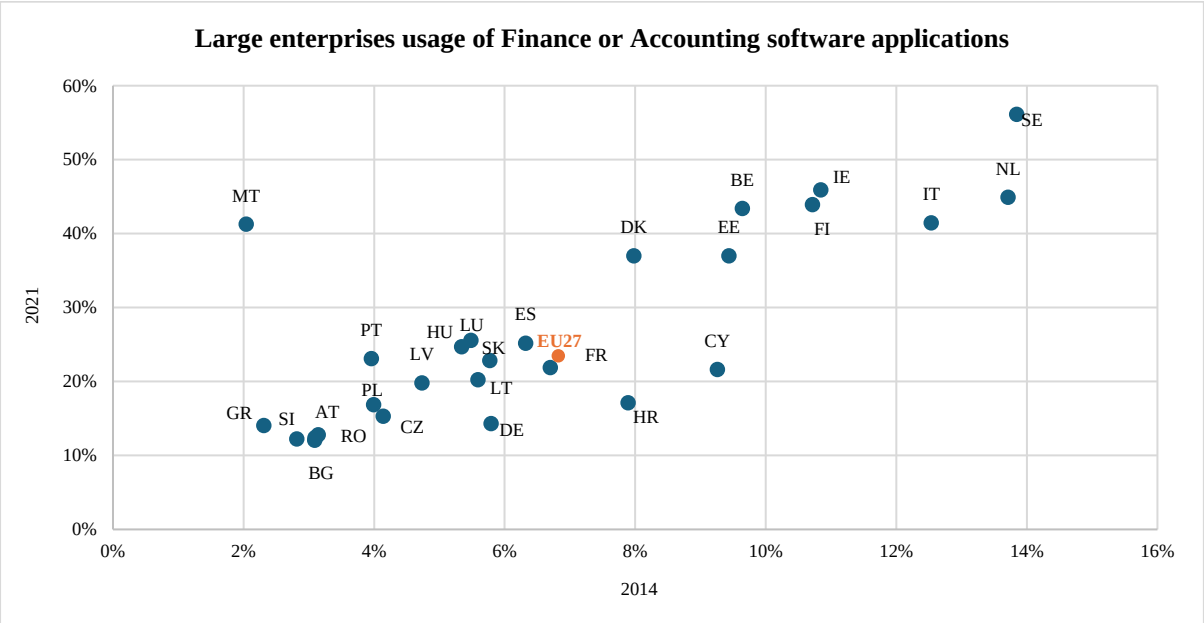
Source: Author's own creation

Appendix D: Comparison of SMEs' usage of Email for 2014 and 2021



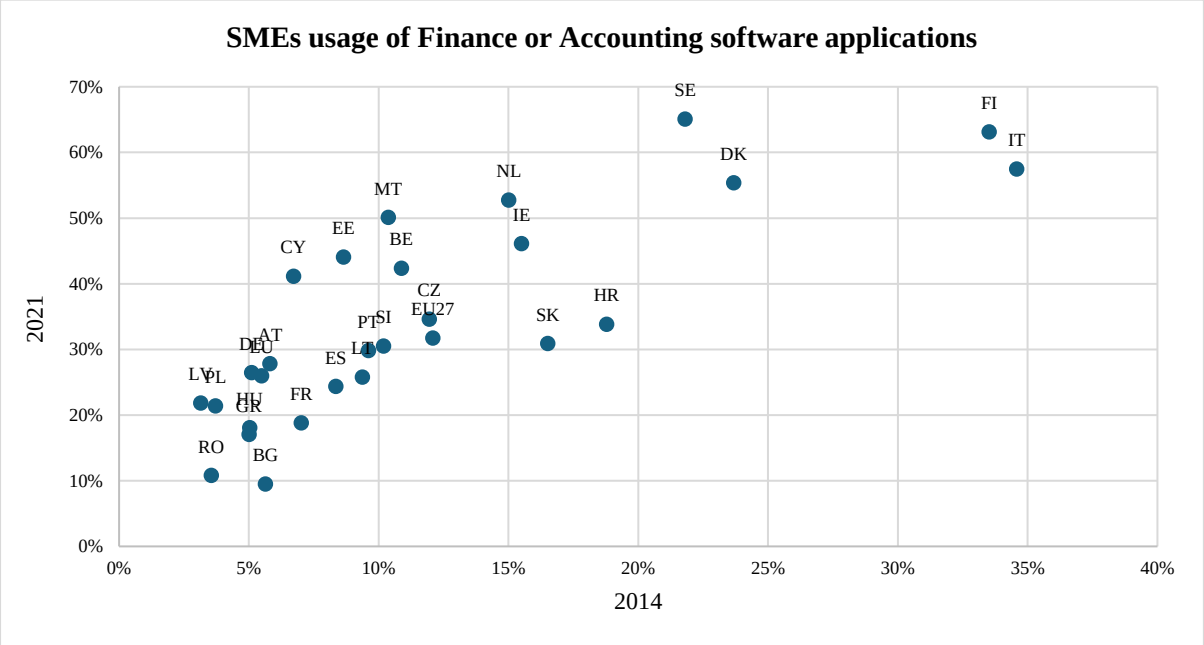
Source: Author's own creation

Appendix E: Comparison of Large enterprises' usage of Fiance or Accounting software for 2014 and 2021



