

https://dspace.org/

# Case Notes: Factors Influencing the Adoption of Virtual Desktop Infrastructure (VDI) Within the South African Banking Sector

**Sekwakwa, Matthews; Mokwena, Sello**

**2015-12-15**

http://hdl.handle.net/10539/20337

Sekwakwa, M., & Mokwena, S. (2015). Case notes: Factors influencing the adoption of virtual desktop infrastructure (VDI) within the South African banking sector. The African Journal of Information and Communication (AJIC), 15, 123-130. https://doi.org/10.23962/10539/20337

Downloaded from a DSpace repository. https://dspace.org/

# CASE NOTES: FACTORS INFLUENCING THE ADOPTION OF VIRTUAL DESKTOP INFRASTRUCTURE (VDI) WITHIN THE SOUTH AFRICAN BANKING SECTOR

**Matthews Sekwakwa**[1]
*Department of Informatics, Faculty of ICT, Tshwane University of Technology, Pretoria, South Africa*

**Sello Mokwena**
*Department of Informatics, Faculty of ICT, Tshwane University of Technology, Pretoria, South Africa*

ABSTRACT
In the 21st century, portable computers and wide area networks are fast becoming the paradigm for computing presence in commercial and industrial settings. The concept of virtualisation in computing originated in the 1960s. Several virtualisation technologies have emerged over the past decade, with the most notable being VMWare, Citrix and Microsoft VDI solutions, including Azure RemoteApp. This paper explores factors influencing the adoption of VDI in the South African banking sector by implementing Rogers' "perceived characteristics of innovations". The study found that the relative advantage of VDI, as perceived in banking institutions, includes improved data security and staff working experience; reduced time to deploy devices; and reduced computer downtime. The findings on compatibility factors indicate that good VDI compatibility with legacy software and hardware has a direct relationship with users' successful adoption. The findings on complexity of use show that other factors, such as the flexibility that comes with remote access, may be a greater influence on adoption than ease of use. Observability of reduced IT support time and increased productivity of remote access have a positive relationship with adoption.

**KEYWORDS**
virtual desktop infrastructure, VDI, virtualisation, thin client, innovation in banking, perceived characteristics of innovations

## INFORMATION TECHNOLOGY IN BANKING: RESEARCH PROBLEM AND OBJECTIVES

The South African banking sector had total assets of approximately ZAR4.6 trillion in September 2015, of which ZAR3.5 trillion consisted of gross loans and advances, ZAR885 billion consisted of home loan assets, ZAR325 billion consisted of commercial mortgage assets, and ZAR108 billion consisted of credit card assets (SA Reserve Bank, 2015). The banking sector allocates a sizeable portion of its annual capital and operating budgets to information technology purchases and deployments (Wati & Koo, 2009). Accompanying the focus on funding is an increasing drive for improved productivity and better use of new and existing IT assets. Traditionally, personal computers have comprised one of the pillars of computing in the banking sector. The complexity of personal computers (PCs) is one of the reasons for the high cost of IT (Valovic, 2009). Vast financial resources are required to maintain and optimise activities such as software licensing, data security, business continuity and upgrading of computer hardware and general technology infrastructure to meet new organisational requirements, resulting in the ever-increasing costs of managing their life cycle. Furthermore, the PC environment has particular shortcomings, including the challenges associated with asset and configuration management, hardware and software management, installing and patching operating systems and applications, and creating higher levels of data security.

One innovative approach to meeting these new organisational requirements is to make use of virtual desktop infrastructure (VDI) to extend computer life, reduce IT costs, improve security and increase availability of technology (Miller & Pegah, 2007). The improvement in productivity reported by companies that have adopted VDI suggests that the introduction of this technology into the banking sector may result in the attainment of similar benefits (Gartner, 2011), however, evidence is required. Gartner trends research also indicates that virtualisation using thin clients will lower IT capital expenditure, when computing becomes just an operational expenditure, because thin clients are less than half the cost of a traditional PC and have a longer life cycle. This is referred to as a "shift from capital to operating expense" (Gartner, 2011).

This article reports on a 2014-2015 study that explored the factors affecting VDI adoption and its impact in the South African banking sector, in terms of reducing cost, increasing manageability of patching, remote access, improved data security and recovery, better compliance and reduced energy consumption.

