Print ISSN: 2233-4165 / Online ISSN 2233-5382
JIDB website: http://www.jidb.or.kr
doi:http://dx.doi.org/10.13106/jidb.2022.vol13.no10.15

How to Implement Successful Virtual Desktop Infrastructure (VDI) in the Manufacturing Sector

Tae-Hi KIM[1]

Received: September 20, 2022. Revised: October 11, 2022. Accepted: October 15, 2022.

Abstract

Purpose: In the manufacturing sector, VDI (Virtual Desktop Infrastructure) offers advantages to the organizations, such as allowing manufacturers access to the system from any location. The most important things are understanding what the user needs, avoiding under-provisioning, network preparation. This research is to provide useful practical l implementations of VDI in manufacturing industry based on numerous prior studies. **Research design, data and methodology:** This research has conducted the qualitative content analysis (QCA). When conducting this research, the present author assumed that it is crucial to create the procedures and processes that will be used to acquire the text data needed to structure or solve problems. **Results:** According to the prior literature analysis, there are five suggestions to implement successful VDI for manufacturing sector. The five solutions are (1) Creation of the machines, (2) Direct users to an available 'Virtual Machine', (3) 'Virtual Machine Power Management', (4) Performance monitoring, and (5) Review security. **Conclusions:** The research clearly details how VDI can be implemented on a manufacturer platform and how it can be connected to hundreds of users. The author can conclude that connecting hundreds of users can be done using the remote connection of devices and encourage manufacturers to work from different areas.

Keywords : Virtual Desktop Infrastructure (VDI), Manufacturing Sector, Technological Management

JEL Classification Code : L24, L69, O18

1. Introduction

Virtualization is a term used in various disciplines to simulate the existence of something specific, especially in research. Information technology is not excluded from its use, so it can be found in many areas where its characteristics are exploited. Virtualizing has historically and broadly been viewed as taking something in a certain state and pretending to be in a different state. From it, two approaches have been evolving: to simulate that a computer is about multiple computers and not just one -virtualization- or achieve that multiple computers are one. Virtualization is the combination of hardware and software that give chance to physical resource to function as numerous logical resources.

Firms grows and acquires different paraphernalia and computer systems and establishes different environs to use equipment specific technological, according to the most specific needs of the company: a mail server, a database server, an Active Directory for security policies and to be able to store information, etc. (Wijaya & Suasih, 2020). Over the years, the number of servers increased and became more complicated management and control of the hardware, with the consequent increase in operating expenses derived from its operation. Only one technology allows us to deal rationally with this escalation in Corporate system administration, which is virtualization.

Virtualization is a means of "creating a virtual version of a device or resource, such as a server, a storage, a network or even an operating system, where it is divided the resource in one or more execution environments." (Zhang et al., 2018) To understand it better, look at it from the user's perspective:

1 First and Corresponding Author. Ph.D. Student, Department of Business Administration, Chung-Ang University, Korea. E-mail: teikimaver@naver.com

"A virtualization is software which allows you to have multiple operating systems running simultaneously. The same computer, it means that it allows transforming machines, in several virtual machines". Virtual machines can have the same components as virtual machines. The processor, memory, disk, and network behave the same way on a physical machine; the difference is that these components are virtual, and we will refer to them as processor virtual, virtual memory, virtual disk, and virtual network.

Virtualization is a nonrepresentational level that decouples the OS and hardware to give greater suppleness and utilization of different computer resources. Virtualization allows multiple virtual machines with heterogeneous systems operations can be executed individually on the same physical machine. Each virtual machine has its virtual hardware by which the system operates operations and applications.

In the manufacturing sector, VDI offers advantages to the organizations, such as allowing manufacturers access to the system from any location. It is known as remote access, allowing different manufacturers from different locations to access files and other important applications from any part of the world. The infrastructure also provides the power of centralized management, allowing easy patching for IT and updating and configuring all the different virtual desktops installed. In dealing with matters related to VDI implementation, the enterprise must consider different things. The most important things are understanding what the user needs, avoiding under-provisioning, network preparation, and performing pilot tests before starting the project. The technology of using virtual machines as a way of having control of virtual desktops with a centralized server requires preparation and elimination of mistakes to be successful in everything that the team does.

