Virtualization Development Trends: Scoping Review

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ABSTRACT

Introduction: The development of virtualization tools, which rapidly unfolded in the 1990s, continues to demonstrate a dynamic trajectory. Modern solutions in this area have significantly evolved and diversified. The relevance of the stated issues in the era of Covid-19 has received an even deeper interpretation.

Purpose: This review analyzes articles on virtualization published during the pandemic years with the aim of identifying virtualization development trends.

Materials and Methods: We conducted a keyword search in the Scopus database. The focus was on articles published in English from December 2019 to December 2022. The authors followed an expanded PRISMA-ScR protocol. The search identified 164 articles, of which 131, based on their title and abstract, were marked as relevant.

Results: The selected articles were classified by year of publication, type of publication, country of publication, area of virtualization, mention of Covid-19, and type of virtualization. The articles included in our review indicate that virtualization had already been integrated into all spheres of life before Covid-19. However, the pandemic caused a surge, which accelerated its implementation in various areas, ranging from education and medicine to smart cities and computer technologies.

Conclusion: The presented review of the subject area allowed us to identify sectors of public life that significantly influenced virtualization during the Covid19 years, as well as the most actively developing forms of virtualization, in particular, those that allow segregating computational processes and resources. It was recorded that modern solutions in the field of virtualization have significantly diversified compared to previous years and can be classified into separate categories.

KEYWORDS

digital medicine; internet of things; cloud computing; virtual world; big data

Тенденции развития виртуализации: обзор предметного поля

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АННОТАЦИЯ

Введение: Развитие инструментов виртуализации, стремительно развернувшееся в 1990-х годах, продолжает демонстрировать динамичную траекторию. Современные решения в этой области значительно эволюционировали и диверсифицировались. Актуальность заявленной проблематики в эпоху Covid-19 получила ещё более глубинное прочтение.

Цель: Данный обзор анализирует статьи на тему виртуализации, опубликованные в годы пандемии с целью выявления трендов развития виртуализации.

Материалы и методы: Мы провели поиск по ключевым словам в базе данных Scopus. В центре внимания были статьи, опубликованные на английском языке с декабря 2019 года по декабрь 2022 года. Авторы следовали расширенному протоколу PRISMA-ScR. Поиск позволил выявить 164 статьи, из которых 131 на основе их названия и аннотации были маркированы как релевантные.

Результаты: Отобранные статьи были классифицированы по году публикации, типу публикации, стране публикации, сфере виртуализации, упоминанию Covid-19 и типу виртуализации. Статьи, включенные в наш обзор, указывают, что виртуализация уже была интегрирована во все сферы жизни до Covid-19. Однако пандемия вызвала всплеск, который ускорил ее внедрение в различных областях, начиная от образования и медицины до умных городов и компьютерных технологий.

Заключение: Представленный обзор предметного поля позволил выявить секторы общественной жизни, которые значительно повлияли на виртуализацию в годы Covid19, а так же наиболее активно развивающиеся формы виртуализации, в частности, те, которые позволяют сегрегировать вычислительные процессы и ресурсы. Зафиксировано, что современные решения в сфере виртуализации значительно диверсифицировались в сравнении с предыдущими годами и могут быть классифицированы в отдельные категории.

INTRODUCTION

A multitude of diverse software and hardware technology services bolster the speed and convenience of information handling. This article delves into a promising and potent technology, rapidly gaining ground in the world of computing — virtualization. The history of virtualization tool development took a leap forward and shows no signs of stopping (Palacin, 2021; Radchenko, 20219; Almurizi, 2022). Contemporary solutions in this sector have become considerably more diverse than in the past. The information technology market offers an array of products designed for both specific, narrow tasks and multifunctional platforms (Sharma et al., 2020; Seidel et al., 2021; Xu et al., 2022; Woo et al., 2020).

During COVID-19, technologies that have been maturing over the past three decades demonstrated their genuine utility to society (Mejía-Dorantes et al., 2022; Lopez-Fernandez et al., 2021; Gupta et al., 2022; Ansin, 2022; Cano-Hila et al., 2021). Amid the pandemic, the world acclimated to virtualization (Zhao et al., 2022; Yee et al., 2022; Díez-Pascual et al., 2022). Digital technologies have further entrenched themselves into various facets of our lives, transforming healthcare systems, public administration, security, and the labor market (Checcucci et al., 2021; Bhargava et al., 2020; Afari et al., 2019; Aroles et al., 2021). In-person meetings with medical professionals and administrators became hazardous, while remote meetings gradually turned into a norm.

Data visualization, the graphical representation of data and information, has become an essential part of many professional sectors. Its influence on professional development is substantial, as it enhances understanding, decision-making, and communication (Aldwairi et al., 2022; Correia et al., 2022; Coto et al., 2022; Czemiel-Grzybowska, 2022). The growing trend of data visualization significantly influences professional development. By improving decision-making capabilities, enhancing communication, increasing employability, and offering cross-disciplinary relevance, data visualization serves as a critical skill in the modern professional landscape (Ebekozien et al., 2021; Falavigna et al., 2021). It's clear that to stay competitive in the current and future job market, professionals must embrace data visualization.

(1) Improved Decision-Making: Visualization tools allow professionals to understand complex data and derive actionable insights. This skill is crucial in many sectors, including finance, marketing, healthcare, and more, where data-driven decision-making is integral. Data visualization skills can enhance a professional's ability to analyze trends, predict outcomes, and make informed decisions, thus contributing to their career progression. Research works in this fields can be found at Chien, 2020; Qiu et al., 2022.

(2) Enhanced Communication. Data visualization is a useful communication tool. It can convey ideas and insights more effectively than text-based data. Professionals who can create effective data visualizations can communicate more effectively with peers, managers, and stakeholders. This can lead to increased influence within their roles and open up leadership opportunities (Atzori et al., 2019; Westmattelmann et al., 2021).

(3) Increased Employability. There's a growing demand for data visualization skills across various industries. As businesses become more data-driven, professionals who can visualize data are becoming increasingly valuable. This trend is likely to continue as data continues to play a more integral role in business decisions (Almurisi et al., 2022; Atzori et al., 2019; Bibri et al., 2019; Zhou et al., 2022). Professionals with robust data visualization skills may find greater job opportunities and career advancement.

(4) Cross-Disciplinary Relevance. Data visualization isn't confined to one industry. Whether in healthcare, where it's used to track disease spread or in finance, where it helps analyze market trends, its relevance is widespread. This cross-disciplinary applicability allows professionals with data visualization skills to transition between sectors more smoothly, promoting career growth and versatility (Ullah et al., 2022; TTC VL Workgroup, 2021; Abed et al., 2022).

Societal virtualization is also becoming more and more significant fenomenon even being. relatively recent. The nature of virtual reality and virtualization mechanisms is currently under exploration in the scientific community. The major research area is electronic virtual reality, and researchers have recently pinpointed a new vector of societal transformation - its "virtualization", referring to the transition of primary activities to the virtual space of the internet (Correia et al., 2022; . Modern virtualization processes are so rapid that they pose challenges to prediction. The consequence of informatization are irreversible, multifaceted changes impacting all aspects of the global community's life. Hence, we deem it crucial to review the virtualization technologies that have surfaced in recent years and influence every sphere of life and professional trajectories of every individual.

The purpose of this scoping review is to identify trends in the development of virtualization that have been triggered by COVID-19. Its objective is to track the changes that have transpired in information technologies in recent years and analyze the current state of virtualization technologies. The research question is, "What impact have the technological trends of recent years had on professional development. It can be hypothesized that Covid-19 has had a monumental impact on the processes of computerization and, consequently, on all spheres of human lives.

MATERIALS AND METHODS

Transparency Statement and Protocol

We conducted a literature search in the Scopus database to conduct a scoping review in accordance with the recommendations of PRISMA-ScR. The authors affirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that discrepancies from the study as planned have been explained. We briefly restate our study methods here.

Search Strategy

Search Sources

To write this review, the relevant literature was searched in the Scopus database. The search was conducted during the global COVID-19 outbreak: from December 2019 to December 2022. Only papers that most fully correspond to the topic of the review were taken into account.

Search Terms

The search conditions were determined based on the available literature and by contacting experts in the relevant fields. The keywords used: *virtualization development trends, computerization development trends, information technology, Covid-19*. We have filtered the list in descending order to include the most frequently cited sources in the article. We conducted a study of the found articles to select potentially relevant literature. The exact search strings used in the search for this study are available in Table 1.