## TRANSITIONING FROM PERSONAL COMPUTERS TO VIRTUALISATION OF DESKTOP INFRASTRUCTURE (VDI)

Desktop computers or PCs (including laptop and tablet devices) offer an environment of inadequate options for contemporary computing use, including limited hard drive storage, longer provisioning time, distributed IT support staff, a short refresh cycle, and leave an environmental footprint during and after production (Infosys Technologies, 2011). In a context where the gap between available resources and the demand for IT resources is widening, IT departments are expected to do more with less, and desktop virtualisation has become a viable option for server consolidation and has produced tangible cost savings (Miller & Pegah, 2007). Desktop virtualisation entails a strategy whereby the operating system and applications are moved from the personal computer (thick client) to a server. The computer screen still displays the image of the desktop, but in reality it is just a shell (Löfman, 2011). The client represents the graphical user interface (GUI) and the communication with the server that is hosting the desktop, while the applications and actual processing are done on the server.

1 In each publication, the journal may select one Masters level contribution for inclusion.

### *BENEFITS AND CHALLENGES*

By virtualising the PC (creating a thin client), management costs for desktops decrease, as applications are no longer installed on individual PCs (Beaty, Kochut & Shaikh, 2009). All updates are performed in data centres, hence the management costs decrease while the manageability of desktop infrastructure improves. This centralised updating is called patch management. The IT department is assured that every user has the correct patch and version of the software, as the patches are installed on the server. As no confidential material is stored on the thin client, the security can be increased with ease, and the information/data is safely locked away in the server. This does not protect the company if a malicious user gains access to the thin client and can log into the servers. Thus users remain responsible for not giving away access and authorisation rights. (Löfman, 2011).

As most of the IT support functions are moved to a data centre, on-site labour costs in terms of helpdesk functions and on-site IT support staff decrease, though there is a shared cost to virtualisation. As a result, virtual desktop infrastructure should have lower total cost of ownership (TCO) than a traditional PC infrastructure (Beaty, Kochut & Shaikh, 2009).

Older computers can continue to be used, obviating the need for upgrades, since the performance is solely dependent on their ability to establish a network connection (Löfman, 2011).

VDI also provides excellent business continuity, as "desktops" are available anytime, anywhere. Employees can easily work at a remote location or from home, which provides the kind of flexibility that is important for organisations that operate in increasingly difficult economic conditions. The ability to provide or relocate a desktop through VDI opens up new opportunities for businesses (Sarrel, 2010).

### *TRIGGERS OF VDI ADOPTION IN THE SOUTH AFRICAN BANKING SECTOR*

PC management is becoming increasingly difficult for banks, partly due to the escalating costs of managing the hardware life cycle. In addition, data security and software compliance are of paramount importance in the context of the cyber-security risks pertinent to financial transactions. An increasingly mobile workforce adds another layer of complexity to ensuring that end users can easily connect wherever they are, in addition to ensuring that data stored on the PC is secure when it leaves company premises (TBR, 2008).

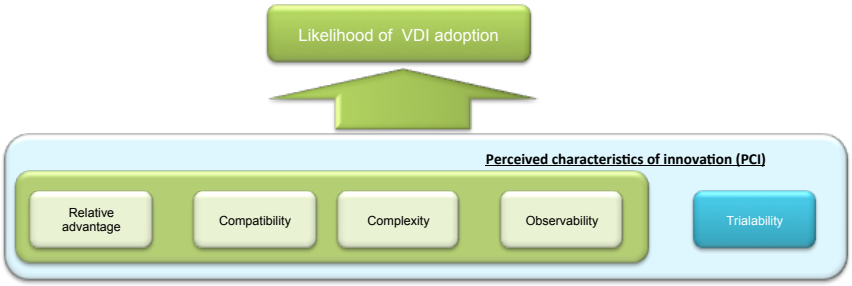
Typically in a desktop environment, IT staff need to access computers, either directly or remotely, in order to fix problems. Software applications regularly require updates and patches in order to protect them from external vulnerabilities. In many cases, these are automated and occur frequently during non-work hours when users' PCs are turned off. Users often disregard instructions and do not install updates or patches, resulting in PCs becoming noncompliant and vulnerable to infection with malicious software (VMware, 2008). Increasingly, users are downloading and installing personal software, thereby adding to the problem of desktop vulnerability.

In summary, an objective of any good business, including those in the banking industry, is to attain the lowest total cost of ownership (TCO). Banks and other firms quantify and measure the various associated costs for the purpose of planning future budgets, and for improving efficiencies and effectiveness in business processes and levels of service (Lam, 2010).