2. Literature Review

Based on the Kubuntu distribution and a multi-user Linux environment, this solution allows users to launch Linux applications through their web browser; the user has a remote BV. The client station must have at least a web browser with the latest version of the Java plugin (Jeong et al., 2015). This solution can integrate an existing network. It is possible to add an Active Directory, an LDAP, NFS, and CIFS file servers (Scroggins, 2017). At least two servers are required to operate this environment: the server "SM" to manage connections and authentications (secured by SSH tunnels) and a server to install the applications that will be available in the BVs and will host the user profiles (Nein, 2013). This environment can be installed on a single physical or virtual server.

VDI technology, initiated in 2006 by VMware, consists of no longer installing any system operating systems or applications on the workstations (Yao et al., 2019). They are virtualized and deported to servers. Virtualization, therefore, makes it possible to operate on a single machine, several operating systems, and/or applications separately from each other, as if they were running on separate physical machines. This technology is not new and has already existed in the days of mainframes.

From a functional point of view, virtualization of the VDI-type workstation is similar to the user presentation virtualization (distributed office), widely used by Citrix in particular, with the difference that users do not have access to opening a session or a shared desktop but benefit from an operating system full customer. Most virtualization like Citrix, VMware, IBM, or Oracle offers VDI platforms. IBM Desktop or Oracle offers VDI platforms. Desk distributed or VDI, the objective of the techniques of virtualization is to facilitate access, regardless of the terminal (PC, smartphone, or tablet), apps and data.

Unlike VDI, where the entire operating system applications are virtualized, with application virtualization, only applications, as its name indicates, are virtualized. Application virtualization is not physically installing the applications on the workstation (Shin et al., 2015). The application is provided by a specific server that provides you with this application and its unique environment. There are two approaches to application virtualization, the published application and application isolation. The technique of the published application makes it possible to virtualize, centralize and manage applications within the data center, then deliver them instantly to users as a service. In other words, the user can access his applications from anywhere and at any time by a simple internet browser or by an agent installed in his workplace. As for the second process, the virtualization of applications by isolation or "application bubble" consists of the installation by streaming an application directly into the workplace (Tang & Ding, 2019).

Virtual machines are administered from consoles that differ a lot from one solution to another. The Citrix solution sends all the information to the administration console by the hypervisor. It is, therefore, sufficient to connect to one (or more) hypervisor to access the virtual machine management options. This is possible in VMWare's solution but only allows access to several options with limited management. Information about all virtual machines is centralized by a server called "Virtual Center," to which the administrator connects via a client ("VMWare Infrastructure Client") to have access to the full spectrum of possible options. This main console, which allows you to turn on, turn off and monitor virtual machines that the consumption of resources, network, etc., as well as interacting with these machines, does not manage, unfortunately, not all the

features described (Calle-Romero et al., 2019). In the VMWare environment, you will need to use an additional web console of the View Connection Server to administer your virtual desktop infrastructure. In the Citrix environment, you will need to manage two additional consoles (one for Desktop Delivery Controller, one for Provisioning Server), or even a third if you use XenApp, the application virtualization solution from Citrix. These additional consoles can be combined into one (bringing the total to two, as for VMWare) because they are "snap-in components" (Sheikholeslami & Graffi, 2015).

Neither Citrix, VMWare, nor Microsoft offers an agent usable under Linux. To connect to a virtual machine that runs Linux, you will need to use a less common solution, such as RHEV (Red Hat Enterprise Virtualization) or Oracle VDI. All publishers offer a client for Linux. It allows a Linux machine to connect to a Windows virtual machine. This can be a solution to reduce the cost of licenses of the operating system, but also and above all of the utilities, such as antivirus, in a solution based on workstation virtualization (Bahudaila & Saeed, 2019). The functionality of these clients is very different: the Linux client for RHEV uses SPICE protocol features, and the Citrix Desktop Receiver handles USB redirection and multimedia. In contrast, the VMWare "Open view client" does not provide any of these functions.

2.1. Research Gap

Desktop virtualization does not only have advantages, but it also brings its share of problems. Among these problems, one of the most critical is multimedia management. Indeed, the remote connection protocols were not created to allow efficient video management. The techniques used for screen offset are suitable when the display is relatively static (i.e., when the difference between two successive images is small) but not when the display changes from one image to the next. In this case, the image obtained on the physical machine is jerky and is updated in blocks. In parallel with these protocols, it is, therefore, necessary to detect the video streams that cause rapid and large changes in the image to be displayed and apply a treatment to them particularly (Li et al., 2020). The editors choose to intercept the videos and play them not by the virtual machine but by the physical workstation. Launching a video is transferred to the network to the physical machine in its original format and read locally. The local computer generates the part of the screen occupied by the video itself, and the graphics rendering of all the rest of the desktop is performed by the virtual machine and transmitted through the Remote Connection protocol. Citrix, VMware, and Red Hat go even further and adapt the way the video is rendered (on the client or the server) depending on the computing capabilities of the client and the quality of the network link between client and server. There is one area where there is little information on how to access multimedia, such as video, remotely and not from local access (Chang et al., 2020).