Table 1
Search Strategy in Scopus database

Database	Search strategy	Hits
Scopus	TITLE-ABS-KEY («virtualization» OR «computerization» OR «information technology») AND («development trends») AND («Covid-19») AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019)	164

Search Eligibility Criteria

In this scoping review, the search was focused on topics that reveal the current state of virtualization. Studies published in English from December 2019 to December 2022 were reviewed. We have included articles that are in the public domain. We did not consider those articles that did not correspond to the topic of the review. Only the peer-reviewed articles were included. Preprints and comments were excluded. No restrictions were imposed on the country of publication.

Study Selection

We looked through the titles of the articles and made initial notes for their inclusion and exclusion. Then we analysed the abstracts of the selected papers. The papers selected by title and abstracts were included in the list for the full-text reading stage. At the stage of full-text reading, we excluded articles that are less relevant to the topic of our review.

Data Extraction

We have prepared a form for data extraction (Table 2). The form was tested before extracting the data according to it. For any problems that arise, we turned to researchers in this field.

Table 2
Data extraction form

Concept	Definition
Study Characteristics	
ID	Unique ID assigned to each study
Author	The first author of the study
Year	The year in which the study was published
Country of publication	Affiliation of the first author of the study
Publication type	Journal or conference or book chapter
Conference name	Name of the conference where the study was published
Journal name	Name of the journal where the study was published
Virtualization method	
Tasks addressed in the study	What are the areas of application of virtualization technologies in different fields (e.g., medicine, education, business, etc.)?
Purpose of using virtualization	The branches/areas of that were used (e.g., segmentation, data augmentation, noise removal, etc.).
Type of the technology	What was the type of technology that was used (e.g. contactless payments, robotic delivery, telemedicine, etc.)?
Key changes in virtualization	Did the authors report fundamental changes to the architecture of the virtualization?

Data Synthesis

The data from the reviewed studies has been summarized using a narrative approach. We classified the included studies in terms of their applications, such as education, medicine, computer technologies, etc. We also divided the data by country, year and Covid-19 impact. All diagrams for an illustrative example were created on RAWGraphs website.

RESULTS

Search Results

164 articles were extracted from Scopus (Figure 1). From the initial retrieval of 164 studies, we excluded 18 due to duplication. We meticulously evaluated the remaining 146

studies based on the established inclusion and exclusion criteria. Consequently, 14 studies were deemed non-compliant and subsequently excluded. This left us with a total of 131 studies included in this review. Additionally, we conducted a review of the references listed in these articles, however, this did not yield any further articles to be included.

Publication Years

Based on the yearly distribution of the publications, we found that 5 studies were published in 2019, 14 studies in 2020, 36 studies in 2021, and a significant increase to 76 studies in 2022 (as depicted in Figure 2). It is noteworthy that the majority of these studies were written following the major waves of COVID-19.

Figure 1
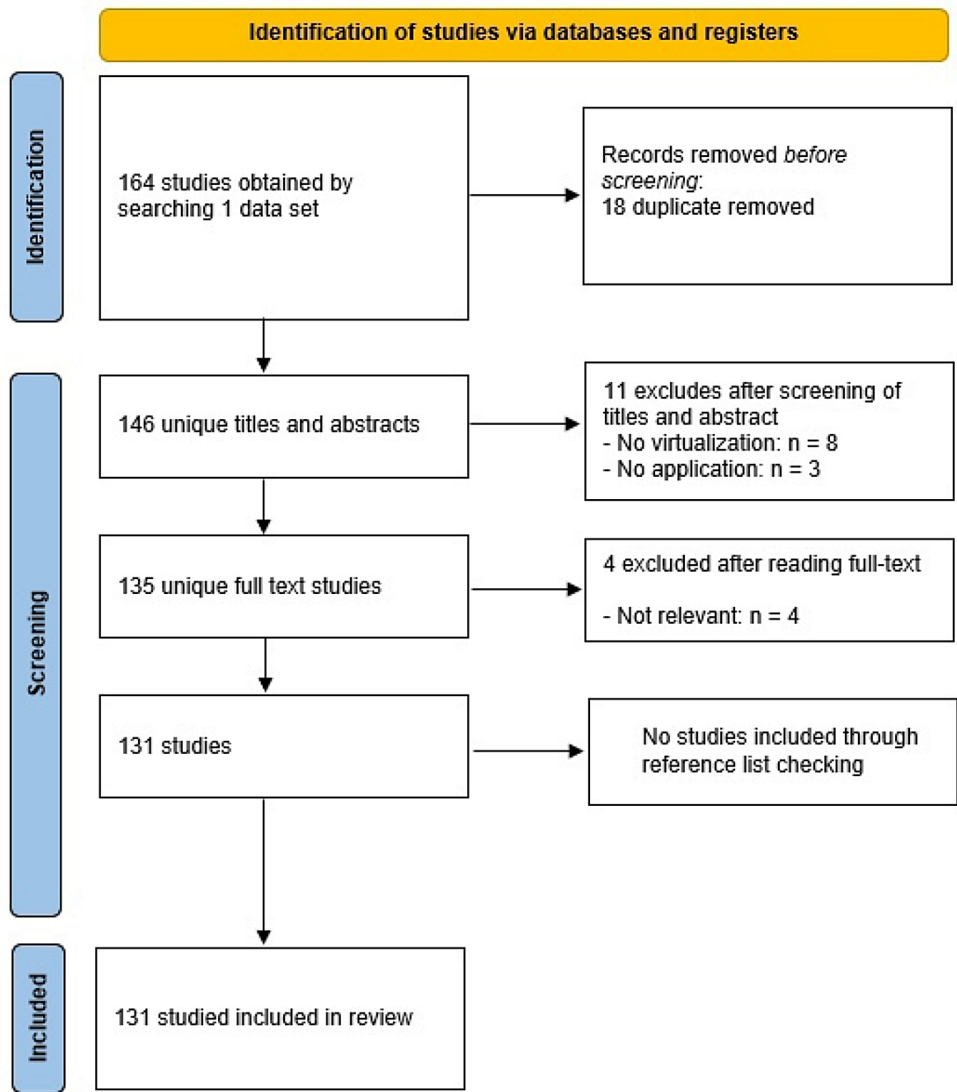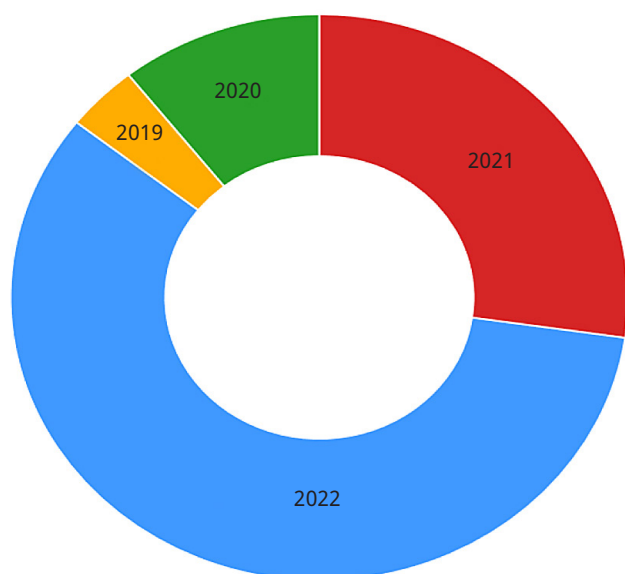Block diagram in accordance with PRISMA-ScR

Figure 2
Year of publication of studies

Publication types

The majority of the studies included in this review were published in journals, accounting for 129 articles. Meanwhile, 2 of the studies were categorized under the publication type "conference" (as shown in Figure 3).