### *RESEARCH FRAMEWORK: PERCEIVED CHARACTERISTICS OF INNOVATION APPLIED TO VDI IN BANKING*

The researcher adopted the perceived characteristics of innovation stated in Rogers' diffusion of innovations theory (Rogers, 2003) to guide the structure of the interview, as well as the observation indicator rating scale. Perceived characteristics of innovation were adopted to explain how and why technology is adopted rapidly. Research relating to customer adoption of innovations, especially in the information technology field, has tended to concentrate on identifying the characteristics of innovators and early adopters (Black, Lockett, Winklhofer, & Ennew, 2001). Although such characteristics of innovators have been identified as significant determinants of consumer's adoption of an innovation, some researchers have argued that the perceived characteristics of the innovation are stronger predictors of the adoption decision than characteristics of the innovators themselves (LaBay & Kinnear, 1981), see research guiding framework in Figure 1 below.

FIGURE 1: VDI RESEARCH FRAMEWORK




Source: Adapted from Rogers, 2003 (Perceived characteristics of innovation)

## RESEARCH QUESTIONS AND METHODOLOGY

The main research question was framed as: What factors influence the adoption of virtual desktop infrastructure (VDI) within the banking sector in South Africa?
The secondary questions were framed as follows with respect to South Africa:

- What relative advantages does adopting VDI have in the banking sector?
- How compatible is VDI with banking legacy systems and applications?
- How easy or complex is it to use VDI in the banks?
- How observable are the benefits of VDI in the banking sector?

The research used a single institutional case study approach, collecting qualitative data through interviews and observation of IT staff who were either using VDI or had experience in the use of VDI, within a single large banking institution in business for many decades. The rationale for using a case study approach was to elicit data on experiences with regard to the adoption of VDI technology. At present, limited academic studies are available that explore factors for VDI adoption and its impact within the banking sector in South Africa. The importance of this exploratory study is its examination of the opportunities for leveraging benefits from replacing the thick client PC with virtual desktop infrastructure. The research results provide initial evidence relevant to banks and banking sector professionals who wish to understand the virtual desktop adoption factors in their industry and who are considering adopting VDI technologies.

The perceived characteristics of innovation by Rogers (2003) were adjusted to formulate specific interview questions for the VDI in banking study. Seventeen broad questions were framed, divided into four categories, which represent the perceived characteristics of VDI adoption, namely relative advantage, compatibility, complexity, and observability. Data was gathered via multiple means, including interviews, observations and a review of the case study bank's reports on incidents and service requests (for 2013 and 2014), as a means of data triangulation, in order to enhance the reliability of the findings. However, general data from the bank report is not permitted to be used for publication.

For interviews, the units of analysis were the bank's IT personnel who use or support VDI. The interviews were focused on eliciting the subjective experience of the respondents who were working with VDI, either as a user or in a project team or in a business-as-usual (BAU) support team, within the IT business units of the case study bank. The seven respondents comprised IT network managers, business analysts, IT technicians and VDI users. The data from interviews is reported here.

The research findings were analysed and responses were categorised based on the codes assigned to the secondary research questions. Feedback from each participant was evaluated and compared with similar responses in the same category for a specific *a priori* theme. Similarities, dissimilarities and new themes emerging from the responses were gauged. The results were viewed holistically, as the aim was to find common factors, or evidence to support the nature of specific inter-relationships (or lack thereof).

The study had a number of limitations. Firstly, only one bank participated in the study, though requests were made to a number of South African registered banks. Secondly, a limited number of interviews (seven) were conducted with IT personnel at this one bank. Hence, this study was effectively an exploratory study. Data from respondents was very basic as interviewees gave the same or similar responses to certain interview questions, even though their job roles were different. A deeper understanding of the subject requires a larger number of participants and participation from multiple banks. Therefore, the results of this study cannot be generalised to the entire population of banks in South Africa. However, it does give some indication of the importance of this area of research.

## DOCUMENT REVIEW AND INTERVIEW FINDINGS: FOUR PERCEIVED CHARACTERISTICS OF VDI ADOPTION

Drawing on the case study bank's incidents and service request reports, the findings were that new non-mobile users (joiners) to the banks were issued with VDIs and very few fault reports were logged for VDI, noticeably mainly where users were requesting password resets.