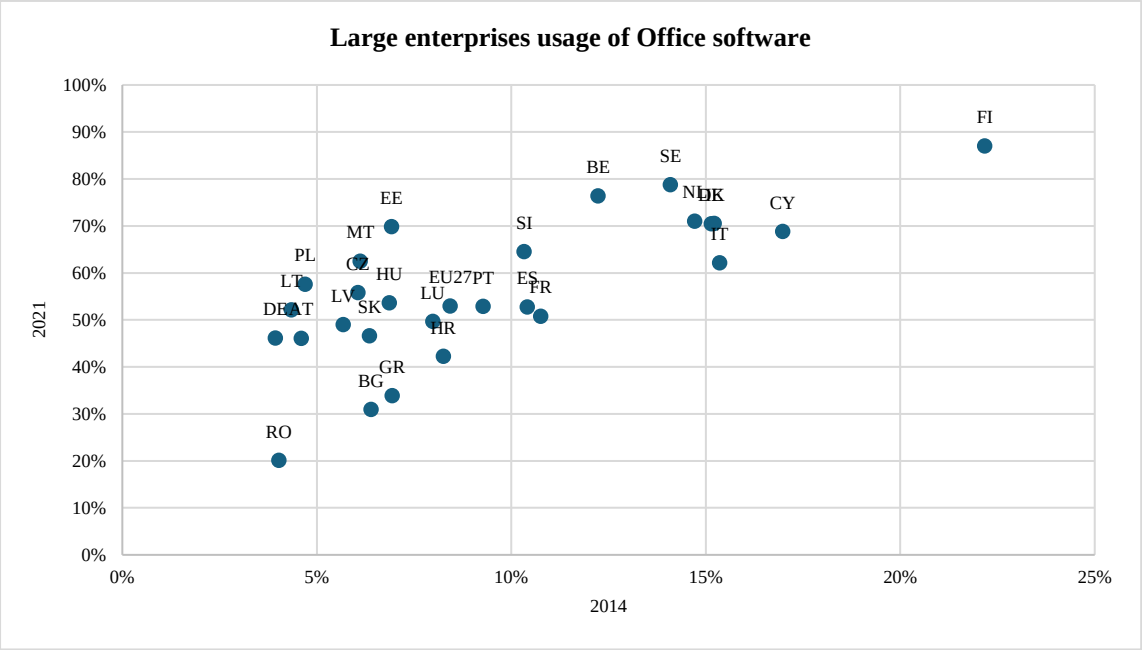
Source: Author's own creation

Appendix F: Comparison of SMEs' usage of Email for 2014 and 2021



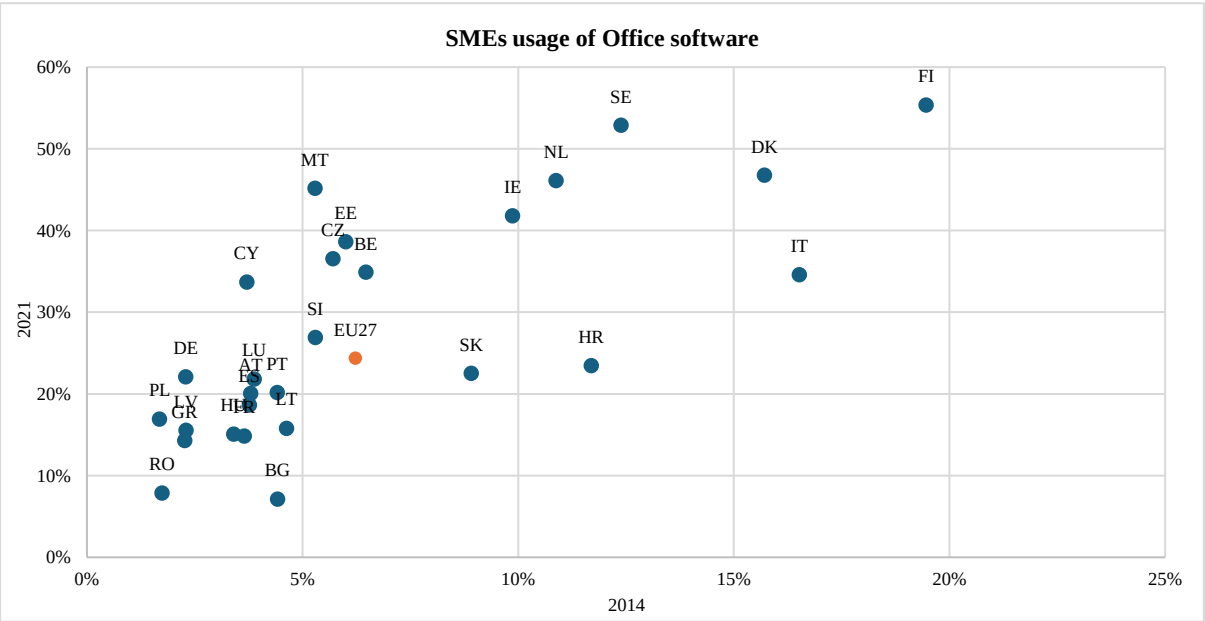
Source: Author's own creation

Appendix G: Comparison of Large enterprises' usage of Office software for 2014 and 2021