3. Methodology

The framework or method used in the study for collecting and interpreting the data is known as the research design. This research has conducted the qualitative content analysis (QCA). When conducting this research, the present author assumed that it is crucial to create the procedures and processes that will be used to acquire the text data needed to structure or solve problems. To arrive at QCA, one must consciously adopt particular thinking. For QCA inference to advance, these three design components must be addressed because they are interrelated. Instead of concentrating on a single methodology, the present author discovered and followed numerous creative QCA approaches (Woo, 2020; Kang, 2021; Nguyen et al., 2022).

The conventional case-based approach that was used by the present author strongly emphasized thoroughly analyzing specific circumstances utilizing powerful tools. Condition-oriented apps use criteria that must be met to investigate scenarios. Measurement and internal validity are essential when much case information is required. This research-practical strategy allows QCA to be constructed on substantive and theoretical understanding and methodological procedures characteristic of modern social scientific research (Lee, 2021). to identify appropriate supersets and subsets of the phenomena that QCA describes.

Every instance in this research in a superset was causally interpreted. Without a thorough justification, QCA reports the outcomes of a particular therapy. Studying conceptual and theoretical difficulties is a recurring aspect of the QCA approach. Truth table analysis looks for outcomes rather than just evaluating the consistency and completeness of set-theoretic assumptions (Kim, 2020). External validity, internal validity, and reasoning are all supported by various tools.

Ad hoc selection of instances can provide further analytical advantages. Because it could result in absurd conclusions about populations that do not exist, statistical inference is not frequently used in QCA applications. Robustness testing could determine how many cases alter how results should be interpreted for this research. Parsimonious and intermediate solution words may comprise configurations that were not encountered but may occur in future scenarios for researchers who need substantial interpretability (Kim & Kang, 2022). Making too many assumptions in hypothetical situations based on scant

information could be dangerous. Researchers can define a threshold for truth table rows to lessen the latter's influence.

Measuring inaccuracy can be addressed in various ways and using different strategies (Mende, 2022). Researchers who focus on their job thoroughly understand the events and problems they study—finding ignored cases by tracking unusual circumstances after they have occurred. Robustness testing can be used to correct model specifications.

The lack of significant variance in social reality may compromise internal authenticity. Different QCA methodologies have other solutions to these validity issues. Case-oriented QCA techniques may compensate for the lack of conflict by incorporating knowledge from prior cases (Kang & Hwang, 2021). For this research, this method emphasized substantive interpretability when developing standards for establishing the veracity of counterfactual claims. Configurations similar to or supersets of conservative or intermediate solution terms are used in the economical solution. Using this approach, a "configurationally accurate" QCA solution only contained causally related elements for this research.

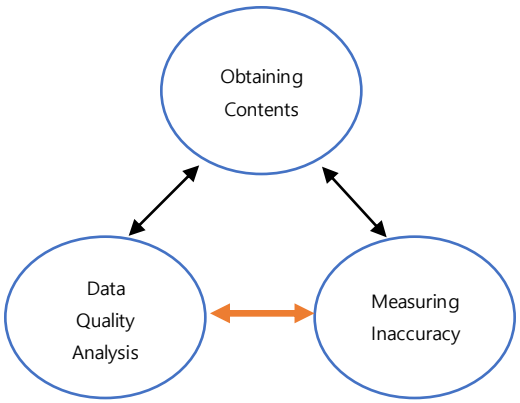

Figure 1: QCA Anaysis Approach

4. Results

Today all IT departments try to look for a more robust environment that meets your needs, such as cost reduction per hardware acquisition, cost reduction in the operation of the data center (energy, cooling...) and increase in productivity, operability, flexibility, and responsiveness (Kumar et al., 2021). There are several virtualization solutions on the market which try to cover most of the needs presented by the IT administrators; we have chosen the most important and positioned in the world of IT.