Demographics of the Included Studies

Research on the trends in virtualization development has been conducted globally, with contributions from 45 countries. The greatest number of studies were published in China (19), followed by Spain (12), the USA (9), Germany (9), In-

Figure 3
Publication type
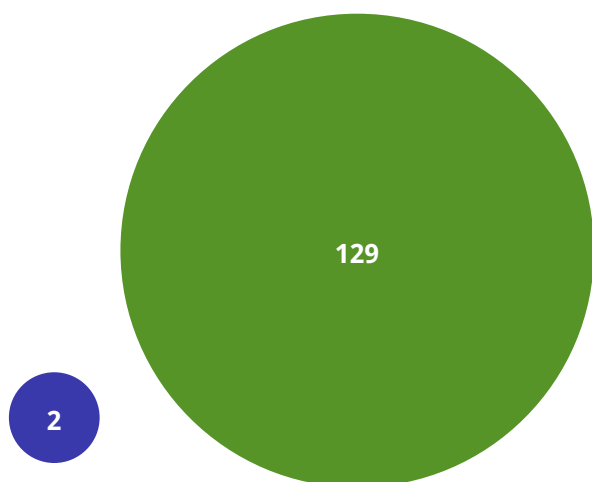
dia (9), and Russia (7). Table 3 provides a detailed summary of the demographic data from the included studies. Additionally, Figure 4 presents a visualization of the geographical distribution of these studies by country. The Covid-19 pandemic has impacted numerous countries worldwide, and many have sought to mitigate the risks of transmission through the implementation of virtualization technologies. By enabling remote work, online learning, telemedicine, and various other digital services, virtualization has played a crucial role in promoting social distancing and reducing physical contact, thereby helping to curb the spread of the virus.

Table 3
Demographics of the included studies

Countries	Number of studies	Countries	Number of studies
Spain	12	Peru	1
China	19	Morocco	1
Germany	9	Jordan	2
Norway	3	Brazil	2
United Kingdom	4	Latvia	1
Russia	7	Nigeria	1
Indonesia	1	Japan	1
Finland	1	Malaysia	1
Barcelona	1	Saudi Arabia	4
Serbia	1	Belgium	2
India	9	Luxembourg	1
Taiwan	1	Kazakhstan	1
USA	9	Romania	3
Ukraine	1	Brunei Darussalam	1
Australia	1	Democratic Republic of Congo	1
South Africa	1	Poland	3
Vietnam	1	Greece	1
Italy	4	Slovenia	1
South Korea	4	Denmark	1
Iran	4	Turkey	1
UAE	1	Hungary	1
Mexico	2	Netherlands	1
Canada	3		

Figure 4
Demographics of the included studies
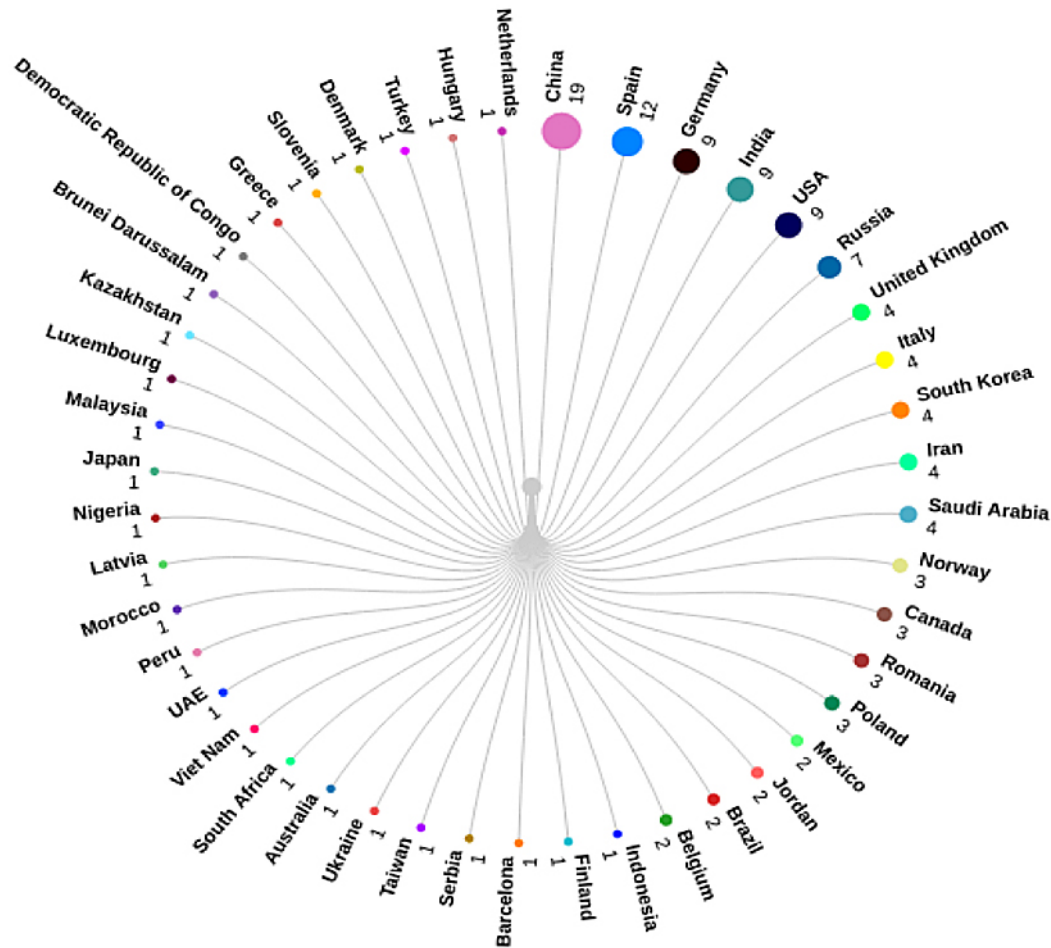
Areas of Development of Virtualization

Virtualization is swiftly proliferating across various facets of our lives. A total of 32 studies were found to be dedicated to the application of virtualization in the realm of education (Affouneh et al., 2021; Alamo et al., 2021; Antón-Sancho et al., 2022; Chamorro-Atalaya et al., 2021; Liu, 2021; Broks, 2020; Díez-Pascual, 2022; Ghadrdoost et al., 2021; Hertling et al., 2022; Pereira et al., 2021; Babieva et al., 2022; Hertrampf et al., 2022), etc. Another 27 studies investigated the development of virtualization in the context of machine learning (Atul, et al., 2019; Mirzaee et al., 2022. In the field of cloud computing, 17 studies scrutinized the trends in virtualization (Al-Yarimi et al., 2022; Hanussek et al., 2021; Furthermore, nine studies focused on the application of virtualization in data centers (Arellano-Uson et al., 2021; Ben-Zvi et al., 2022; Bermejo et al, 2022; Compastié et al., 2020; Fati et al., 2020, etc.), while eight studies each examined the Internet of Things and virtual laboratories respectively (Almurisi et al, 2022; Atzori et al., 2019; Jiao, 2022), etc.

Additionally, seven studies delved into the essence of the development of mobile communication technologies (Azari et al., 2022; Chie et al., 2020; , seven studies scrutinized the application of virtualization in medicine (Fouladi et al., 2021; Greenough et al., 2022; Grøndahl et al., 2022; , and seven studies were devoted to the development of e-learning (Kamouna et al., 2022). Lastly, three studies each focused on the virtualization of smart cities (Bibri, 2019; Bibri, 2022; Kuzior et al., 2022) , flexible work, and teleworkers respectively (Checcucci et al., 2021).

Table 4 and Figure 5 succinctly represent these prevailing trends in the development of virtualization, clearly demonstrating the diverse applications and growing relevance of this technology across numerous domains.

The virtualization of operating systems has seen substantial advancements in the past three to four years, both from a technological and marketing perspective (Hadasik et al., 2022). Technologically, the ease of use of virtualization

Table 4

Application of virtualization development trends in various areas

Application area	Number of studies
Education	32
Machine learning	27
Cloud computing	17
Data centers	9
Internet of things	8
Virtual laboratories	8
Mobile communication systems	7
Medicine	7
E-learning	7
Smart city	3
Flexible work	3
Teleworker	3

products has greatly improved, alongside enhancements in their reliability and functionality. From a marketing standpoint, there has been a proliferation of novel and intriguing applications for virtual machines.

These developments underscore the ongoing evolution and growing impact of virtualization technologies. They offer not only practical solutions for managing computer resources more effectively but also open up new possibilities for innovation across various fields (Jiang et al., 2022; Khakimov et al., 2022; Li et al., 2022). As these trends continue, we can expect to see even more creative and efficient uses for virtual machines in the future, further solidifying the role of virtualization in modern computing.