Source: Author's own creation

Appendix H: Comparison of SMEs' usage of Office software for 2014 and 2021



Source: Author's own creation

Appendix I: Selected papers for document analysis

PID	Country	Papers
SE1	Sweden	LIM, Nena, GRÖNLUND, Åke and ANDERSSON, Annika, 2015. Cloud computing: The beliefs and perceptions of Swedish school principals. Computers & Education. May 2015. Vol. 84, p. 90–100. DOI 10.1016/j.compedu.2015.01.009.
SE2	Sweden	HADDARA, Moutaz, FAGERSTRØM, Asle and MÆLAND, Bjørnar, 2015. Cloud ERP Systems: Anatomy of Adoption Factors & Attitudes. Journal of Enterprise Resource Planning Studies. 17 September 2015. P. 1–24. DOI 10.5171/2015.521212.
SE3	Sweden	MICHALAS, Antonis, PALADI, Nicolae and GEHRMANN, Christian, 2014. Security aspects of e-Health systems migration to the cloud. In: 2014 IEEE 16th International Conference on e-Health Networking, Applications and Services (Healthcom). IEEE. October 2014. p. 212–218. ISBN 978-1-4799-6644-8. DOI 10.1109/HealthCom.2014.7001843.
SE4	Sweden	FAIZI, Ana, PADYAB, Ali and NAESS, Andreas, 2021. From rationale to lessons learned in the cloud information security risk assessment: a study of organizations in Sweden. Information & Computer Security. 25 August 2021. Vol. ahead-of-print. DOI 10.1108/ICS-03-2021-0034.
SE5	Sweden	VONDERAU, Asta, 2019. Scaling the Cloud: Making State and Infrastructure in Sweden. Ethnos. 8 August 2019. Vol. 84, no. 4, p. 698–718. DOI 10.1080/00141844.2018.1471513.
SE6	Sweden	TOOR, Salman, LINDBERG, Mathias, FALMAN, Ingemar, VALLIN, Andreas, MOHILL, Olof, FREYHULT, Pontus, NILSSON, Linus, AGBACK, Martin, VIKLUND, Lars, ZAZZIK, Henric, SPJUTH, Ola, CAPUCCINI, Marco, MOLLER, Joakim, MURTAGH, Donal and HELLANDER, Andreas, 2017. SNIC Science Cloud (SSC): A National-Scale Cloud Infrastructure for Swedish Academia. In: 2017 IEEE 13th International Conference on e-Science (e-Science). IEEE. October 2017. p. 219–227. ISBN 978-1-5386-2686-3. DOI 10.1109/eScience.2017.35.
SE7	Sweden	AASI, Parisa, NIKIC, Jovana, LI, Melisa and RUSU, Lazar, 2020. The Influence of Cloud Computing on IT Governance in a Swedish Municipality. In: . p. 623–639.
SE8	Sweden	ISLAM, M. Sirajul and KARLSSON, Fredrik, 2022. The Public Sector Cloud Service Procurement in Sweden. International Journal of Public Administration in the Digital Age. 6 May 2022. Vol. 8, no. 1, p. 1–22. DOI 10.4018/ijpada.302906.
SE9	Sweden	LUNDELL, Björn, GAMALIELSSON, Jonas, KATZ, Andrew and LINDROTH, Mathias, 2022. Use of Commercial SaaS Solutions in Swedish Public Sector Organisations under Unknown Contract Terms. In: . p. 73–92.
SE10	Sweden	BORGLUND, Erik A.M., 2015. What About Trust in the Cloud? Archivists' Views on Trust / La question de la confiance dans le nuage: Le point de vue des archivistes sur la question. Canadian Journal of Information and Library Science. 2015. Vol. 39, no. 2, p. 114–127. DOI 10.1353/ils.2015.0017.
SE11	Sweden	HU, Yan, BAI, Guohua, ERIKSÉN, Sara and LUNDBERG, Jenny, 2021. An IoT Cloud Model for Diabetes Home-Based Care: A Case Study for Perceived Future Feasibility. In: . p. 99–115.
SE12	Sweden	KOUR, Ravdeep, KARIM, Ramin, PARIDA, Aditya and KUMAR, Uday, 2014. Applications of radio frequency identification (RFID) technology with eMaintenance cloud for railway system. International Journal of System Assurance Engineering and Management. 5 March 2014. Vol. 5, no. 1, p. 99–106. DOI 10.1007/s13198-013-0196-z.
SE13	Sweden	KHALDI, Fouad el, AHOUANGONOU, Christian, NIESS, Matthieu and DAVID, Olivier, 2016. Cloud Based HPC for Innovative Virtual Prototyping Methodology: Automotive Applications. Transportation Research Procedia. 2016. Vol. 14, p. 993–1002. DOI 10.1016/j.trpro.2016.05.079.
SE14	Sweden	KHISRO, J, BERGENSTJERNA, M, MAGOULAS, T and PESSI, Kalevi, 2014. Patient-centred healthcare: Stakeholder views of cloud computing on information sharing and communication. Proceedings of the 8th European Conference on Information Management and Evaluation, ECIME 2014. 1 January 2014. P. 109–117.
SE15	Sweden	HODOSI, Georg, HAIDER, Arif and RUSU, Lazar, 2021. Risk Factors in Cloud Computing Relationships: A Study in Public Organizations in Sweden.

		Procedia6Computer Science. 2021. Vol. 181, p. 1179–1186. DOI 10.1016/j.procs.2021.01.315.
SE16	Sweden	AYELE, Workneh Y. and JUELL-SKIELSE, Gustaf, 2015. User Implications for Cloud Based Public Information Systems. In: Proceedings of the 2015 2nd International Conference on Electronic Governance and Open Society: Challenges in Eurasia. New York, NY, USA: ACM. 24 November 2015. p. 217–227. ISBN 9781450340700. DOI 10.1145/2846012.2846036.
FI1	Finland	LAATIKAINEN, Gabriella and LUOMA, Eetu, 2014. Impact of Cloud Computing Technologies on Pricing Models of Software Firms – Insights from Finland. In: . p. 243–257.
FI2	Finland	KAISLA PAKKANEN, 2019. FACTORS AFFECTING SUCCESSFUL CLOUD ADOPTION IN FINNISH ORGANIZATIONS.
FI3	Finland	HAUKKALA, Mikko, 2018. Qualitative Study to Explore Obstacles of Public Cloud Adoption Case Finnish Government Agencies and Public Administration.
FI4	Finland	OTTO BUURE, 2020. CHALLENGES IN MOVING TO CLOUD COMPUTING ENVIRONMENT: CASE FINNISH TELEOPERATOR.
FI5	Finland	MIKKONEN, Ilkka and KHAN, Imran, 2016. Cloud computing : SME company point of view. In: . Online. 2016. Available from: https://api.semanticscholar.org/CorpusID:63203305
FI6	Finland	MARIKA HELTTULA, 2023. Enabling data-driven decision-making for a Finnish SME: a data lake solution.
FI7	Finland	CARVALLO, Pamela, CAVALLI, Ana R and MALLOULI, Wissam, 2018. A Platform for Security Monitoring of Multi-cloud Applications. In: PETRENKO, Alexander K and VORONKOV, Andrei (eds.), Perspectives of System Informatics. Cham: Springer International Publishing. 2018. p. 59–71. ISBN 978-3-319-74313-4.
FI8	Finland	KARN, Arodh Lal, SAPKOTA, Niranjan, KARNA, Rakshha Kumari and RAFIQ, Muhammad, 2020. Striving to make better decision quicker in cloud: big data event trading in high frequency trading perspective. International Journal of Services Technology and Management. 2020. Vol. 26, no. 2/3, p. 215. DOI 10.1504/IJSTM.2020.106684.
NL1	Netherlands	SCHOLTEN, Jules J, 2017. The determinants of cloud computing adoption in The Netherlands : a TOE-perspective. In: . Online. 2017. Available from: https://api.semanticscholar.org/CorpusID:115716923
NL2	Netherlands	BEULEN, Erik, 2017. Cloud Readiness as an Enabler for Application Rationalization: A Survey in the Netherlands. In: . p. 111–123.
NL3	Netherlands	LOUKIS, Euripidis, JANSSEN, Marijn and MINTCHEV, Ianislav, 2019. Determinants of software-as-a-service benefits and impact on firm performance. Decision Support Systems. February 2019. Vol. 117, p. 38–47. DOI 10.1016/j.dss.2018.12.005.
NL4	Netherlands	DIMA, Adriana, BUGHEANU, Alexandru-Mihai, BOGHIAN, Ruxandra and MADSEN, Dag Øivind, 2022. Mapping Knowledge Area Analysis in E-Learning Systems Based on Cloud Computing. Electronics. 23 December 2022. Vol. 12, no. 1, p. 62. DOI 10.3390/electronics12010062.
NL5	Netherlands	DRAGO, Idilio, DE O. SCHMIDT, Ricardo, HOFSTEDE, Rick, SPEROTTO, Anna, KARIMZADEH, Morteza, HAVERKORT, Boudewijn R. and PRAS, Aiko, 2013. Networking for the Cloud: Challenges and Trends. PIK - Praxis der Informationsverarbeitung und Kommunikation. 1 January 2013. Vol. 36, no. 4. DOI 10.1515/pik-2013-0035.
NL6	Netherlands	TULER DE OLIVEIRA, Marcela, AMORIM REIS, Lúcio Henrik, MARQUERING, Henk, ZWINDERMAN, Aeilko H and DELGADO OLABARRIAGA, Sílvia, 2022. Perceptions of a Secure Cloud-Based Solution for Data Sharing During Acute Stroke Care: Qualitative Interview Study. JMIR Formative Research. 23 December 2022. Vol. 6, no. 12, p. e40061. DOI 10.2196/40061.
NL7	Netherlands	CURRIE, Wendy and SEDDON, Jonathan, 2014. A cross-country study of cloud computing policy and regulation in healthcare. ECIS 2014 Proceedings - 22nd European Conference on Information Systems. 1 January 2014.
NL8	Netherlands	BEULEN, Erik, 2017. Cloud Readiness as an Enabler for Application Rationalization: A Survey in the Netherlands. In: . p. 111–123.