A study on the most consolidated options on the market was carried out for the system to be used to implement the virtualization model within the manufacturing industry. Each of these virtualization technologies is analyzed, highlighting its characteristics, strengths, and weaknesses (Lee et al., 2021). Desktop virtualization is a concept that allows multiple environments workstations to coexist on the same physical machine using platform virtualization called a hypervisor. It is, therefore, possible to take an environment normally run on a standard physical workstation and run it on a centralized server. The user can access his work environment using a telecommunications link and a peripheral such as a workstation or a thin client.

The hypervisor is a virtualization platform allowing different systems operating systems to run in parallel on the same physical machine while sharing its resources (Tong et al., 2015). The computer on which the hypervisor is running is named the host, and the virtual operating systems hosted by the hypervisor are named the guests. The role of the hypervisor is to allow the different environments to run on the host computer while isolating the environments from each other in the same way they would be if they were running on separate physical machines. The hypervisor is responsible for providing the hardware resources necessary for different virtual environments. Hypervisors are subdivided into two types.

Type 1 of this is software that runs straight on the host computer's hardware without dependency on its operating system for sharing material resources (Alagappan et al., 2016). The guest operating systems, therefore, remain close to the host's physical resources, increasing performance. Type 2 hypervisor is software that runs directly on the operating system from the host computer (Yoo et al., 2012). The execution of virtual workstations then depends directly on the system host operation. Therefore, two software layers are inserted between the workstation's guest workload and host physical resources, which can affect performance.

The hypervisor is responsible for making available to each operating system invited a workspace of its own, which does not interfere or react with its operating system or that of other guest operating systems (Ibrahim et al., 2016). Therefore, virtual desktops have the most isolated work environments from each other and are distinct from physical workstation environments standard.

3.1. Type of Desktop Virtualization

There are two main types of desktop virtualization. There is the type "station of local virtual work" or "Local Desktop Virtualization" and the type "virtual desktop hosted" or "Hosted Desktop Virtualization." These two types of virtualization respond to different needs (Lee et al., 2015).

3.1.1. Local Desktop Virtualization

There In this type of virtualization, the virtual environment of the workstation runs entirely on the physical workstation of the user but in a completely separate environment and independent of the host environment. This type of virtualization allows a mobile virtual workstation to operate autonomously without dependency on telecommunication. This type of virtualization is often used to provide the user with a multitude of distinct environments responding to specific needs, for example, an environment for professional work and an environment for personal use (Makoviy & Khitskova, 2019).

3.1.2. Hosted Desktop Virtualization

Unlike the "local virtual workstation" type of virtualization, where the virtual workstation resides on the user's physical workstation, the hosted virtual workstation resides on a centralized physical server. The user can then access his virtual environment from a thin client or a standard workstation such as a desktop or laptop computer (Ge et al., 2013). This virtualization requires communication between client and server and generally cannot work without this communication. This type of virtualization is used in the architecture of VDI workstations. This essay deals primarily with this type of virtualization.

For this type of virtualization, there are two types of server architecture. In the first type, the workstations are stored in a server with a standard architecture and serve multiple users simultaneously. In the second type, the posts of work are stored on a server with an architecture called "PC Blade" or "Blade server". In a "Blade server" architecture, the server has several blades. The blades are composed of independent motherboards on each of which a computer stripped of certain components is assembled. Each blade has its or its processors and its memory and is inserted inside a server supporting this type of architecture. The blades may share some central server resources, such as network interfaces and disks. A blade can have the performance of a simple workstation and serve a virtual environment simultaneously, just as it can have the performance of a server and serve a multitude of virtual environments simultaneously.

The principle of a virtual workstation infrastructure is as follows: several machines computers (one per physical workstation) equipped with a desktop operating system running on a server, itself running with a particular operating system called a "hypervisor" (Yang et al., 2018). When a user turns on his physical workstation, he connects to one of these machines and opens a session. The display and sound of this virtual machine are transferred to the physical workstation through the network.

3.2. Implementing Virtual Desktop Infrastructure

3.2.1. Creation of the Machines (Solution 1)

Even if the tools vary from one solution to another, the principle used to create the machines virtual machines is simple: it is a question of completely installing a single virtual machine (system operating systems, updates, print drivers, possible applications, etc., and to create all other virtual machines using this "mother" machine as a template (Nehra & Kumar, 2020; Makoviy et al., 2017). A copy of the hard drive of the parent machine is made, and the child machines all use this copy as their local hard disk, except that writes are made to an individual cache and not to the disk himself.