Findings from interviews and observations are set out below noting key characteristics pertaining to VDI use, reporting user and manager statements, and providing a summary figure. Each graph illustrates one of the four categories of factors influencing VDI adoption, namely relative advantage, compatibility, complexity/ease-of-use and observability.

### *RELATIVE ADVANTAGE OF VDI*

With respect to relative advantage, about 58% of participants agreed that VDI has improved their day-to-day work experience, indicating greater advantage compared with desktops, noting various characteristics, see Figure 2 below. The findings reveal that (i) VDI technology has drastically reduced computer downtime, evident in the following statement:

> I agree in terms of software upgrades, it doesn't have a direct impact on the device. I don't have to stare at the machine while it finishes installing some software; be it antivirus or just a patch.

(ii) VDI is seen to have improved data security as compared with personal computers (70% of respondents agree), explained as follows by two respondents:

> There is better data security as this is a centralised system

> If I lose my personal computer there is no risk of data being lost too as it is stored outside my personal computer, with the use of VDI.

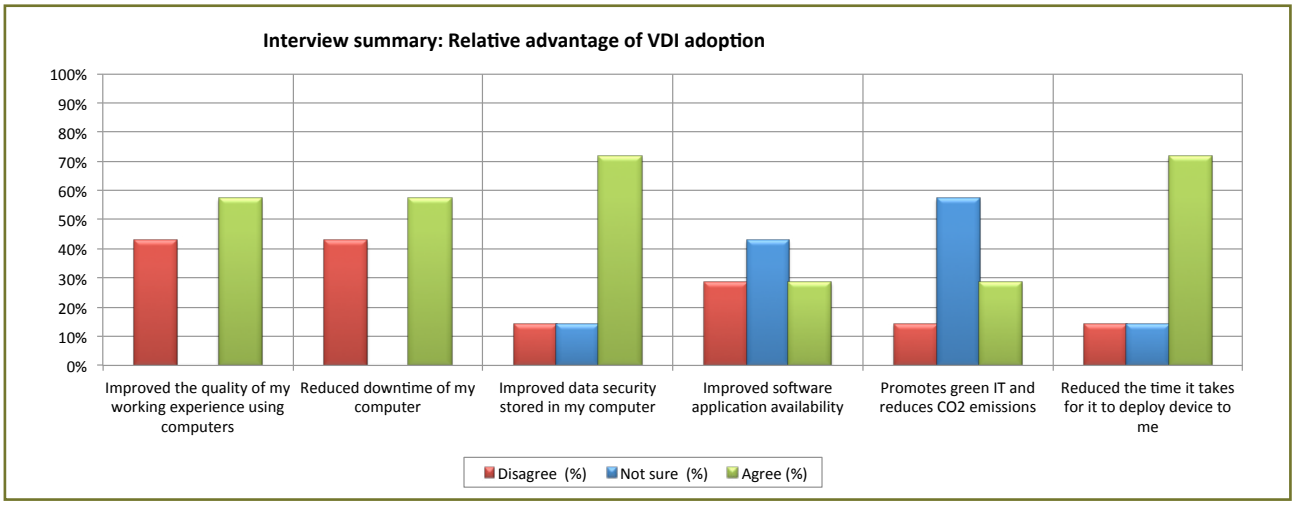
However, (iii) about 42% of respondents were not sure whether VDI has improved application availability:

> I am not sure, I have not noticed any difference compared to my old desktop.

> Availability between the two technologies is the same, in my opinion.

Uncertainties were also noticeable with respect to the question of whether VDI reduces CO2 emissions, as 68% of respondents were not sure about the benefits. Notably, 71% of respondents agreed that it now takes less time for the IT department to deploy VDI devices as compared with desktops or laptops.

FIGURE 2: SUMMARY: PERCEPTIONS OF RELATIVE ADVANTAGE OF VDI ADOPTION




### *COMPATIBILITY OF VDI WITH LEGACY SYSTEMS*

It has been argued that the compatibility of new technology to the individual's job functions will influence the adoption of the new service (Tornatzky & Klein, 1982). In this particular case, users are more likely to adopt VDI if it is compatible with legacy systems and applications used to perform their daily tasks. With respect to VDI compatibility with existing technologies in the banking workplace, 85% of respondents agreed that VDI functions well with the applications used to perform day-to-day functions. About 71% attested to VDI being compatible with legacy software and hardware applications. In addition, 86% of participants said they have good experiences when accessing VDI sessions remotely. This data is illustrated in Figure 4 below.