COVID-19 Mentioning

Upon analyzing the articles selected for our review, we quantified the frequency of mentions related to the topic of coronavirus infection. Our investigation revealed that out of the articles we studied, the topic of COVID-19 is addressed in 56 of them, as depicted in Figure 6. This observation underscores the significant influence that the pandemic has exerted on the process of virtualization. The prevalent reference to COVID-19 in the context of these studies reaffirms

Figure 5

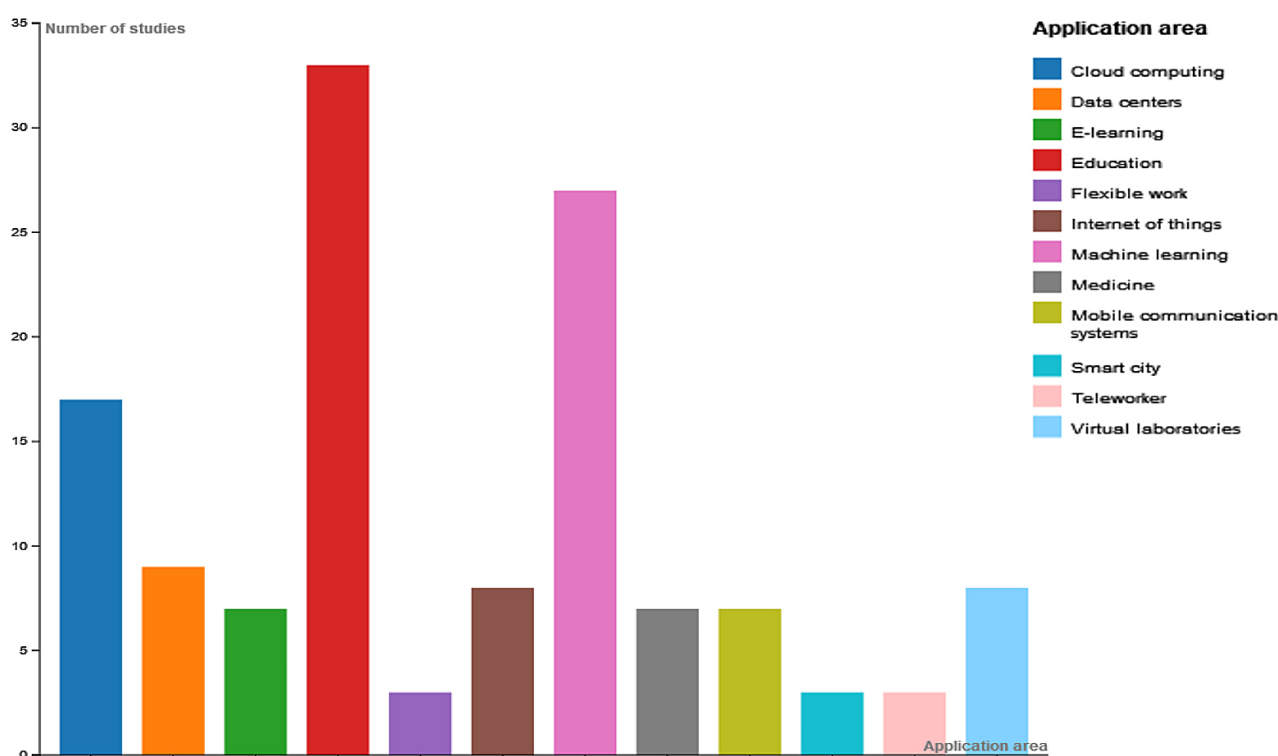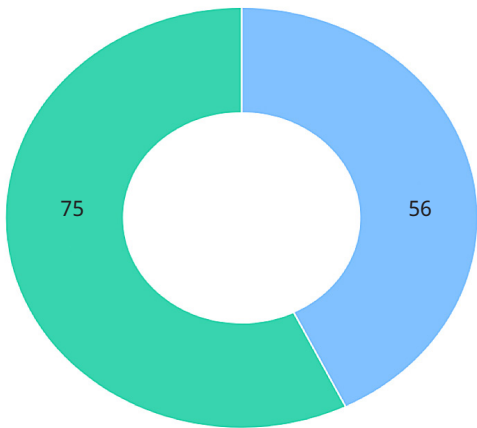Application of virtualization development trends in various areas

Figure 6
COVID-19 mentioning

Table 5
Types of virtualization

Types	Number of studies
Paravirtualization	22
Infrastructure virtualization	30
Server Virtualization	14
OS-level virtualization	20
Resource virtualization	12
Application Virtualization	33

the contention that global events, such as a pandemic, can act as major catalysts for advancements and shifts in technological paradigms, specifically in the realm of virtualization in this instance.

Current Types of Virtualization

Virtualization serves as an umbrella term that encapsulates the abstraction of resources across numerous facets of computing. Through the course of our research, we were able to distinguish and categorize the most prevalent types of virtualization, as depicted in Table 5 and illustrated in Figure 7. These types broadly encompass virtualization of servers, networks, storage, data, desktops, and applications (Li et al., 2022; Liu., 2021; Nazarov et al., 2020; Park et al., 2021; Pons, et al., 2022; Qazi, 2020; Radchenko et al., 2019; Rosioru et al., 2022; Saravanakumar et al., 2022). The diversity in types of virtualization underscores the broad applicability and immense potential of this technology in transforming various aspects of computing and information technology. These classifications serve as a baseline for understanding

Figure 7
Types of virtualization
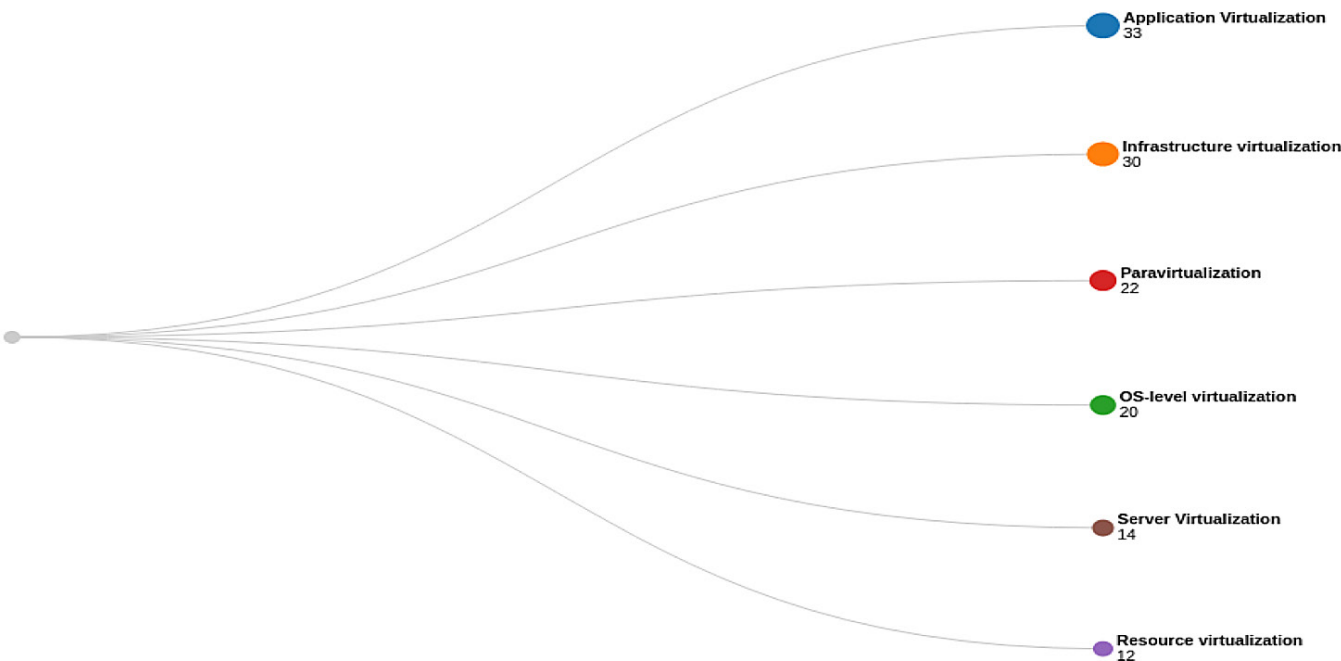
how different domains leverage virtualization and will aid in the ongoing discourse surrounding the evolution of virtualization, particularly in the wake of transformative events such as the COVID-19 pandemic.