3.2.2. Direct Users to an Available VM (Solution 2)

Users do not have access to management tools for the virtual machine fleet. It makes it difficult for them to identify which machines are on or off and which machines are already used or not (Alzoubaidi et al., 2021; Ge et al., 2013). Virtual desktops have the most isolated work environments from each other and are distinct from physical workstation environments standard.

When several hundred users want to get a connection to a virtual machine, you have to be able to manage their requests, direct them to a virtual machine switched on and available, and switch on new ones if necessary. This is the role of the "Broker." This server has different names following the solutions but always has the same role. Each virtual machine launches an agent ("Virtual Desktop Agent" in the case of Citrix, "View Agent" in the case of VMWare), which dialogues with the server mentioned above to provide him with information about his condition.

3.2.3. Virtual Machine Power Management (Solution 3)

Users cannot remotely power on or power off virtual machines. They can only request a connection to a virtual desktop from the broker (Redondo Gil et al., 2014). If no machine is on, no connection is possible. Brokers, therefore, integrate functions to start or automatically shut down virtual machines. They can be configured so that there are always several VMs powered on and idle, waiting for a connection. When a user requests a connection and uses one of these machines, another is started by the broker to maintain a constant number of on and inactive machines (Miseviciene et al., 2012). This number may vary based on the time and day of the week. The broker turns off Surplus machines and inactive virtual machines to save energy.

3.2.4. Performance Monitoring (Solution 4)

The two publishers have developed machine performance monitoring virtual solutions (EdgeSight for Citrix, VMWare ESXtop, and RDTS (Remote Desktop

Terminal Services) for Microsoft). These solutions make it possible to detect performance problems before they become blocked for the user (for example, when a machine consumes too many resources, the administrator can be alerted and find the origin of the problem). Virtual machines created by the Citrix Provisioning Server on a VMWare ESX hypervisor). However, publishers emphasize strong integration between their products, including in licensing modes, which limits the interest in a mixed solution (Makoviy et al., 2017; Nayyar, 2019).

Table 1: Results Derived from Privious Contents

Main Findings	Description and Prior Textual Resources
1. Creation of the Machines	A copy of the hard drive of the parent machine is made, and the child machines all use this copy as their local hard disk (Nehra & Kumar, 2020; Makoviy et al., 2017)
2. Direct Users to an Available VM	Virtual desktops have the most isolated work environments from each other and are distinct from physical workstation environments standard.(Alzoubaidi et al., 2021; Ge et al., 2013)
3. Virtual Machine Power Management	Users cannot remotely power on or power off virtual machines. They can only request a connection to a virtual desktop from the broker (Redondo Gil et al., 2014; Miseviciene et al., 2012)
4. Performance Monitoring	Publishers emphasize strong integration between their products, including in licensing modes (Makoviy et al., 2017; Nayyar, 2019)
5. Review Security	Security involves educating and training users to handle the whole system remotely without causing harm or threat to others (Zissis & Lekkas, 2012; Rong et al., 2013).

3.2.5. Review Security (Solution 5)

A security review is done to ensure that the data and connection are secure, which can use third-party security infrastructure to provide security. Security also involves educating and training users to handle the whole system remotely without causing harm or threat to others (Zissis & Lekkas, 2012; Rong et al., 2013).

5. Discussions

Virtualization is the combination of hardware and software that lets a physical equipment to function as multiple logical resources. Virtual desktop infrastructure (VDI) consists of hosting the operating system of a workstation in a virtual machine. It can be hosted in the enterprise data center or the cloud. In this way, VDI is accessible from devices such as thin clients, PCs, refurbished smartphones, tablets, etc. Virtualization allows companies to make significant savings and provides them with great flexibility (Patil & Shekar, 2012). Infrastructure Virtual Desktop Infrastructure is a virtualization technology that many businesses are taking advantage of. In the manufacturing sector, VDI offers advantages to the organizations, such as allowing manufacturers access to the system from any location.

It is always easy for manufacturers of IT solutions to highlight the multiple advantages offered by their solutions while ignoring the negatives (Lan & Xu, 2014). A VDI project brings to the real company advantages, real disadvantages, and real risks. For some companies, the benefits will be more attractive and important than the disadvantages and risks, while for others, the risks will be more important than the benefits gained. Therefore, a VDI project will not have the same relevance from one company to another, and it is for this reason that the decision support tool presented in this essay becomes useful when the time comes to assess the relevance of such a project. This tool does not reveal the answer beyond any doubt to all the questions, but it makes it possible to assess the relevance of such a project according to the needs of the company (Rodríguez Lera et al., 2021). The result obtained using the developed tool is a good indicator of the relevance of such a project in the business. The paper includes every information necessary for implementing a successful virtual desktop infrastructure (VDI) in the manufacturing sector.

