Virtualization: disaster recovery for the hospitality industry?

Manognya Murukutla, University of Nevada, Las Vegas

Introduction and Purpose

As organizations in the hospitality industry become more complex and increasingly reliant upon various technologies to function effectively, they become increasingly exposed to natural, technological or security disaster. Therefore, it is imperative that they are able to recover from the sudden loss of computing and communications resources (Hempell & Wendland, 1999). The Association for Contingency Planning (ACP) (2000) draws attention to the point that the risk of data unavailability and loss does not only impact monetary aspect of a firm, but also affects customer confidence, liability, and current and future business. Companies are most exposed to the loss of their IT capability (90%) followed by fires (70%) and loss of sites (67%) (Pendrous, 2006).

Hospitality organizations remain cautious when allotting money to IT initiatives. Business continuity and disaster recovery are not considered urgent or important enough, and have to compete with other urgent projects for a part of the IT budget (Snedaker, 2007), since implementing disaster recovery usually comes with a large cost, which more companies are not able to or willing to spend (Vanover, 2009). Due to budget constraints, these companies need systems that would mitigate the effects of an IT disaster, but at a modest cost (Adeshiyan et. al., 2009). Companies wanting to cut costs or maximize efficiency, or both, might wish to consider virtualization as a method of disaster recovery. However, the issue is that it may not be applicable to every industry. The objective of this study is to evaluate virtualization as a method of disaster recovery and it's applicability to the hospitality industry by calculating the Return on Investment (ROI) and the Total Cost of Operation (TCO) to determine if virtualization is a worthy investment for firms with varying numbers of servers.

Literature Review

In virtualization, several "virtual" servers are installed on a single computer. Virtualization as a form of disaster recovery involves the duplication of the virtual server infrastructure and data at remote facilities for recovery. This allows the data to be accessible even if the primary site is not. For example, if the location where the IT functions are stored is destroyed, the data is still protected, retrievable and accessible. Because server workloads packaged as virtual machines are easier to transport and restart on remote systems, virtualization simplifies disaster recovery in many ways (Citrix Systems, Inc., 2009).

Virtualization for Disaster Recovery. Studies have shown that over three-quarters of companies with over 500 employees are using virtual servers, with over half of them running production-level, mission-critical applications and that by the end of 2010, 1.7 million physical servers (14.6 % of those shipped) would be hosting 7.9 million virtual machines. Studies have also found that in 2007, 88% of U.S. companies with revenues in excess of $250 million currently invest in virtualization (64% worldwide). Companies have also begun using the technology for disaster recovery by hosting their virtualized data centre on a few offsite physical machines instead of recreating the entire hardware environment (Greiner, 2009).

The evolution of technology has seen disaster recovery develop over the years. The increasing popularity of virtualization is causing 64% of organizations to re-evaluate their disaster recovery plans, a significant increase from 55% in 2008. In addition, companies only back up 36% of their data in virtual environments. Nonetheless, virtualization still has a long way to go (Symantec, 2009). A virtualized data centre is ideal for business continuity as it allows operations to be running round the clock (Geisa, 2006; Schultz, 2009). Virtualization

also reduces long term hardware, software, maintenance, and operation costs (Geisa, 2006; Sellers, 2009).

On the hospitality front, virtualization is still a new technology. While other industries have embraced this technology with full force, and have seen it successful, the hospitality industry has still not embraced it. The Mandarin Oriental Hotel Group and the Intercontinental Hotel Group both praise virtualization. However, have yet to explore virtualization as a method of disaster recovery (Hotel Business, 2010). Marriott International, on the other hand, has revised its disaster recovery plan to include virtualization technology in 2009 (Silwa, 2008).

Nonetheless, Dorion (2010) predicts that virtualization as a method of disaster recovery will pick up in 2010. Virtualization vendors are making an effort to take virtualization to a new level by leveraging it with cloud computing as the driving force. And throughout the next year, it is expected that more IT organizations will be leveraging this maturing technology to further automate their disaster recovery capabilities (Dorion, 2010).

Benefits of Virtualization. Certain disaster recovery solutions are based on replication and failover, and often require a one-to-one pairing of production systems with disaster recovery systems, and result in interoperability issues with some server-based applications and the complexity of managing such a configuration. Therefore, these solutions are often not recommended or not possible to fail over multiple physical workloads to a single operating system instance running on standard server hardware. This results in organizations having to either purchase enough hardware for the disaster recovery site to handle production capacity, which can be very expensive and take up a lot of space, or choose not to protect certain systems, which can be very risky (Vanover, 2009; VMware, 2007).

Since virtualization gives companies flexibility with time, money and space (Matthew, 2008; VMware, 2007), many companies are currently evaluating the cost of having the work outsourced, and the expense of doing the work internally, which gives the firm flexibility to manage and test their disaster recovery processes instead of having to conform to the rigid time-frames of external parties, and addresses the increasing need for quicker response and recovery times. Marriott International, however, chose to manage its disaster recovery processes internally after evaluating the external and internal process from both an economic and an environmental standpoint. The company calculated that the 10-year cost of co-locating a new data centre at an underground facility would be cost neutral compared to its existing agreement for disaster recovery, and the opportunity to improve energy efficiency would bring significant savings, in addition to helping the company to achieve its environmental goals (Silwa, 2008).