Respondents indicated that they experience challenges with VDI with respect to some applications:

> VDI is mostly slow with large Visio documents and (the) PtoH legacy application I use … day to day.

> Not sure if it was just IE6 vs. IE7 issue on windows 7 for AOR users, it was a bit of a hiccup, had to downgrade due to incompatibility.

As illustrated in Figure 4 below, 85% of participants agreed that VDI works well with applications which participants need to do their day-to-day work:

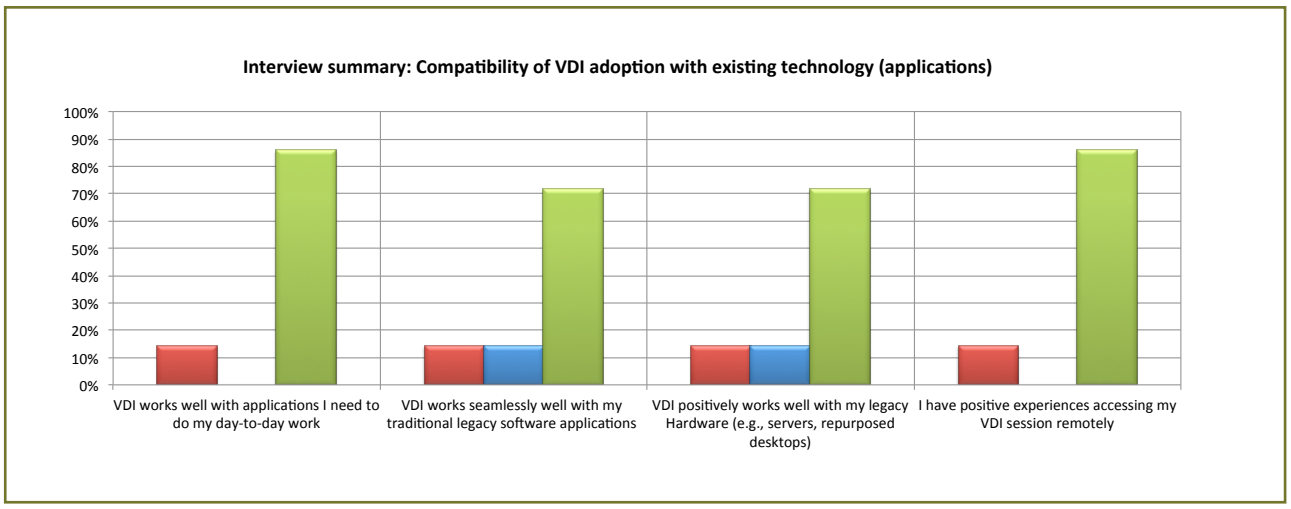
> I use standard applications (MS Office and SAP) so I haven't experienced any problems.

> All my apps were fully functional.

> I mostly use Microsoft apps on day-to-day and I haven't experienced any issues using these apps.

> All the office apps that I rely on were readily available.

FIGURE 3: SUMMARY: COMPATIBILITY OF VDI ADOPTION WITH EXISTING TECHNOLOGY (APPLICATIONS)




***EASE OF USING VDI***

In terms of ease of VDI use (see Figure 6 below), all participants (100%) agreed that it is easy and requires less complex procedures to use than the thick client PC:

> In my experience of using the VDI, it was a pleasant experience in my day-to-day (work).

With regard to the extent to which VDI simplicity would affect respondents' decision to adopt VDI, respondents were of the opinion that there are other factors that they would take into consideration when considering adopting any technology.

> I don't adopt a technology due to only its simplicity, there are other factors as well … portability, battery life.