The paper provides every piece of information that one needs to know and a successful way to implement virtual desktop infrastructure (Adeliyi & Olugbara, 2021). The research clearly details how VDI can be implemented on a manufacturer platform and how it can be connected to hundreds of users. The author can conclude that connecting hundreds of users can be done using the remote connection of devices and encourage manufacturers to work from different areas. As stated, "a VDI project brings to the real company advantages, real disadvantages and real risks. For some companies, the benefits will be more attractive and important than the disadvantages and risks, while for others, the risks will be more important than the benefits gained." It is thus the work of the organization to come up with an answer to what they want to achieve and the strategy they need to put in place. Today all IT departments try to look for

a more robust environment that meets your needs, such as cost reduction per hardware acquisition and cost reduction operation of the data center. Virtual desktop infrastructure is a solution to this and provides an answer to working and connecting users from different areas. As companies grow, it is thus important to use such a solution to ensure that the industrial equipment is fully utilized without losing any part. The technology of using virtual machines as a way of having control of virtual desktops with a centralized server requires preparation and elimination of mistakes to be successful in everything that the team does. Through this, the manufacturer is able to separate operations on logical part from the hardware and speeds up system changes, offering a platform that reinforces business endurance and balances quickly to meet its demands. With different solutions in place from different companies, it is the work of the firm to decide the best solution based on the needs and the number of users they have. This study provides a proper background of what the researchers and users need to understand the use and implementation of the VDI in any manufacturing setting fully.

Although the proposed decision support tool can indicate whether a VDI project represents the best solution and implementation of the VDI, it does not allow you to compare the various VDI solutions with each other (Huang & Li, 2021). He would be interested in future work to use the AHP method to develop tools in order to compare the different possible VDI solutions to find the best applicable solution.

With a lot of VDI technologies and software brokers available, the study does not concentrate on the installation and implementation of one software but generalizes the whole study. The study also does not provide the cost of implementing the whole project, making it hard to come up with the whole solution. Without the budgeted figures stated, it becomes hard to successfully come to know if the solution is feasible or not.

The study is also limited to a lack of full detail on a matter relating to VDI security and connectivity issues which are important in implementation. VDI security is one of the most important topics that need to be addressed to ensure that the connectivity is secure. Without a secure connection, then, the success of the VDI implementation would lead to threats later. With little research being conducted based on this area, it was hard to come up with full detailed information relating to security on VDI.

The study also faced some problems, such as time constraints with not enough time to conduct the research at full and come up with a full detailed analysis. The research, however, has all the necessary gathered information on what is needed to successfully implement VDI. Limited access to information also limited my research since the information came from few available sources; my work was concentrated and based on certain information.

References

Adeliyi, T. T., & Olugbara, O. O. (2021). *Optimizing Remote Access Using Mobile Cloud Virtual Desktop Infrastructure. In 2021 Conference on Information Communications Technology and Society (ICTAS)* (pp. 1-4). IEEE.

Alagappan, A., Venkataraman, S., & Sivakumar, S. (2016). *Virtual desktop infrastructure for rendering education technology in multifaceted learning platforms—a case study at both universities. In 2016 International Conference on Signal Processing, Communication, Power and Embedded System* (pp. 1717-1720). IEEE.

Alzoubaidi, A. R., Alzoubaidi, M., Ismaiel Abu Mahfouz, T., Alkhamis, F. F. S. A., & Alzoubaidi, M. (2021). Virtual Desktop Infrastructure in Higher Education Institution: An Application of Home and Mobile Computing Environment. *Azerbaijan Journal of High-Performance Computing, 4*(1), 29-38.

Bahudaila, S. A. R., & Saeed, A. A. H. A. (2019). Remote system performance analysis of the virtual applications and virtual desktops by using Parallels 2X RAS technique. *University of Aden Journal of Natural and Applied Sciences, 23*(2), 411-421.

Calle-Romero, P. E., Lema-Sarmiento, P. A., Gallegos-Segovia, P. L., León-Paredes, G. A., Vintimilla-Tapia, P. E., & Bravo-Torres, J. F. (2019, *December). Virtual Desktop Infrastructure (VDI) deployment using OpenNebula as a private cloud. In International Conference on Applied Technologies* (pp. 440-450). Springer, Cham.