DK1	Denmark	CHAUHAN, Muhammad Aufeef and BABAR, Muhammad Ali, 2012. Cloud infrastructure for providing tools as a service. In: Proceedings of the WICSA/ECSA 2012 Companion Volume. New York, NY, USA: ACM. 20 August 2012. p. 5–13. ISBN 9781450315685. DOI 10.1145/2361999.2362002.
DK2	Denmark	PANTIĆ, Zoran and BABAR, Muhammad Ali, 2012. Guidelines for Building a Private Cloud Infrastructure. ISBN 978-87-7949-254-7.
DK3	Denmark	SVEJVIG, Per, STORGAARD, Torben and MØLLER, Charles, 2013. Hype or Reality: Will Enterprise Systems as a Service Become an Organizing Vision for Enterprise Cloud Computing in Denmark? In: . p. 190–197.
IT1	Italy	CALDARELLI, Adele, FERRI, Luca and MAFFEI, Marco, 2017. Expected benefits and perceived risks of cloud computing: an investigation within an Italian setting. Technology Analysis & Strategic Management. 7 February 2017. Vol. 29, no. 2, p. 167–180. DOI 10.1080/09537325.2016.1210786.
IT2	Italy	SPAGNOLI, Francesca, AMENDOLA, Carlo and CRENCA, Francesco, 2014. The Economic and Legal Perspectives of Cloud Computing in Italian Public Administration and a Roadmap to the Adoption of g-Cloud in Italy. In: . p. 47–56.
IT3	Italy	COCCOLI, Mauro, DE FRANCESCO, Vincenzo, FUSCO, Antonio and MARESCA, Paolo, 2022. A cloud-based cognitive computing solution with interoperable applications to counteract illegal dumping in smart cities. Multimedia Tools and Applications. 3 January 2022. Vol. 81, no. 1, p. 95–113. DOI 10.1007/s11042-021-11238-8.
IT4	Italy	STECCA, Giuseppe, PULIAFITO, Antonio, SIMONETTI, Marco, MARIOTTA, Guido and SCIUTO, Pierluigi, 2016. A Cloud-based System to Protect Against Industrial Multi-risk Events. Procedia CIRP. 2016. Vol. 41, p. 650–654. DOI 10.1016/j.procir.2015.12.093.
IT5	Italy	BENCIVENNI, Marco, MICHELOTTO, Diego, ALFIERI, Roberto, BRUNETTI, Riccardo, CECCANTI, Andrea, CESINI, Daniele, COSTANTINI, Alessandro, FATTIBENE, Enrico, GAIDO, Luciano, MISURELLI, Giuseppe, RONCHIERI, Elisabetta, SALOMONI, Davide, VERONESI, Paolo, VENTURI, Valerio and VISTOLI, Maria Cristina, 2015. Accessing Grid and Cloud Services Through a Scientific Web Portal. Journal of Grid Computing. 23 June 2015. Vol. 13, no. 2, p. 159–175. DOI 10.1007/s10723-014-9310-y.
IT6	Italy	REFORGIATO RECUPERO, Diego, CASTRONOVO, Mario, CONSOLI, Sergio, COSTANZO, Tarcisio, GANGEMI, Aldo, GRASSO, Luigi, LODI, Giorgia, MERENDINO, Gianluca, MONGIOVÌ, Misael, PRESUTTI, Valentina, RAPISARDA, Salvatore Davide, ROSA, Salvo and SPAMPINATO, Emanuele, 2016. An Innovative, Open, Interoperable Citizen Engagement Cloud Platform for Smart Government and Users' Interaction. Journal of the Knowledge Economy. 30 June 2016. Vol. 7, no. 2, p. 388–412. DOI 10.1007/s13132-016-0361-0.
IT7	Italy	FERRI, Luca, MAFFEI, Marco, MANGIA, Gianluigi and TOMO, Andrea, 2017. Analyzing Cloud-based Startups: Evidence from a Case Study in Italy. International Business Research. 12 April 2017. Vol. 10, no. 5, p. 73. DOI 10.5539/ibr.v10n5p73.
IT8	Italy	FERRI, Luca, SPANÒ, Rosanna and TOMO, Andrea, 2020. Cloud computing in high tech startups: evidence from a case study. Technology Analysis & Strategic Management. 1 February 2020. Vol. 32, no. 2, p. 146–157. DOI 10.1080/09537325.2019.1641594.
IT9	Italy	BOCCIA, Marinella, FERRAGINA, Anna Maria and IANDOLO, Stefano, 2022. Follow the cloud! The impact of ICT on Italian provinces' trade. Journal of Industrial and Business Economics. 30 December 2022. Vol. 49, no. 4, p. 667–690. DOI 10.1007/s40812-022-00230-4.
IT10	Italy	BAGNASCO, S, COLAMARIA, F, COLELLA, D, CASULA, E, ELIA, D, FRANCO, A, LUSSO, S, LUPARELLO, G, MASERA, M, MINIELLO, G, MURA, D, PIANO, S, VALLERO, S, VENARUZZO, M and VINO, G, 2015. Interoperating Cloud-based Virtual Farms. Journal of Physics: Conference Series. 23 December 2015. Vol. 664, no. 2, p. 022033. DOI 10.1088/1742-6596/664/2/022033.
IT11	Italy	FURINGHETTI, Marco, PAVESE, Alberto, LUNGHI, Francesco and SILVESTRI, Davide, 2019. Strategies of structural health monitoring for bridges based on cloud computing. Journal of Civil Structural Health Monitoring. 20 November 2019. Vol. 9, no. 5, p. 607–616. DOI 10.1007/s13349-019-00356-5.