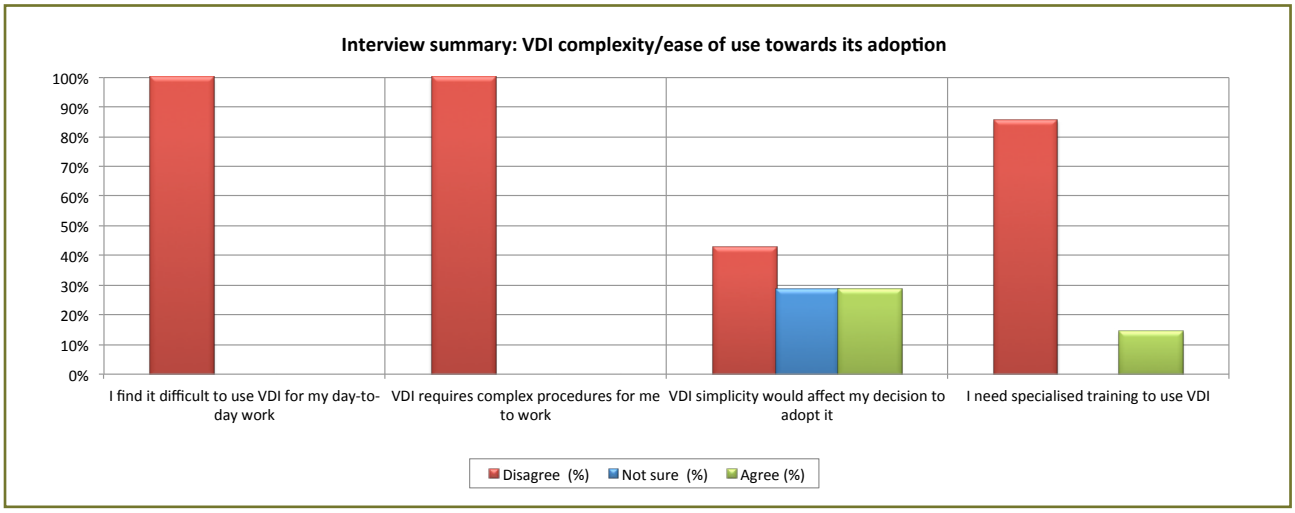
40% of respondents disagreed with the statement that VDI simplicity would affect their decision to adopt, citing reasons that:

> This is (a) perception based question – a lot goes into deciding to adopt any technology. (In this particular instance, remote access was considered more important than simplicity.)

> I would be happier if I no longer have to carry a laptop.

83% agree that staff do not need any form of specialised training to use VDI.

FIGURE 4: SUMMARY: VDI COMPLEXITY OR EASE OF USE




***OBSERVABILITY OF VDI ADVANTAGES***

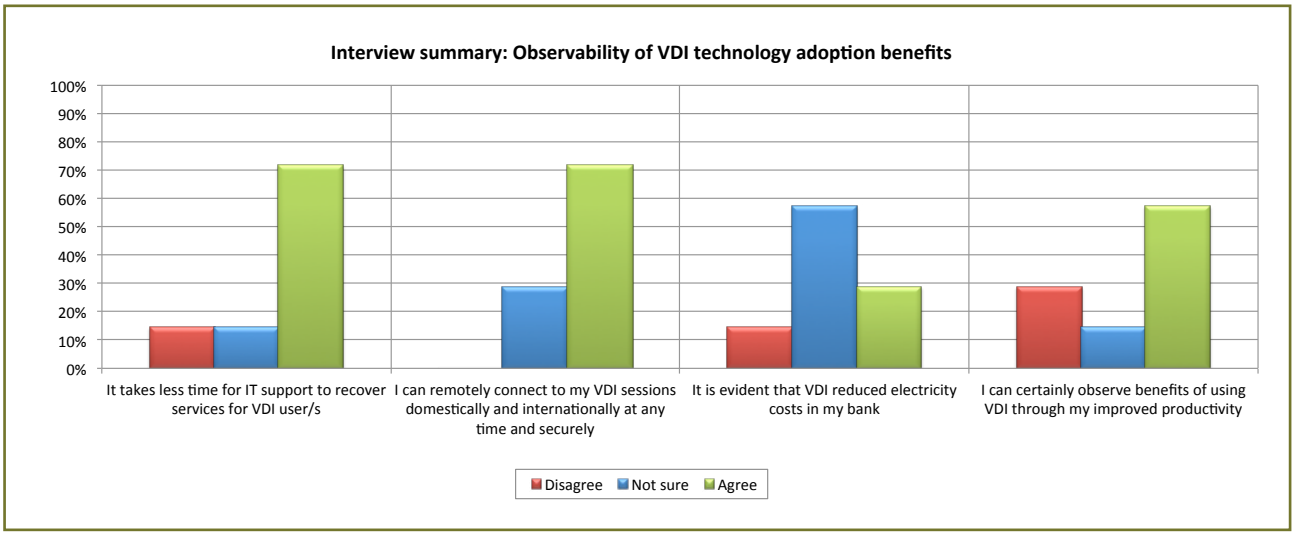
The respondents agreed that VDI benefits are observable. Just more than 70% agreed that it takes less time to recover data compared with working with desktops, mainly due to the fact that data is stored in a remote server farm, which makes it easy for the IT storage team to retrieve, see Figure 8 below. As illustrated in Figure 8, 70% of participants indicated that they can remotely connect to their VDI sessions domestically and internationally at any time and securely. Sample, verbatim responses regarding the observability of VDI benefits are:

> Agree, although speed would likely become an issue when connecting internationally.
>
> Agree, I travel between our regional offices and indeed I can work remotely any day at any time.
>
> Domestically, yes I agree this worked well."