Various forms of platform virtualization include but are not limited to:
(1)   Full Virtualization: Involves the complete simulation of actual hardware to allow an unmodified guest OS for a different CPU to be run in isolation.
(2)   Para-virtualization: The guest OS is aware of the virtualization and cooperates with the hypervisor to achieve efficient system calls, rather than simulating hardware.
(3)   OS-level virtualization: Involves multiple instances of the same OS running on a host, each instance being a container running a separate group of applications.
(4)   Hardware-assisted Virtualization: Virtualization support is built into the hardware, typically the CPU, to assist performance of the virtual machine monitor.

However, it's crucial to note that terminologies in the realm of virtualization are yet to be universally standardized. Consequently, the classification of platform virtualization types may vary across different sources, reflecting the evolving and dynamic nature of this field. Figure 7 presents the most frequently mentioned types of visualization in the analyzed sources.

DISCUSSION

In this study, we conducted a scoping review of trends in the development of virtualization. We found that the majority of studies were published in 2022 (n=76), followed by 2021 (n=36), with a minority of studies published in 2019 and 2020 (n=5 and n=14, respectively). This data suggests an escalating interest in virtualization, with its technologies continually expanding. China leads in the number of publications (n=19), followed closely by Spain (n=12), jointly accounting for more than 20% of the total publications.

Almost 25% of the studies focus on the development of virtualization in education (n=32). This trend seems natural given that educational institutions often manifest the extensive advantages of employing virtual computing (Wolf et al., 2022; Xu et al., 2022; Yee et al., 2022). Slightly over 20% of the studies target virtualization in the field of machine learning (n=27). To avert incompatibility issues with disparate software components, researchers and developers are paying significant attention to stringent version control of all software components and system settings.

Almost 15% of the studies center around virtualization in the field of cloud computing (n=17), likely attributable to cloud providers' cost-effective measures to decrease hard-

ware costs and conserve energy (Xie, 2022; Shi et al., 2022). Nearly 7% of studies are devoted to data center virtualization (n=9). Virtual data centers, collections of cloud resources that eliminate the need for in-house data center maintenance, have proven essential in light of the surge in remote work and the increased demand for digital services.

Concerning the classification of virtualization techniques, application virtualization emerged as the most popular, accounting for 26% of the total studies (n=33). Application virtualization provides a localized working environment for applications using local resources. The next most popular virtualization types were infrastructure virtualization at 23% (n=30) and paravirtualization at 17% (n=22). These approaches involve abstracting computing resources from physical equipment and preparing guest operating systems for execution in a virtualized environment through minor kernel modification.

The COVID-19 pandemic has indeed accelerated many trends in technology, including those in virtualization (Woo et al., 2020; Xu et al., 2022; Zhou et al., 2022; Ullah et al., 2022; Stanimirovic et al., 2022). Here are several key trends that have been triggered or accelerated by the pandemic:
(1)   Remote Work and Virtual Desktop Infrastructure (VDI): With the advent of COVID-19, many businesses had to shift to a remote work environment. This sudden shift caused an increased need for secure, remote access to applications and data. Virtual Desktop Infrastructure (VDI) and Desktop as a Service (DaaS) have become increasingly relevant and critical. These technologies create a user's "desktop" environment on a virtual machine that can be accessed from anywhere, ensuring productivity regardless of physical location.
(2)   Increased Demand for Cloud Services: With the need for scalable and flexible IT solutions during the pandemic, there's been a massive increase in the demand for cloud services. Organizations are moving more of their infrastructure to the cloud, often using a mix of on-premises, private cloud, and public cloud services. Virtualization is a key enabler for these multi-cloud strategies.
(3)   Network Function Virtualization (NFV) and Software-Defined Networking (SDN): With the increase in remote work, the strain on networks has been immense. Organizations have increasingly turned to NFV and SDN to enhance network agility and manageability. These technologies allow network managers to deploy, control, and adjust network resources using automated processes.
(4)   Virtual Events and Conferences: Due to travel restrictions and social distancing measures, physical events and meetings have largely been replaced by virtual ones. Tools for virtual meetings, webinars, and conferences have seen a tremendous increase in usage.

This shift may continue to influence how business communications and collaborations are conducted in the future.

(5) Virtualization in Education and Training: Virtualization has made remote learning a reality for millions of students around the world. In addition, virtual labs, digital simulations, and remote access to educational resources have transformed how practical skills are taught and learned.

(6) Telemedicine: The healthcare sector has experienced a drastic shift towards telemedicine due to the pandemic. Virtualization has been crucial in this transition, allowing secure and efficient remote consultations, monitoring, and access to medical records.

CONCLUSION

COVID-19 has not only accelerated the adoption of virtualization but also expanded its applications across different sectors. The trends that have emerged during the pandemic are likely to continue, shaping the post-pandemic world in many ways. In our review, we have analysed studies written over the years of Covid-19, because we believe that the pandemic has had a strong impact on the trends of virtualization development. Unlike reviews that covered a specific virtualization application area, this review was not focused on a specific area, covering various areas. In addition, we have identified the current types of virtualization.

This review was not intended to provide exhaustive descriptions of each type of virtualization or their extensive applications. Thus, we included only the types of virtualization and the sectors impacted by it, omitting detailed descriptions of each specific type and their application areas. Definitions of certain virtualization development areas may overlap. For instance, E-learning could be viewed as a subset of Education. Consequently, categorizing e-learning research under education would augment the number of studies in the education category. However, we believe that the classification presented in this review more accurately reflects the essence of our research. Due to practical constraints, our review solely consists of studies published in English, potentially excluding relevant studies published in other languages.

AUTHOR CONTRIBUTIONS

Ya. Aseeva: концептуализация, проведение исследования, программное обеспечение, верификация данных, создание черновика рукописи, создание черновика рукописи и ее редактирование**.**

I. Yukhnin: концептуализация, проведение исследования, программное обеспечение,, верификация данных, создание черновика рукописи, создание черновика рукописи и ее редактирование**.**

A. Uvarov: концептуализация, проведение исследования, программное обеспечение, верификация данных, создание черновика рукописи, создание черновика рукописи и ее редактирование**.**

V. Syrov: концептуализация, проведение исследования, программное обеспечение, верификация данных, создание черновика рукописи, создание черновика рукописи и ее редактирование**.**