IT12	Italy	BALDASSARRE, Maria Teresa, BOFFOLI, Nicola, CAIVANO, Danilo, DEL CAMPO, Gennaro and VISAGGIO, Giuseppe, 2015. Building a Community Cloud Infrastructure for a Logistics Project. In: Proceedings of the 17th International Conference on Enterprise Information Systems. SCITEPRESS - Science and and Technology Publications. 2015. p. 420–427. ISBN 978-989-758-096-3. DOI 10.5220/0005400504200427.
IT13	Italy	CALDARELLI, Adele, MARCO MAFFEI and LUCA FERRI, 2014. Perceived riskiness of cloud computing an investigation of the italian setting. . 2014.
IT14	Italy	ASHTARI, Sadaf and EYDGAHI, Ali, 2017. Student perceptions of cloud applications effectiveness in higher education. Journal of Computational Science. November 2017. Vol. 23, p. 173–180. DOI 10.1016/j.jocs.2016.12.007.
IT15	Italy	FERIOTTO, Chiara, BIANCARDI, Michela, HOHENSTEIN, Ursula Thun, BREDA, Marzia and LEONFORTE, Antonio, 2013. Cloud computing for cataloguing and valorization of the Cultural Heritage.: Experimentation of the LiveBase platform for the fast development of cataloguing. In: 2013 Digital Heritage International Congress (DigitalHeritage). IEEE. October 2013. p. 103–106. ISBN 978-1-4799-3170-5. DOI 10.1109/DigitalHeritage.2013.6744738.
IT16	Italy	CALDARELLI, Adele, MARCO MAFFEI and LUCA FERRI, 2014. Perceived riskiness of cloud computing an investigation of the italian setting. 2014.
IT17	Italy	LEONE, Sabrina and BIANCOFIORE, Giovanni, 2019. Sustainable Cloud Computing Frameworks for E-Government. In: Web Services. IGI Global. p. 280–313.
CZ1	Czechia	MARESOVA, Petra and KACETL, Jaroslav, 2015. Cloud Computing in the Public Sector – Case Study in Educational Institution. Procedia - Social and Behavioral Sciences. May 2015. Vol. 182, p. 341–348. DOI 10.1016/j.sbspro.2015.04.781.
CZ2	Czechia	POULOVÁ, Petra, KLÍMOVÁ, Blanka and ŠVARC, Martin, 2021. Cloud Computing in the World and Czech Republic—A Comparative Study. In: . p. 771–778.
CZ3	Czechia	MAREŠOVÁ, Petra and HÁLEK, Vítězslav, 2014. Deployment of cloud computing in small and medium sized enterprises in the Czech Republic. E+M Ekonomie a Management. 2 December 2014. Vol. 17, no. 4, p. 159–174. DOI 10.15240/tul/001/2014-4-012.
CZ4	Czechia	PAVLIK, Jakub, KOMAREK, Ales and SOBESLAV, Vladimir, 2014. Security information and event management in the cloud computing infrastructure. In: 2014 IEEE 15th International Symposium on Computational Intelligence and Informatics (CINTI). IEEE. November 2014. p. 209–214. ISBN 978-1-4799-5338-7. DOI 10.1109/CINTI.2014.7028677.
CZ5	Czechia	HOMAN, Jiří and BERÁNEK, Ladislav, 2023. Factors Influencing Cloud Computing Adoption by SMEs in the Czech Republic: An Empirical Analysis Using Technology-Organization-Environment Framework. Acta Informatica Pragensia. 10 October 2023. Vol. 12, no. 2, p. 296–310. DOI 10.18267/j.aip.217.
CZ6	Czechia	SVOBODA, Tomá and KARAMAZOV, Simeon, 2017. Analysis of Security Threats of Cloud Computing. Journal of Telecommunication, Electronic and Computer Engineering. Online. 2017. Vol. 9, p. 59–64. Available from: https://api.semanticscholar.org/CorpusID:62842218
EL1	Greece	NANOS, Ioannis, MANTHOU, Vicky and ANDROUTSOU, Efthimia, 2019. Cloud Computing Adoption Decision in E-government. In: . p. 125–145.
EL2	Greece	CHATZITHANASIS, Georgios and MICHALAKELIS, Christos, 2018. The Benefits of Cloud Computing: Evidence From Greece. International Journal of Technology Diffusion. 1 April 2018. Vol. 9, p. 61–73. DOI 10.4018/IJTD.2018040104.
EL3	Greece	KALLERGIS, Dimitrios, PAPACHARALAMPOU, Chrysoula, CHIMOS, Konstantinos, CHAVAKIS, Thomas and DOULIGERIS, Christos, 2014. A Hybrid Cloud Computing Approach for Managing Spatial Data: A Case Study for Water Resources in Greece. In: 2014 Fifth International Conference on Computing for Geospatial Research and Application. IEEE. August 2014. p. 33–37. ISBN 978-1-4799-4321-0. DOI 10.1109/COM.Geo.2014.18.
EL4	Greece	KYRIAKOU, Niki and LOUKIS, Euripidis, 2017. Cloud Computing Business Value and Human Determinants. In: Proceedings of the 21st Pan-Hellenic Conference on