Chang, C. H., Yang, C. T., Lee, J. Y., Lai, C. L., & Kuo, C. C. (2020). On construction and performance evaluation of a virtual desktop infrastructure with GPU accelerated. *IEEE Access, 8*, 170162-170173.

Ge, J. W., Zheng, H. M., & Fang, Y. Q. (2013). *A Hybird Virtual Machine Placement Aglrithm for Virtualized Desktop Infrastructure. In Advanced Materials Research* (Vol. 760, pp. 1906-1910). Trans Tech Publications Ltd.

Huang, K., & Li, Z. (2021). The campus cloud platform setup is based on virtualization technology. *Procedia Computer Science, 183*, 73-78.

Ibrahim, A. A. Z. A., Kliazovich, D., Bouvry, P., & Oleksiak, A. (2016). *Using virtual desktop infrastructure to improve power efficiency in the grief system. In 2016 IEEE International Conference on Cloud Computing Technology and Science (CloudCom)* (pp. 85-89). IEEE.

Jeong, D., Park, J., Lee, S., & Kang, C. (2015). Investigation methodology of a virtual desktop infrastructure for IoT. *Journal of Applied Mathematics, 2015*, 689870.

Kang, E. (2021). Qualitative content approach: Impact of organizational climate on employee capability. *East Asian Journal of Business Economics, 9*(4), 57-67.

Kang, E., & Hwang, H. J. (2020). The consequences of data fabrication and falsification among researchers. *Journal of Research and Publication Ethics, 1*(2), 7-10.

Kim, J. H., & Kang, E. (2022). The Role of Wearable Devices for the Success of the Healthcare Business: Verification from PRISMA Approach. *Journal of Economics Marketing, and Management, 10*(4), 13-24.

Kim, S. G. (2020). The marketing model applying the concepts of educational psychology in the private educational service

sector. *Journal of Distribution Science, 18*(11), 15-22.

Kumar, R., Yadav, A. K., & Verma, H. N. (2021). An analysis of Approaches for Desktop Virtualization and Challenges. *International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 7*(4), 600-612.

Lee, J. H. (2021). Effect of sports psychology on enhancing consumer purchase intention for retailers of sports shops: Literature content analysis. *Journal of Distribution Science, 19*(4), 5-13.

Lee, K. H., Kwon, S. W., Shin, J. H., & Choi, G. S. (2015). *A study on design of virtual desktop infrastructure (VDI) system model for cloud computing BIM service. In ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction* (Vol. 32, p. 1). IAARC Publications.

Lee, K., Shin, J., Kwon, S., Cho, C. S., & Chung, S. (2021). BIM Environment Based Virtual Desktop Infrastructure (VDI) Resource Optimization System for Small to Medium-Sized Architectural Design Firms. *Applied Sciences, 11*(13), 6160.

Lan, Y., & Xu, H. (2014). Research on technology of desktop virtualization based on SPICE protocol and its improvement solutions. *Frontiers of Computer Science, 8*(6), 885–892.

Li, S., Xiao, L., Shi, C., Che, L., Zhang, C., & Li, Y. (2020). Boosting performance of virtualized desktop infrastructure with physical GPU and SPICE. *Science China Information Sciences, 63*(7), 1-3.

Makoviy, K., & Khitskova, Y. (2019, April). Complex interaction of AHP technique and SWOT–analysis for virtual desktop infrastructure (VDI). In *Journal of Physics: Conference Series* (Vol. 1202, No. 1, p. 012029). IOP Publishing.

Makoviy, K., Proskurin, D., Khitskova, Y., & Metelkin, Y. (2017). Server hardware resources optimization for virtual desktop infrastructure implementation. In *CEUR Workshop Proceedings* (Vol. 1904, p. 178).

Mende, J. (2022). Extended qualitative content analysis: researching the United Nations and other international institutions. *Qualitative Research Journal, 22*(3), 340-353.

Miseviciene, R., Ambraziene, D., Tuminauskas, R., & Pazereckas, N. (2012). Educational infrastructure using virtualization technologies: Experience at Kaunas university of technology. *Informatics in Education, 11*(2), 227-240.

Nayyar, A. (2019). *Handbook of Cloud Computing: Basic to Advance research on the concepts and design of Cloud Computing*. BPB Publications.