APPLICATION 1

Summary table of all articles

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S1	Virtualization of Higher Education during COVID-19: A Successful Case Study in Palestine	Saida Affouneh	2021	Spain	Journal	Education	Yes	Paravirtual-ization
S2	Virtual Machine Resource Allocation Optimization in Cloud Computing Based on Multiobjective Genetic Algorithm	Feng Shi	2022	China	Journal	Cloud Computing	No	Infrastruc-ture virtual-ization
S3	The show must go on — virtualisation of sport events during the COVID-19 pandemic	Daniel Westmattel-mann	2021	Germany	Journal	Machine learning	Yes	OS-level vir-tualization
S4	The anatomy of the data-driven smart sustainable city: instrumentation, datafication, computerization and related applications	Simon	2019	Norway	Journal	Smart city	No	Paravirtual-ization
S5	Smart Grid Security and Privacy: From Conventional to Machine Learning Issues (Threats and Countermeasures)	PARYA HAJI MIRZAEE	2022	United Kingdom	Journal	Machine learning	No	Server Virtu-alization
S6	SAP Analytics Cloud: intellectual analysis of small and medium-sized business activities in Russia in the context of COVID-19	Nazarov D.M	2020	Russia	Confer-ence	Machine learning	Yes	Infrastruc-ture virtual-ization
S7	Research Mapping in the Use of Technology for Fake News Detection: Bibliometric Analysis from 2011 to 2021	Budi Gun-awan	2022	Indonesia	Journal	Education	No	Infrastruc-ture virtual-ization
S8	Reframing E-participation for Sustainable Development	Victoria Palacin	2021	Finland	Confer-ence	Machine learning	No	Server Virtu-alization
S9	Perspectives on the information and digital competence of Social Sciences students and faculty before and during lockdown due to Covid-19	Dora Sales	2020	Spain	Journal	Education	Yes	Paravirtua-lization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S10	Mobility Trends before and after the Pandemic Outbreak: Analyzing the Metropolitan Area of Barcelona through the Lens of Equality and Sustainability	Lucía Me-jía-Dorantes	2021	Barcelona	Journal	Machine learning	No	Infrastructure virtualization
S11	Mobile Fog Computing by Using SDN/NFV on 5G Edge Nodes	G. R. Sreekanth	2021	Serbia	Journal	Internet Of Things	No	OS-level virtualization
S12	Machine Learning & its Classification Techniques	Atul B.Kathole	2019	India	Journal	Machine learning	No	OS-level virtualization
S13	Resource Management in 5G Mobile Networks: Survey and Challenges	Wei-Che Chien	2020	Taiwan	Journal	Machine learning	No	Infrastructure virtualization
S14	How Digital Platforms Enhance Urban Resilience	Dong Qiu	2022	China	Journal	Education	No	Resource virtualization
S15	Development Status and Trend Analysis of Internet of Medical Things Industry in China	Jian JIAO	2022	China	Journal	Medicine	No	OS-level virtualization
S16	Emotion-Aware and Intelligent Internet of Medical Things Toward Emotion Recognition During COVID-19 Pandemic	Tao Zhang	2021	China	Journal	Machine learning	Yes	Paravirtualization
S17	Emerging Health and Education Issues Related to Internet Technologies and Addictive Problems	Olatz Lopez-Fernandez	2021	Spain	Journal	Education	No	OS-level virtualization
S18	Educating for the Future: a Preliminary Investigation of Doctoral-Level Clinical Psychology Training Program's Implementation of Telehealth Education	Jonathan G. Perle	2022	USA	Journal	Education	No	Server Virtualization
S19	Digitalization: potential risks for civil society	Irina Aseeva	2020	Russia	Journal	Machine learning	No	Paravirtualization
S20	Digital Information Security: Coronavirus Crisis Impact on the Accountants, Business Analysts and Auditors Training	Karina Naz-arova	2022	Ukraine	Journal	Education	Yes	OS-level virtualization
S21	Design and Implementation of Software-Defined Data Center (SDDC) for Medical Colleges and Universities	Wei Lin	2022	China	Journal	Education	No	Infrastructure virtualization
S22	Computer Vision Positioning and Local Obstacle Avoidance Optimization Based on Neural Network Algorithm	Lei Yang	2022	China	Journal	Machine learning	No	Resource virtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S23	Comparative Analysis of Virtualization Methods in Big Data Processing	Gleb I. Radchenko	2019	Russia	Journal	Education	No	Infrastructure virtualization
S24	Cloud-based virtualization environment for IoT-based WSN: solutions, approaches and challenges	Nasr Al-murisi	2022	Germany	Journal	Internet of Things	No	Server Virtualization
S25	Towards emotive sensory Web in virtual health care: Trends, technologies, challenges and ethical issues	Elliot Mbunge	2022	South Africa	Journal	Machine learning	No	Resource virtualization
S26	Readiness for digital transformation of higher education in the Covid-19 context: The dataset of Vietnam's students	Huyen Pham	2021	Viet Nam	Journal	Education	Yes	Infrastructure virtualization
S27	Deep learning based model for classification of COVID 19 images for healthcare research progress	Saroj Kumar	2022	India	Journal	Medicine	Yes	Resource virtualization
S28	SDN&NFV contribution to IoT objects virtualization	L. Atzori	2019	Italy	Journal	Machine learning	No	Paravirtualization
S29	Virtualizing GPU direct packet I/O on commodity Ethernet to accelerate GPU-NFV	Changue Jung	2022	South Korea	Journal	Education	No	Paravirtualization
S30	Virtual labor market during the COVID-19 pandemic and their impact on transport industry	Tatyana Rusakova	2022	Russia	Journal	Flexible work	Yes	Application Virtualization
S31	Efficient deep neural networks for classification of COVID-19 based on CT images: Virtualization via software defined radio	Saman Fouladi	2021	Iran	Journal	Flexible work	Yes	Infrastructure virtualization
S32	Flexible architecture for deployment of edge computing applications	Abdukodir Khakimov	2022	Russia	Journal	Internet Of Things	No	Paravirtualization
S33	New trends in the global digital transformation process of the agri-food sector: An exploratory study based on Twitter	María Ancín	2022	Spain	Journal	Machine learning	No	Application Virtualization
S34	Zero down time-smart data guard for collaborative enterprise dataware systems	Azeemi N.Z.	2020	UAE	Journal	Flexible work	No	OS-level virtualization
S35	Real-Time Power Electronics Laboratory to Strengthen Distance Learning Engineering Education on Smart Grids and Microgrids	Gutiérrez Juan Roberto López	2021	Mexico	Journal	Education	No	Application Virtualization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S36	Virtualization of Teaching and Learning of Engineering Students and its Impact on Self-Perception of Attitude Acquisition, in the Context of COVID-19	Chamorro-Atalaya Omar	2021	Peru	Journal	Machine learning	Yes	Paravirtualization
S37	Covid-19 impact on modern virtual pathology education: Challenges and opportunities	Khatibani Seyed Esmaeil Azimi	2021	Iran	Journal	Education	Yes	Application Virtualization
S38	The resilience of cardiac care through virtualized services during the covid-19 pandemic: Case study of a heart function clinic	Shah Amika	2021	Canada	Journal	E-Learning	Yes	Application Virtualization
S39	Virtuality and teams: Dealing with crises and catastrophes	Bhargava Sushant	2020	India	Journal	Machine learning	No	Infrastructure virtualization
S40	Improvement for tasks allocation system in VM for cloud datacenter using modified bat algorithm	Ullah Arif	2022	Morocco	Journal	Cloud Computing	No	Infrastructure virtualization
S41	The use of telecommunication and virtualization among ongoing and discontinued COVID-19 clinical trials: A cross-sectional analysis	Greenough Mary C.	2022	USA	Journal	Data centers	Yes	Application Virtualization
S42	Virtualization of Laboratory Practices Using Visual Basic Excel	Coto Baudilio	2022	Spain	Journal	Virtual Laboratory	No	Server Virtualization
S43	Evaluating virtual laboratory platforms for supporting on-line information security courses	Aldwairi Monther	2022	Jordan	Journal	Virtual Laboratory	No	Application Virtualization
S44	Virtualizing project-based learning: An abrupt adaptation of active learning in the first days of the covid-19 pandemic, with promising outcomes	Pereira Marco Antonio Carvalho	2022	Brazil	Journal	Education	Yes	OS-level virtualization
S45	Early childhood and lockdown: The challenge of building a virtual mutual support network between children, families and school for sustainable education and increasing their well-being	Cano-hila Ana Belén	2021	Spain	Journal	Education	No	Paravirtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S46	Virtual reality for behavioral health workforce development in the era of COVID-19	TTC VL Workgroup	2020	USA	Journal	Medicine	Yes	Resource virtualization
S47	Business (Teaching) As Usual Amid The Covid-19 Pandemic: A Case Study Of Online Teaching Practice In Hong Kong	Ng D.T.K.	2019	China	Journal	Education	Yes	Paravirtualization
S48	General remarks on basic actualities within our life and education during first 20 years of 21st century	Broks Andris	2020	Latvia	Journal	Education	No	Server Virtualization
S49	Innovation Through Virtualization: Crisis Mental Health Care during Covid-19	Jennifer M. Hensel	2020	Canada	Journal	Data centers	Yes	Application Virtualization
S50	Virtualization of the Brazilian Nursing Week in the COVID-19 pandemic: the novelty and the tangible	Luiza Mara Correia	2021	Brazil	Journal	Education	Yes	OS-level virtualization
S51	Impact of Corona Virus on Knowledge Service Centers in West Bengal	Saha Sujan Majumder Sayantani	2021	India	Journal	Data centers	Yes	Infrastructure virtualization
S52	Unforeseen Collateral Damage of COVID-19 with the Virtualization of Fellowship Interviews	Rojas Kristin E.	2021	USA	Journal	Education	Yes	Server Virtualization
S53	COVID-19 recovery for the Nigerian construction sites: The role of the fourth industrial revolution technologies	Ebekozien Andrew	2021	Nigeria	Journal	Medicine	Yes	Application Virtualization
S54	Implementation, relevance, and virtual adaptation of neuro-oncological tumor boards during the COVID-19 pandemic: a nationwide provider survey	Schäfer Niklas	2021	Germany	Journal	Data centers	Yes	Paravirtualization
S55	Validity and reliability of a virtual education satisfaction questionnaire from the perspective of cardiology residents during the COVID-19 pandemic	Ghadrdoost Behshid	2021	Iran	Journal	Education	Yes	Application Virtualization
S56	Sustainable educational robotics. Contingency plan during lockdown in primary school	Alamo Judit	2021	Spain	Journal	Education	No	Infrastructure virtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S57	An innovative protocol for the artificial speech-directed, contactless administration of laboratory-based comprehensive cognitive assessments: PAAD-2 trial management during the COVID-19 pandemic	Park K. Shin	2021	USA	Journal	Education	Yes	Application Virtualization
S58	Implementing telemedicine for the management of benign urologic conditions: a single centre experience in Italy	Checcucci Enrico	2021	Italy	Journal	Data centers	No	OS-level virtualization
S59	Scenario-based analysis of the carbon mitigation potential of 6G-enabled 3D videoconferencing in 2030	Seidel Andres	2021	Germany	Journal	Education	No	Paravirtualization
S60	What virtual laboratory usage tells us about laboratory skill education pre- and post-COVID-19: Focus on usage, behavior, intention and adoption	Radhamani Rakhi	2021	India	Journal	Virtual Laboratory	Yes	OS-level virtualization