		Informatics. New York, NY, USA: ACM. 28 September 2017. p. 1–6. ISBN 9781450353557. DOI 10.1145/3139367.3139485.
EL5	Greece	KALLONIATIS, Christos, MOURATIDIS, Haralambos and ISLAM, Shareeful, 2013. Evaluating cloud deployment scenarios based on security and privacy requirements. Requirements Engineering. 4 November 2013. Vol. 18, no. 4, p. 299–319. DOI 10.1007/s00766-013-0166-7.
EL6	Greece	KYRIAKOU, Niki, EURIPIDES, Loukis and PARASKEVI, Dimitropoulou, 2020. Factors affecting cloud storage adoption by Greek municipalities. In: Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance. New York, NY, USA: ACM. 23 September 2020. p. 244–253. ISBN 9781450376747. DOI 10.1145/3428502.3428537.
EL7	Greece	ROUNGERIS, Konstantinos, KAROLIDIS, Georgios I. and ANDROULAKIS, George S., 2013. The business perspective of cloud computing adoption: evidence from Greece. International Journal of Technology Intelligence and Planning. 2013. Vol. 9, no. 3, p. 200. DOI 10.1504/IJTIP.2013.059654.
RO1	Romania	DUMITRACHE, Mihail, SANDU, Ionuţ-Eugen and BARBU, Dragoş-Cătălin, 2017. An Integrated Cloud Computing Solution for Romanian Public-Sector Entities: ICIPRO Project. Studies in Informatics and Control. 13 December 2017. Vol. 26, no. 4. DOI 10.24846/v26i4y201712.
RO2	Romania	NEICU, Andra-Ileana, RADU, Anamaria-Cătălina, ZAMAN, Gheorghe, STOICA, Ivona and RĂPAN, Florian, 2020. Cloud Computing Usage in SMEs. An Empirical Study Based on SMEs Employees Perceptions. Sustainability. 18 June 2020. Vol. 12, no. 12, p. 4960. DOI 10.3390/su12124960.
RO3	Romania	TUTUNEA, Mihaela Filofteia, 2014. SMEs' Perception on Cloud Computing Solutions. Procedia Economics and Finance. 2014. Vol. 15, p. 514–521. DOI 10.1016/S2212-5671(14)00498-5.
RO4	Romania	BUCEA-MANEA-TONIS, Rocsana, PISTOL, Luminita and BUCEA-MANEA-TONIS, Radu, 2017. Cloud Computing Application for Romanian SMEs. Marketing of Scientific and Research Organizations. 10 August 2017. Vol. 3. DOI 10.14611/minib.25.09.2017.15.
RO5	Romania	ANA-GABRIELA, Babucea and BRANCUSI, Constantin, 2019. ROMANIAN ENTERPRISES' WILLINGNESS TO ADOPT THE CLOUD COMPUTING SERVICES FOR HOSTING THEIR DATABASES.
RO6	Romania	IONESCU, Bogdan, IONESCU, Iuliana and TUDORAN, Laura, 2013. The economic impact of cloud computing technology on new business and employment in Romania. Manager. 26 August 2013. Vol. 17, p. 293–302.
RO7	Romania	FRĂŢILĂ, Lucian Alexandru, ZOTA, Răzvan Daniel and CONSTANTINESCU, Radu, 2013. An Analysis of the Romanian Internet Banking Market from the Perspective of Cloud Computing Services. Procedia Economics and Finance. 2013. Vol. 6, p. 770–775. DOI 10.1016/S2212-5671(13)00201-3.
RO8	Romania	ANDREEA BENDOVSCHI, ANDREI TINCA, BOGDAN IONESCU and DELIA PLEŞCAN, 2014. Cloud computing enabling drivers and adoption issues. 2014.
RO9	Romania	SHULESKI, Darko, BÎRSAN, Alexandru, CRISTEA, Crina Veronica and RADU, Ioan, 2016. IMPACT OF CLOUD COMPUTING TECHNOLOGY IMPLEMENTATION IN PUBLIC SECTOR. In: . Online. 2016. Available from: https://api.semanticscholar.org/CorpusID:113634746
BG1	Bulgaria	TICK, Andrea, 2023. Industry 4.0 Narratives through the Eyes of SMEs in V4 Countries, Serbia and Bulgaria. Acta Polytechnica Hungarica. 2023. Vol. 20, no. 2, p. 83–104. DOI 10.12700/APH.20.2.2023.2.5.

Appendix J: Benefit Classification

Communication, Collaboration, and Data Sharing	1. Facilitates communication and collaboration between teachers and students 2. Supports classroom learning 3. Easier internal collaboration and data sharing 4. Enhanced communication 5. Enhanced collaboration and remote learning opportunities

	6. Facilitation of collaboration across multiple organizations 7. Data storage and management 8. Enhanced data availability and sharing among professionals 9. Enables federated storage, reducing data duplication and improving data access efficiency 10. Ability to share information 11. Partner's pressure 12. Ability to provide large storage space 13. Access to stored data 14. Information stored in the cloud is allowed access to other employees
Accessibility and Availability	1. Users can access data anywhere provided there is Internet access 2. Accessibility anytime, anywhere from numerous devices 3. Global accessibility 4. Accessibility to advanced technical solutions 5. Simplified access to computing resources 6. Access to corporate data from anywhere 7. Access from a particular location 8. Increased accessibility and flexibility in educational delivery 9. Global connectivity 10. Flexibility (ability to work from anywhere) 11. Reliability of cloud services 12. Trialability 13. Increased Mobility and Information Access 14. Portability 15. Integration of heterogeneous data sources 16. Enables access to recorded data for further analyses and post-processing procedures 17. Possibility of providing instant data access 18. Removing restrictions on the type of device connected to the Internet
Cost Reduction	1. Significant reduction in costs, increase in services 2. Reduced investment in hardware and software 3. ICT Employees Reduction 4. Reduces capacity and financial constraints
Scalability and Flexibility	1. Flexibility in choice 2. Scalability and flexibility of computational resources 3. Ability to adapt infrastructure to application needs 4. Facilitates interactive analysis and parallelization of computing activities 5. Optimizes overall efficiency of computing system through on-demand computing allocation 6. Potential for higher profitability through HFT strategies 7. Evolution in ICT delivery 8. Customization 9. Real-time processing 10. Real-time monitoring and analysis 11. Efficiency in distributing computational tasks 12. Interoperability 13. Increased agility 14. Facilitates entry into new markets and sectors 15. Elasticity 16. Ease of implementation
Environmentally friendly	1. Energy efficiency and green computing 2. Ideological motivation
Management and Optimization	1. Enhanced monitoring and management (service delivery optimization) 2. Resource monitoring 3. Business continuity 4. Lower demand for internal competency 5. Increased resource utilization and productivity 6. Improved operational management 7. Operational efficiency 8. Increased efficiency

	9. Improved infrastructure efficiency 10. Rapid deployment 11. Timesaving 12. Facilitates the management of several monitored infrastructures in a centralized manner 13. Sharing of resources 14. Efficiency and reliability 15. Automation of data ingestion and transformation routines 16. Real-time data analysis capabilities 17. Increased speed and efficiency in trading 18. Potential for reducing the number of applications 19. Shorter implementation roadmaps 20. Simplification of business processes 21. Productivity improvement 22. Support for business processes 23. New opportunities and enhanced functionality (efficiency) 24. Centralized monitoring 25. Efficient use of ICT resources
Security and Support	1. Enhanced data security 2. Effective IT support 3. Enhanced security awareness 4. Ability to enforce security measures across multiple cloud environments 5. Disaster recovery 6. Reduced technology risk 7. Secure data communication 8. Increased user confidence through trust-building measures 9. Automatic updates and new versions of programs 10. Online technical support 11. Elimination of system failure risk
User Experience	1. Improved user experience 2. Provision of more attractive services to users 3. Perceived ease of use 4. No need for installation and maintenance 5. Increased citizens' engagement 6. Provides a user-friendly web interface for accessing synchronized data and executing post-processing operations 7. Reduced need for internal competence 8. Perceived usefulness 9. Ready-to-use functionality 10. Data migration tools
Business Opportunities	1. Faster time to market 2. Competitive advantages 3. Strategic opportunities for innovation 4. Increased opportunities 5. Innovation/rapid innovation 6. Learning opportunity 7. Support for business processes 8. Simplification of the growth period 9. Quality improvement 10. Market expansion 11. Facilitates entry into new markets and sectors 12. Enables SMEs to exploit business opportunities across national borders 13. Access to venture capital 14. Greater number of customers 15. Relative advantage 16. Competitive edge