Although 60% of participants are not sure if VDI reduces the cost of electricity use, 58% of respondents say they can certainly observe the benefits of improved productivity through using VDI:

> Agree, the flexibility of being able to work from anywhere definitely has resulted in improved productivity.
>
> On the other hand, respondents maintain that recovery services for VDI users are not more time efficient than desktop support. In both cases, the service level agreement is a minimum of three days.
>
> Agree, normally yes, but this is based on a minimum 3 days SLA for data recovery.

FIGURE 5: SUMMARY: OBSERVABILITY OF VDI TECHNOLOGY ADOPTION BENEFITS



## ANALYSIS OF FINDINGS: KEY THEMES THAT EMERGE FROM THE DATA

In this section, we briefly examine the influence on adoption with respect to the four perceived characteristics, offering four *a priori* themes.

### *A PRIORI THEME (1): RELATIVE ADVANTAGE OF VDI IN INCREASED DATA SECURITY AND REDUCED TIME FOR DEPLOYMENT STRONGLY INFLUENCES ADOPTION*

The study found that, with respect to relative advantage, the characteristics of improved data security and reduced time for deployment of devices scored the highest ratings, followed by the characteristics of staff working experience, reduced computer downtime, and green IT. The software application availability included in the relative advantage construct is the only attribute not supported out of the five innovation attributes used for this construct. Findings show that application availability has a negative relationship with adoption, as respondents did not regard application availability as an advantage gained from VDI.

### *A PRIORI THEME (2): VDI IS COMPATIBLE WITH LEGACY SOFTWARE AND HARDWARE STRONGLY AFFECTING ADOPTION*

The compatibility characteristics that significantly support adoption of VDI in banks includes how well VDI works with day-to-day applications, compatibility with legacy software and hardware and remote use experiences. Such compatibility positively influences adoption. It is important to note that in theory, vendors offer compatibility of their VDI technology with a competitor's server virtualisation technology. For example, it is possible to run a Citrix XenDesktop VDI system on a virtualised data centre powered by VMWare's vSphere virtualisation software (Shad, 2011).

### *A PRIORI THEME (3): VDI EASE OF USE IS A WEAKER INFLUENCE ON ITS ADOPTION*

The research results on complexity or ease of use indicates that users' experience in using VDI and the ease of use of this technology may not be the strongest influence on the adoption and that considerations such as the value gained from remote access are more important to the user or IT manager than ease of use. In other words, users and IT managers will tolerate complexity of use in favour of remote access.

### *A PRIORI THEME (4): VDI REDUCED IT SUPPORT TIME, REMOTE ACCESS AND REDUCED ELECTRICITY COSTS STRONGLY INFLUENCES ADOPTION*

The observability of reduced IT support time, remote access and reduced electricity costs may encourage VDI adoption, particularly among IT and business managers responsible for very large IT budgets and ancillary costs.

### *IMPLICATIONS FOR RESEARCH*

The findings from this study have significant implications for the banking research community. Overall, the results of this exploratory study show that bank VDI technology adoption is influenced by each of the perceived characteristics of innovation in Rogers' (2003) framework. Further research could expand the study to all South African banks, designed from a combined industry and academic perspective, enabling banking institutions to participate in studies that examine a range of innovation characteristics, rather than only examining the medium-term financial and operational benefits.

### *IMPLICATIONS FOR SOUTH AFRICAN BANKS*

The findings from this study have important implications for banks that use VDI or are intending to adopt such technology. The study revealed that the relative advantage of such technology, its compatibility with organisational values, its ease of use and observable benefits were among the most significant factors encouraging VDI adoption. This suggests that it is essential for banks to investigate the benefits of using VDI and to publish milestones or perceived benefits, for example electricity consumption statistics before and after implementation of VDI technology.