Nehra, S., & Kumar, C. R. S. (2020, June). *Enterprise virtual desktop infrastructure architecture on OpenStack cloud with lightweight directory access protocol. In 2020 8th International Conference on Reliability, Infocom Technologies and Optimization (Trends and Future Directions)(ICRITO)* (pp. 1050-1055). IEEE.

Nein, W. (2013). *An Economic Analysis of Cloud:"Software as a Service"(SaaS) Computing and "Virtual Desktop Infrastructure"(VDI) Models. In Cloud Computing Service and Deployment Models: Layers and Management* (pp. 289-295). IGI Global.

Nguyen, L. T., Nantharath, P., & Kang, E. (2022). The Sustainable Care Model for an Ageing Population in Vietnam: Evidence from a Systematic Review. *Sustainability, 14*(5), 2518.

Patil, P., & Shekar, S. (2012). Desktop Virtualization Technologies and Implementation. *IOSR Journal of Engineering, 2*(2), 310=314.

Redondo Gil, C., Vega Prieto, P., Silva, M., & Teixeira, A. M. (2014). *Virtual desktop infrastructure (VDI) technology: FI4VDI project. In New Perspectives in Information Systems and Technologies, Volume 2* (pp. 35-42). Springer, Cham.

Rodríguez Lera, F. J., Fernández González, D., Martín Rico, F., Guerrero-Higueras, Á. M., & Conde, M. Á. (2021). Measuring Students Acceptance and Usability of a Cloud Virtual Desktop Solution for a Programming Course. *Applied Sciences, 11*(15), 7157.

Rong, C., Nguyen, S. T., & Jaatun, M. G. (2013). Beyond lightning: A survey on security challenges in cloud computing. *Computers & Electrical Engineering, 39*(1), 47-54.

Scroggins, R. (2017). Emerging virtualization technology. *Global Journal of Computer Science and Technology, 17*(3), 11-16.

Sheikholeslami, A., & Graffi, K. (2015, August). *A Systematic Quality Analysis of Virtual Desktop Infrastructure Technologies. In European Conference on Parallel Processing* (pp. 311-323). Springer, Cham.

Shin, J., Lee, K., Kwon, S., Choi, G., & Ko, H. (2015). A Study of the Establishment of BIM Design Environment based on Virtual Desktop Infrastructure (VDI) of Cloud Computing Technology. *Korean Journal of Construction Engineering and Management, 16*(4), 118-128.

Tang, Y., & Ding, X. (2019, November). *Application research of desktop virtualization technology based on VOI in computer room management of colleges and universities. In Journal of Physics: Conference Series* (Vol. 1345, No. 6, p. 062055). IOP Publishing.

Tong, Y. J., Yan, W. Q., & Yu, J. (2015). Analysis of a secure virtual desktop infrastructure system. *International Journal of Digital Crime and Forensics (IJDCF), 7*(1), 69-84.

Wijaya, P. Y., & Suasih, N. N. R. (2020). The effect of knowledge management on competitive advantage and business performance: A study of silver craft SMEs. *Entrepreneurial Business and Economics Review, 8*(4), 105-121.

Yang, C. T., Liu, J. C., Lee, J. Y., Chang, C. H., Lai, C. L., & Kuo, C. C. (2018, October). *The implementation of a virtual desktop infrastructure with GPU accelerated on OpenStack. In 2018 15th International Symposium on Pervasive Systems, Algorithms and Networks (I-SPAN)* (pp. 366-370). IEEE.

Yao, Q., Wu, Y., & Gao, J. (2019, July). *Research on application of cloud desktop virtualization for computer laboratories in universities. In IOP Conference Series: Materials Science and Engineering* (Vol. 563, No. 5, p. 052028). IOP Publishing.

Yoo, S., Kim, S., Kim, T., Kim, J. S., Baek, R. M., Suh, C. S., ... & Hwang, H. (2012). Implementation issues of virtual Desktop Infrastructure and Its Case Study for a Physician's Round at Seoul national university bundang hospital. *Healthcare informatics research, 18*(4), 259-565.

Zhang, Q., Liu, L., Pu, C., Dou, Q., Wu, L., & Zhou, W. (2018, July). *A comparative study of containers and virtual machines in big data environment. In 2018 IEEE 11th International Conference on Cloud Computing (CLOUD)* (pp. 178-185). IEEE.

Zissis, D., & Lekkas, D. (2012). Addressing cloud computing security issues. *Future Generation computer systems, 28*(3), 583-592.