Appendix K: Papers described cloud benefits

PID	Communication, Collaboration, and Data Sharing	Accessibility and Availability	Cost Reduction	Scalability and Flexibility	Environmentally friendly	Management and Optimization	Security and Support	User Experience	Business Opportunities
SE1	*	*						*	
SE2	*	*	*	*	*				
SE3	*	*	*	*		*			
SE4		*		*		*			
SE5		*		*		*			
SE6				*					
SE7	*	*		*		*			
SE8		*	*	*		*		*	
SE9		*	*	*		*			
SE10		*	*	*		*			
SE11	*								
SE12		*	*	*		*			
SE13	*	*	*	*		*			*
SE14			*	*	*	*			
SE15	*	*	*	*		*			
SE16		*	*	*		*			
FI1		*	*	*		*			
FI2	*					*		*	
FI3			*			*		*	
FI4			*	*					
FI5			*	*			*		
FI6		*	*	*		*		*	
FI7		*		*			*		
FI8		*		*		*			*
NL1		*		*		*		*	*
NL2						*		*	
NL3		*	*	*		*		*	
NL4	*	*	*	*					
NL5			*	*					
NL6	*	*		*		*	*		
NL7	*	*	*	*		*			
NL8			*	*		*			*
DK1		*	*	*		*			*
DK2	*	*	*	*					
DK3		*	*	*					
IT1		*	*	*		*		*	
IT2		*				*			
IT3		*		*					
IT4		*		*		*			
IT5		*		*		*			
IT6	*	*		*		*			
IT7		*	*	*		*			*
IT8		*	*	*					*

PID	Communication, Collaboration, and Data Sharing	Accessibility and Availability	Cost Reduction	Scalability and Flexibility	Environmentally friendly	Management and Optimization	Security and Support	User Experience	Business Opportunities
IT9									*
IT10		*		*		*			
IT11		*		*		*		*	
IT12			*	*			*		
IT13			*	*		*			
IT14	*					*		*	*
IT15		*		*		*			
IT16		*	*	*					
IT17	*				*	*			*
CZ1		*	*	*		*			*
CZ2		*	*	*		*			*
CZ3		*	*	*		*	*		*
CZ4				*		*	*		
CZ5			*	*		*		*	*
CZ6			*		*	*	*	*	*
EL1			*		*	*	*	*	
EL2		*	*			*	*	*	*
EL3	*	*		*		*			
EL4			*	*		*			*
EL5			*	*					
EL6	*		*			*			
EL7			*	*	*	*			*
RO1		*	*	*		*			
RO2		*		*		*			
RO3		*	*	*					
RO4	*	*		*		*		*	*
RO5		*	*	*		*			*
RO6			*						
RO7			*	*	*	*	*		
RO8	*		*				*		
RO9		*	*	*	*	*			
BG1		*		*		*			*

Appendix L: Obstacles Classification

Data Privacy and Security	1. Concerns about regulatory requirements such as privacy legislation 2. Concerns about the security and privacy of data (e.g., not knowing where data are stored) 3. Data security risks, including breaches, data loss, and account hijacking 4. Security concerns regarding data confidentiality and integrity 5. Lack of transparency in security and privacy practices 6. Losing control of data 7. Security considerations 8. Confidentiality 9. Information security 10. Potential risks of identity theft 11. Adaptation to new attack strategies 12. Designing secure and privacy-preserving EMR cloud-based applications 13. Dynamic access control to patient EMR data during treatment 14. Malicious attacks on the cloud provider

	15. System integrity 16. Data leakage 17. Shared technology vulnerabilities 18. Other general social engineering 19. Data privacy and protection 20. Physical security 21. Lost or stolen backups 22. Loss or compromise of security logs 23. Infrastructural, economic, legal, and organizational cultural barriers 24. Security and compatibility issues with traditional financial applications 25. Lack of information on the geographical location of the servers where the data is stored
Organizational Readiness and Knowledge	1. Organizational readiness and competence needed for successful adoption 2. Lack of IT competence and knowledge regarding cloud computing options 3. Uncertainty in determining total costs of ownership and benefits realization 4. Need for updated guidelines and increased awareness among employees 5. Lack of knowledge and awareness 6. Need for a centralized approach to cloud services consumption in public administration 7. Need for updated guidelines and increased awareness among employees regarding cloud computing security 8. Divergence in opinions on definition and business case 9. Resistance from business 10. Unclear benefits realization 11. Need for substantial adaptations 12. Cultural and contextual influences 13. Lack of unified approach and extensive bibliometric review 14. Difficulty in maintaining currency as research themes evolve over time 15. Infrastructure readiness 16. ICT organizational changes 17. Employees' fears 18. Lack of experts 19. Need for extensive and systematic analysis for appropriate cloud deployment and service model selection 20. Lack of readiness in some European countries for cloud adoption 21. Lack of support or other training from cloud service providers
SLA Issues	1. SLA specifications and reliability 2. SLA implementation challenges 3. Concerns about SLA complexity and trust issues 4. Missing features or services
Trust and Vendor Related Issues	1. Trust and security concerns regarding cloud service providers 2. Perceived security and quality of supplier concerns 3. Concerns about trust complexity and potential risks of identity theft 4. Concerns about the trustworthiness of providers and interoperability of services 5. Compliance with regulations, legal contractual requirements, and data privacy laws 6. Policy-driven limitations and ambiguity in current instructions and regulations 7. Reliability and trust issues, including system availability and downtime 8. Bankrupt service provider 9. Vendor dependency 10. Dependence and trust in suppliers 11. Trust complexity 12. Need for trust-building measures 13. Quality of supplier 14. Risk of isolation from cloud providers 15. Risks related to outsourcing and sharing 16. Strong influence of existing market players 17. Lack of support or other training from cloud service providers
Technical Challenges and Complexity	1. Dependability, network provisioning, and monitoring challenges 2. Complexity of integration with existing applications and systems 3. Technical weaknesses and obstacles to implementation 4. Quality of network communication, bandwidth, and connection speed 5. Lack of interoperability and connectivity between systems 6. Complexity of measurement and resource overhead 7. Integration challenges with diverse operating systems and hardware platforms 8. Lack of standards 9. Lack of customization 10. Migration complexity 11. Continuously evolving nature of cloud services