## CONCLUSIONS

VDI was perceived to have a relative advantage over thick client PCs in a single large banking institution – this should come as no surprise. What is of interest, however, is the set of factors to be considered with respect to advancing VDI adoption. Banks that continue with or are planning to adopt VDI are likely to benefit from its compatibility with many legacy systems, and staff require no additional computer skills as it consists of the same features as the desktop. While some of the benefits are visible to the organisation, better organisational communication of the benefits of VDI is needed.

## REFERENCES


Beaty, K., Kochut, A., & Shaikh, H. (2009). Desktop to cloud transformation planning. *IEEE International Symposium on Parallel and Distributed Processing*, (pp. 1-8). Rome, Italy:IEEE. Available at http://dx.doi.org/10.1109/IPDPS.2009.5161236

Black, N., Lockett, A., Winklhofer, H., & Ennew, C. (2001). The adoption of Internet financial services: A qualitative study. *Journal of Retail and Distribution Management, 29*, pp. 8390–8398.

Gartner. (2011, February 01). *Cloud computing and emerging economies: A mixed opportunity*. ID Number: G00209391: Author.

IVF. (2005). *Personal computers (desktops and laptops) and computer monitors*. Final Report (Task 1-8). Prepared for European Commission DG TREN: Preparatory studies for eco-design requirements of EuPs. Mölndal, Sweden: IVF Industrial Research and Development Corporation. Retrieved from https://www.energimyndigheten.se/globalassets/energieffektivisering/produkter-med-krav/datorer-och-servrar/eup_lot3_pc_finalreport.pdf

Infosys Technologies. (2011). *Green IT - Business innovation through technology*. Author.

LaBay, D. G., & Kinnear, T. C. (1981). Exploring the consumer decision process in the adoption of solar energy systems. *Journal of Consumer Research, 8*, pp. 271-278.

Lam, M. (2010). *Lower total cost of ownership of ONE-NET by using thin-client desktop deployment and virtualization-based server technology*. Masters thesis. Monterey: California Naval Postgraduate School. Retrieved from http://calhoun.nps.edu/bitstream/handle/10945/5197/10Sep_Lam.pdf?sequence=1

Löfman, J. (2011). *Market uncertainty estimation of desktop cloud*. Masters Thesis. Stockholm: AALTO University. Retrieved from http://lib.tkk.fi/Dipl/2011/urn100545.pdf

Miller, K. & Pegah, M. (2007). Virtualization, virtually at the desktop. *Proceedings of the 35th annual ACM SIGUCCS fall conference*, (pp. 255-260). Retrieved from http://dl.acm.org/citation.cfm?id=1294107

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

SA Reserve Bank. (2015, September). *Selected South African banking sector trends*. Pretoria: South African Reserve Bank. Retrieved from https://www.resbank.co.za/Lists/News%20and%20Publications/Attachments/6651/09%20September%202015.pdf

Sarrel, M. (2010, 28 September). *Managing the virtual image lifecycle*. eWeek. Retrieved from http://www.eweek.com/c/a/Virtualization/Managing-the-Virtual-Image-Life-Cycle-569827

Shad, B. (2011). *Implementing a virtual desktop infrastructure at the District of North Vancouve*r. Masters thesis. Vancouver: Simon Fraser University. Retrieved from http://summit.sfu.ca/item/13008

TBR. (2008). White Paper: Lenovo ThinkVantage tools generate hard dollar savings through every stage of the PC lifecycle, Executive Summary. Hampton, N.H.: Technology Business Research, Inc. (TBR), ThinkVantage Technologies. Retrieved from http://www.lenovo.com/us/en/PDFs/lenovo_tbr_tvt_white_paper.pdf

Tornatzky, L., & Klein, K. (1982). Innovation characteristics and innovation adoption implementation: A meta-analysis of findings. *IEEE Transactions on Engineering Management, 29*(1), pp. 28-45.

Valovic, T. (2009, 1 January). *The disappearing desktop: How VDI is changing the game*. Retrieved from http://virtualizationreview.com/articles/2009/01/01/the-disappearing-desktop-how-vdi-is-changing-the-game.aspx

VMware. (2008, November). White Paper: Comprehensive virtual desktop deployment with VMware and NetApp. Califonia, USA: Author. Retrieved from http://www.vmware.com/files/pdf/partners/netapp-vmware-view-wp.pdf

Wati, Y., & Koo, C. (2009). A comparative study of Internet banking satisfaction model in South Korea and Indonesia. *Asia Pacific Journal of Information Systems, 19*(4), pp. 1-11. Retrieved from http://apjis.or.kr/pdf/MIS019-004-1.pdf