S61	Stop sanitizing project management education: Embracing Desirable Difficulties to enhance practice-relevant online learning	van der Hoorn Bronte	2021	Australia	Journal	Education	No	OS-level virtualization
S62	Sustainable circular micro index for evaluating virtual substitution using machine learning with the path planning problem as a case study	Maldonado-Romo Javier	2021	Mexico	Journal	Machine learning	No	Infrastructure virtualization
S63	New ways of working (NWW): Workplace transformation in the digital age	Aroles Jeremy	2021	United Kingdom	Journal	Teleworker	No	Resource virtualization
S64	Jordanian nurses' attitudes toward using electronic health records during COVID-19 pandemic: Using EHRs During COVID-19 in Jordan	Abed Walaa H.	2022	Jordan	Journal	Medicine	Yes	Server Virtualization
S65	Remote Teaching of Chemistry Laboratory Courses during COVID-19	Díez-Pascual Ana M.	2022	Spain	Journal	Virtual Laboratory	Yes	Application Virtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S66	Performance measurement of construction suppliers under localization, agility, and digitalization criteria: Fuzzy Ordinal Priority Approach	Mahmoudi Amin	2022	China	Journal	Machine learning	No	Paravirtualization
S67	Stay at home: Implementation and impact of virtualising cancer genetic services during COVID-19	Norman Maia Leigh	2022	Canada	Journal	Medicine	Yes	Application Virtualization
S68	Tactile based Intelligence Touch Technology in IoT configured WCN in B5G/6G-A Survey	Gupta Mantisha	2022	India	Journal	Mobile Communication Systems	No	OS-level virtualization
S69	Lessons Learned From Transition of an In-Person to a Virtual Randomized Controlled Trial for Weight and Fitness Concerns in Active-Duty Service Members: Survey Study	Afari Niloofar	2022	USA	Journa	Machine learning	No	Infrastructure virtualization
S70	E-commerce market environment formed by the COVID-19 pandemic – a strategic analysis	Hadasik Bartłomiej	2022	Poland	Journal	Data centers	Yes	Infrastructure virtualization
S71	Impacts of Transitioning to an Online Curriculum at a Graduate School in South Korea Due to the COVID-19 Pandemic	Yee Eric	2022	South Korea	Journal	Education	Yes	Application Virtualization
S72	Post-Pandemic IT: Digital Transformation and Sustainability	Tal Ben-Zvi	2022	USA	Journal	E-learning	No	OS-level virtualization
S73	Impact Analysis of Resilience Against Malicious Code Attacks via Emails	Lee, Chulwon	2022	South Korea	Journal	Machine learning	No	Application Virtualization
S74	Effect of Hyper-Threading in Latency-Critical Multithreaded Cloud Applications and Utilization Analysis of the Major System Resources	Pons, Lucía	2022	Spain	Journal	Data centers	No	Paravirtualization
S75	Cultivation Design of Applied Undergraduates' Engineering Innovation Ability Based on Virtualization Technology	Zhao, Qiuduo	2022	China	Journal	Education	No	Application Virtualization
S76	Leveraging Scale-Up Machines for Swift DBMS Replication on IaaS Platforms Using BalenaDB	Fukuchi, Kaiho	2022	Japan	Journal	Cloud Computing	No	Application Virtualization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S77	Protocol-agnostic method for monitoring interactivity time in remote desktop services	Arel-lano-Uson, Jesus	2021	Spain	Journal	Virtual lab-oratory	No	Infrastruc-ture virtual-ization
S78	Impact of Artificial Intelligence-enabled Software defined Networks in Infrastructure and Operations: Trends and Challenges	Belgaum, Mohammad Riyaz	2021	Malaysia	Journal	Machine learning	No	Resource vir-tualization
S79	An Improved Task Allocation Strategy in Cloud using Modified K-means Clustering Technique	Sharma, Vrajesh	2020	India	Journal	Cloud Comput-ings	No	OS-level vir-tualization
S80	Modelling virtual machine workload in heteroge-neous cloud computing platforms	Fati, Suliman Mohamed	2020	Saudi Arabia	Journal	Cloud Computing	No	Paravirtual-ization
S81	Enabling Virtual Radio Functions on Software Defined Radio for Future Wireless Networks	Liu, Wei	2020	Belgium	Journal	Mobile Commu-nication Systems	No	OS-level vir-tualization
S82	Optimization of Innovation and Entrepreneurship Education and Training System in Colleges and Universities Based on OpenStack Cloud Computing	Xu, Chun-yan	2022	China	Journal	Internet Of Things	No	Infrastruc-ture virtual-ization
S83	Optimal load balancing in cloud environment of virtual machines	Al-Yarimi, Fuad A.M.	2022	Saudi Arabia	Journal	Cloud Computing	No	Infrastruc-ture virtual-ization
S84	Sustainable Development Based on Green GDP Accounting and Cloud Computing: A Case Study of Zhejiang Province	Qi, Shan-zhong	2021	China	Journal	Cloud Computing	No	Resource vir-tualization
S85	A container-based ap-proach for sharing environmental models as web services	Qiao, Xiao-hui	2021	USA	Journal	Data centers	No	OS-level vir-tualization
S86	Empirical performance analysis of collective communication for distributed deep learning in a many-core CPU environment	Woo, Jun-ghoon	2020	South Korea	Journal	Data centers	No	Infrastruc-ture virtual-ization
S87	Modeling real-world load patterns for benchmarking in clouds and clusters	Qazi, Kashi-fuddin	2020	USA	Journal	Cloud Computing	No	Server Virtu-alization
S88	Evolution of Non-Terres-trial Networks from 5G to 6G: A Survey	Azari, M. Mahdi	2022	Luxem-bourg	Journal	Virtual lab-oratory	No	Resource vir-tualization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S89	Construction and Promotion of Reading Service Platform of University Library Based on Computer Network Cloud Platform	Xie, Na	2022	China	Journal	E-learning	No	Paravirtualization
S90	Circular economy: Challenges and opportunities in the construction sector of Kazakhstan	Torgautov, Beibut	2021	Kazakh-stan	Journal	Internet of things	No	Resource virtualization
S91	Design and Implementation of English Listening Teaching Based on a Wireless Communication Microprocessor and Virtual Environment	Liu, Li	2021	China	Journal	E-Learning	No	Application Virtualization
S92	Research on virtual machine consolidation strategy based on combined prediction and energy-aware in cloud computing platform	Wang, Jin-jiang	2022	China	Journal	Cloud Computing	No	Infrastructure virtualization
S93	An Efficient On-Demand Virtual Machine Migration in Cloud Using Common Deployment Model	Saravana-kumar C.	2022	India	Journal	Cloud Computing	No	Application Virtualization
S94	A New Malware Detection Method Based on VMCADR in Cloud Environments	Zheng, Luxin	2021	China	Journal	Mobile communication systems	No	Application Virtualization
S95	A general method for evaluating the overhead when consolidating servers: performance degradation in virtual machines and containers	Bermejo, Belen	2022	Spain	Journal	Machine learning	No	Server Virtualization
S96	An Improved Ant Colony Algorithm for Solving a Virtual Machine Placement Problem in a Cloud Computing Environment	Alharbe, Nawaf	2022	Saudi Arabia	Journal	Cloud Computing	No	Application Virtualization
S97	Allocation and migration of virtual machines using machine learning	Talwani, Suruchi	2022	India	Journal	Machine learning	No	Infrastructure virtualization
S98	Performance and scaling behavior of bioinformatic applications in virtualization environments to create awareness for the efficient use of compute resources	Hanussek, Maximilian	2022	Germany	Journal	Mobile communication systems	No	Application Virtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S99	vChecker: an application-level demand-based co-scheduler for improving the performance of parallel jobs in Xen	Jiang, Peng	2022	United Kingdom	Journal	Mobile communication systems	No	Paravirtualization
S100	PROSIM in the Cloud: Remote Automation Training Platform with Virtualized Infrastructure	Rosioru, Sabin	2022	Romania	Journal	Education	No	Application Virtualization
S101	Server consolidation: A technique to enhance cloud data center power efficiency and overall cost of ownership	Uddin, Mueen	2021	Brunei Darussalam	Journal	Cloud Computing	No	Application Virtualization
S102	Relief Policy and the Sustainability of COVID-19 Pandemic: Empirical Evidence from the Italian Manufacturing Industry	Falavigna, Greta	2022	Italy	Journal	Machine learning	Yes	Infrastructure virtualization
S103	Firms' solidity before an exogenous shock: Covid-19 pandemic in Italy	Stefano Costa	2022	Italy	Journal	Cloud computing	Yes	Application Virtualization
S104	Digitalized long-lasting insecticidal nets mass distribution campaign in the context of Covid-19 pandemic in Kongo Central, Democratic Republic of Congo: challenges and lessons learned	Likwela, Joris Losimba	2022	Democratic Republic of Congo	Journal	Cloud computing	Yes	OS-level virtualization
S105	Digital technology-enabled dynamic capabilities and their impacts on firm performance: Evidence from the COVID-19 pandemic	Li, Lixu	2022	China	Journal	Cloud computing	Yes	Paravirtualization
S106	Remote monitoring of cancer patients during the Covid-19 pandemic – an interview study of nurses' and physicians' experiences	Grøndahl, Vigdis Abrahamsen	2022	Norway	Journal	Medicine	Yes	Application Virtualization
S107	Analysing supply chain coordination mechanisms dealing with repurposing challenges during Covid-19 pandemic in an emerging economy: a multi-layer decision making approach	Mahdiraji, Hannan Amoozad	2022	Iran	Journal	Machine learning	Yes	Infrastructure virtualization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S108	How far has the digitiza-tion of medical teaching progressed in times of COVID-19? A multinational survey among medical students and lecturers in German-speaking central Europe	Hertling, Stefan Fer-dinand	2022	Germany	Journal	Education	Yes	Application Virtualization
S109	Digital science platform: an interactive web appli-cation and database of osteological material for anatomy education	Regulski, Piotr	2022	Poland	Journal	Virtual lab-oratory	No	Server Virtu-alization
S110	COVID-19: a catalyst for the digitization of surgi-cal teaching at a German University Hospital	Wolf, Milan Anton	2022	Germany	Journal	E-Learning	Yes	Infrastruc-ture virtual-ization
S111	The Impact of Social Media and Digital Plat-forms Experience on SME International Orientation: The Moderating Role of COVID-19 Pandemic	Lee, Jeoung Yul	2022	China	Journal	Smart city	Yes	Application Virtualization
S112	Suspension of face-to-face teaching and ad hoc tran-sition to digital learning under Covid-19 condi-tions – a qualitative study among dental students and lecturers	Hertrampf, Katrin	2022	Germany	Journal	Education	Yes	Infrastruc-ture virtual-ization
S113	Students' Mobile Phone Practices for Academic Purposes: Strengthening Post-Pandemic University Digitalization	Nikolopou-lou, Kleop-atra	2022	Greece	Journal	Mobile commu-nication systems	No	Application Virtualization
S114	Teleworking in Romania during Covid-19 crisis: From conjunctional adaptation to change of economic paradigm	Gavril, Ioa-na Andrada	2022	Romania	Journal	Teleworker	Yes	Infrastruc-ture virtual-ization
S115	Accelerated Digitalization of the Epidemiological Measures: Overcoming the Technological and Process Complexities of Establish-ing the EU Digital COVID Certificate in Slovenia	Stanimi-rovic, Dalibor	2022	Slovenia	Journal	E-learning	Yes	Resource vir-tualization
S116	'The show must go on!': Hustling through the compounded precarity of Covid-19 in the creative industries	Langevang, Thilde	2022	Denmark	Journal	Cloud com-puting	Yes	Resource vir-tualization