	12. Capacity limitations of existing infrastructure (VIRVE Radio Network) need for increased capacity or alternative transfer channels 13. Handling large/an enormous volume of data 14. Need for ultra-fast speed and processing capabilities 15. Reliance on real-time data feeds 16. Data collection method limitations 17. Control and management complexity 18. Resource consumption 19. Tool interoperability 20. Potential complexity in the migration process 21. Technical resource-sharing isolation problems 22. Cloud cross-compatibility 23. Integration of complex solutions 24. Interoperability of different systems 25. Data management and processing optimization 26. Integration with diverse operating systems and hardware platforms 27. Integration with Cloud frameworks 28. Data transfer across Grid and Cloud resources 29. Adoption and integration with existing systems 30. Managing and maintaining cloud-based infrastructure 31. Dependency on internet connectivity 32. Limited customization options 33. Limited integration options 34. Missing features or services 35. Transition from existing monolithic applications 36. Administration of more cloud services 37. Little flexibility of cloud computing 38. Complexity of developing a private cloud 39. Issues related to access to a secure and high-speed Internet connection to access data stored in the cloud 40. Users' concerns regarding the applications integrated into the cloud
Cost and Financial Concerns	1. Payment model uncertainty and concerns about costs 2. Financial burden and limitations in cost savings, particularly for small and medium-sized companies 3. Cost management challenges and economic value considerations 4. Cost and constraints 5. Potential uncertainty or concerns regarding cost savings for small and medium-sized companies transitioning existing IT structure to Cloud Computing
System Availability and Performance	1. Performance variability and concerns about service availability breaches 2. System availability 3. Service downtime 4. Availability and reliability 5. Outlier execution times 6. Potential variability in cloud service performance 7. Ensuring continuous execution and availability of functionalities for services 8. Data availability concerns 9. Dependability 10. Ensuring QoS (Quality of Service) 11. Network performance variability 12. Natural disaster recovery 13. Reporting and support for storage provisioning errors 14. Slow response time
Data Migration and Handling	1. Challenges related to data storage, deletion, and migration 2. Complexity of migration processes and integration with diverse operating systems 3. Handling an enormous volume of data
Governance and Control	1. Loss of governance and control over IT resources 2. Uncertainty and challenges related to datacenter location and service availability 3. Dependence on service providers 4. Risks related to changes in jurisdiction and liability obligations 5. Auditors and government agencies not supporting cloud computing 6. Data ownership issues 7. Lack of control over data processing and maintenance 8. Concerns about losing control of data 9. Integration of risk management culture 10. Legal contractual requirements 11. Environmental impact

	12. Regulatory and control limitations 13. Local social and environmental effects 14. Adaptation of governance models 15. Legal and contractual issues 16. Risk of controlling information 17. Lack of full control over data processing and maintenance 18. Legal compliance 19. The lack of cloud-specific criteria in auditing tools increases uncertainty in adoption 20. Decreased control over the system when moving to the cloud 21. Individualized use of applications by authorities over time 22. Lack of data analysis skills 23. Need for organizational culture shift towards a data-driven mindset 24. Potential time investment in acquiring the necessary skills 25. Potential limitations in strategy selection and implementation 26. Governance complexities 27. Need for better legislation 28. Need for consolidation and standardization 29. Limitations in relational governance 30. Legal risks resulting from changes of jurisdiction 31. Liability or obligation of the CSP in case of loss of data 32. Responsibility of CSP in case of business interruption 33. Potential risks related to cloud infrastructures and data management 34. Loss of governance 35. Lack of control over IT resources 36. Management and control of cloud computing 37. Policy-driven limitations

Appendix M: Papers described cloud obstacles

PID	Data Privacy and Security	Organizational Readiness and Knowledge	SLA Issues	Trust and Vendor Related Issues	Technical Challenges and Complexity	Cost and Financial Concerns	System Availability and Performance	Data Migration and Handling	Governance and Control
SE1	*						*		*
SE2	*		*	*			*		*
SE3	*							*	
SE4	*		*						*
SE5									*
SE6						*			
SE7	*								
SE8	*	*	*						*
SE9			*	*					*
SE10	*	*		*			*		
SE11	*	*							*
SE12	*				*				
SE13	*					*			
SE14	*	*			*				*
SE15	*	*	*	*	*				
SE17	*			*	*		*		
FI1									
FI2	*	*	*	*			*		*
FI3									*
FI4	*	*							*
FI5	*				*		*		*
FI6		*			*		*		
FI7	*						*	*	*
FI8					*		*		

PID	Data Privacy and Security	Organizational Readiness and Knowledge	SLA Issues	Trust and Vendor Related Issues	Technical Challenges and Complexity	Cost and Financial Concerns	System Availability and Performance	Data Migration and Handling	Governance and Control
NL1	*		*	*		*			*
NL2			*					*	*
NL3		*						*	*
NL4		*						*	
NL5				*			*		*
NL6	*								*
NL7	*	*		*		*			
NL8	*			*		*		*	
DK1	*		*		*		*		
DK2					*	*	*		
DK3	*	*					*		
IT1	*		*		*		*		*
IT2	*	*	*						*
IT3					*			*	
IT4	*				*		*	*	
IT5					*		*	*	
IT6	*				*				
IT7	*						*		*
IT8	*						*		*
IT9									
IT10									
IT11	*	*			*				
IT12	*				*		*		*
IT13	*					*		*	*
IT14	*					*			*
IT15					*		*		*
IT16	*	*		*	*		*		
IT17	*	*					*		
CZ1	*		*				*		*
CZ2	*	*			*	*	*		*
CZ3	*	*			*	*	*		
CZ4	*								
CZ5	*	*				*			
CZ6	*			*			*		*
EL1	*		*		*				*
EL2									
EL3									
EL4									
EL5	*								
EL6	*						*		
EL7	*			*			*	*	*
RO1									
RO2	*			*					
RO3									
RO4									
RO5	*			*		*		*	

PID	Data Privacy and Security	Organizational Readiness and Knowledge	SLA Issues	Trust and Vendor Related Issues	Technical Challenges and Complexity	Cost and Financial Concerns	System Availability and Performance	Data Migration and Handling	Governance and Control
RO6									
RO7	*								
RO8	*								*
RO9	*				*				*
BG1		*							