ID	Title	Author	Year	Country	Publica-tion type	Applica-tion area	Covid-19	Type of vir-tualization
S117	Emerging technology and management research in the container terminals: Trends and the COVID-19 pandemic impacts	Zhou, Chen-hao	2022	China	Journal	Cloud com-puting	Yes	Paravirtual-ization
S118	Machine Learning Sensors for Diagnosis of COVID-19 Disease Using Routine Blood Values for Internet of Things Application	Velichko, Andrei	2022	Russia	Journal	Machine learning	Yes	Server Virtu-alization
S119	Multicultural Education Policies and Connected Ways of Living during COV-ID-19: Role of Educators as Cultural Transformers	Kirac, Necla İzbul	2022	Turkey	Journal	Education	Yes	Application Virtualization
S120	Resilience of Smart Cities to the Consequences of the COVID-19 Pandemic in the Context of Sustainable Development	Kuzior, Al-eksandra	2022	Poland	Journal	Smart City	Yes	Infrastruc-ture virtual-ization
S121	The impact of COVID-19 on cultural industries: An empirical research based on stock market returns	Zhang, Rong	2022	China	Journal	Education	Yes	Application Virtualization
S122	The COVID-19 pandemic as a catalyst for digitalisation and remote working in Germany	Har-tig-Merkel, Wendy	2022	Belgium	Journal	Teleworker	Yes	Paravirtual-ization
S123	Technology Adoption in the Digital Entertainment Industry during the COV-ID-19 Pandemic: An Ex-tended UTAUT2 Model for Online Theater Streaming	Aranyossy, Marta	2022	Hungary	Journal	Mobile commu-nication systems	Yes	Application Virtualization
S124	Conceptualization and Mapping of Predictors of Technological Entre-preneurship Growth in a Changing Economic Envi-ronment (COVID-19) from the Polish Energy Sector	Cze-miel-Grzy-bowska, Wioletta	2022	Saudi Arabia	Journal	Virtual lab-oratory	Yes	OS-level vir-tualization
S125	Influence of Knowledge Area on the Use of Digital Tools during the COVID-19 Pandemic among Latin American Professors	Antón-San-cho, Álvaro	2022	Spain	Journal	Education	Yes	Infrastruc-ture virtual-ization
S126	Digitalization as a Factor in Reducing Poverty and Its Implications in the Context of the COVID-19 Pandemic	Spulbar, Cristi	2022	Romania	Journal	Internet of things	Yes	Application Virtualization

ID	Title	Author	Year	Country	Publication type	Application area	Covid-19	Type of virtualization
S127	High User Acceptance of a Retina e-Learning App in Times of Increasing Digitalization of Medical Training for Ophthalmologists	Kamouna, Alexander	2022	Germany	Journal	E-Learning	No	Server Virtualization
S128	Digitalization during the era of COVID-19: An analysis of the psychophysiological strain of university students	Babieva, Nigina S.	2022	Russia	Journal	Education	Yes	OS-level virtualization
S129	Innovating under pressure: Adopting digital technologies in social care organizations during the COVID-19 crisis	Kateb, Sanaz	2022	Netherlands	Journal	Machine learning	Yes	Infrastructure virtualization
S130	The Metaverse as a Virtual Form of Data-Driven Smart Urbanism: On Post-Pandemic Governance through the Prism of the Logic of Surveillance Capitalism	Bibri, Simon Elias	2022	Norway	Journal	Internet of Things	No	Paravirtualization
S131	From Challenge to Opportunity: Virtual Qualitative Research During COVID-19 and Beyond	Keen, Sam	2022	United Kingdom	Journal	Machine learning	Yes	Server Virtualization

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