Existing literature has shown that the primary appeal of virtual data centres is cost reduction. Therefore, due to the current economic climate, virtualization is being heavily promoted and, in some cases, initiatives to accelerate its implementation are in place. Server and Storage Virtualization have seen the following benefits (Barr, 2009; Marks, 2009; Matthew, 2008; Silwa, 2008; VMWare, 2007): reduction of equipment costs, reduction of software license fees, reduction of utility bills, freeing floor space, achieving a "greener" IT environment, leading to positive publicity and better, image for the company (Corporate Social Responsibility), providing a less expensive, and more reliable, disaster recovery capability, and reduction of the number of IT staff.

From an architecture standpoint the benefits of virtualization are plenty. Since less hardware and less expensive hardware is being used to do the same work, the better use of infrastructure results in operational efficiency, with 99.999% availability, and simplified management. The resulting performance can go up to 5 times the original performance for a

third of the cost when a mid-range system is compared to a server farm that cost about $3,000 a piece (Geisa, 2006).

If 10 of those low cost servers are placed in a virtualized resource pool, the result is 5 to 10 times the power of the most powerful mid-range system at a third of the cost. By virtualizing servers, companies not only save an incredible amount of money, but also have a much better architecture for availability and ongoing maintenance. In the event that one server needs to be brought down, it doesn't impact the others, and the IT department can add in and take out systems as needed to support the company's underlying architecture (Geisa, 2006). In addition, if an application crashes, it affects only one virtual machine and not the entire server (Marks, 2010).

As a method of disaster recovery, virtualization is cheaper and more cost effective than other methods of disaster recovery, which usually demand a huge upfront cost. In addition, since virtualization reduces storage by up to 40%, in comparison to other methods of disaster recovery, which at least double storage, virtualization also sees a reduction in storage costs. Virtualization takes care of data storage and data protection issues at the same time. As such, instead of spending a separate amount of data storage, and disaster recovery, with virtualization, both functions are achieved at a lower cost. Furthermore, as a method of disaster recovery, virtualization is easier to manage and more flexible as well (Vanover; Mello,Jr., 2009). Finally, the use of virtualization results in 85% improvement in recovery time from unplanned downtime. This makes it ideal for disaster recovery over other methods VMware, 2009).

Disadvantages of Virtualization. Gartner, a research firm, stated that the "overall virtualization market is expected to reach a healthy $1.7 billion by the end of the year". This is probably due to companies looking for ways to save costs, and protect data in a time where economic instability and security risks are high. However, even the best of technology can be expected to run into some difficulties. Many of the organizations that have installed virtualization have begun to encounter unforeseen challenges that are holding up further adoption across the infrastructure and, in some cases, even keeping current projects from delivering the value initially expected. According to a survey of 120 IT decision makers conducted by Network Instruments at Interop this year, 55 % reported experiencing more problems than benefits from virtualization. Some of the issues stated were higher than expected implementation costs. Of those surveyed, 4-7 % said implementation costs were too high, 59 % reported that they faced virtualization management issue because their organizations lacked the experience to appropriately manage the technology, and 27 % said the lack of visibility and tools to manage virtualization was their biggest troubleshooting challenge in virtual environments(Chikowski; Dubie, 2009).

While every method of disaster recovery faces implementation costs and management issues, virtualization faces a set of issues that are exclusive to virtualization itself, such as extra security issues. Due to the chance of an attack through a compromised virtual machine, the underlying operating system's security requires extra attention, and caution in permissions and access it grants to the hosted virtual machines. Through accessing one virtual machine, hackers are easily able gain access to the entire network (Marks, 2009; Matthew, 2008; Tiller, 2006). Furthermore, overloading the server with too many applications results in downtime as well (Gittlen, 2010).

In addition to software issues and security loopholes, hardware failure also poses a likely threat to a virtual environment. In the event that the physical machine failed, all the virtual machines and servers hosted by that machine would be affected. In comparison, in a non-virtual environment, the failure of one server would not result in a failure or disruption in the functioning of the other servers. Additionally, when dealing with virtual machines, it is critical that proper operation procedures are established, system details are documented,

correct permissions are set, recovery plans are in place and patching is up-to-date. The failure to do so will result in many problems, increasing costs and downtime (Marks 2009; Matthew, 2008).

Virtualization is not applicable for everybody (GSS America; Marks, 2009). The point of virtualization is to maximize potential capacity. However, in attempting to do so, many companies overload the server, resulting in downtime, IT failure and increased costs. One the other hand, running several servers at partial capacity might work out to be cheaper (Gittlen, 2010; Marks, 2009;). Most companies have fewer than six servers in their companies and are not running high-growth, high-storage-type applications and as such, would not realise the benefits of virtualization (Marks, 2009).As utilization increases, the cost of managing servers may stay the same or increase as organizations implement technologies they are unfamiliar with (Chickowski, 2009). Implementing virtualization with false expectations is also a cause of management failure and increased costs, as well as project failure (Gittlen, 2010).

Furthermore, it is absolutely necessary to engage in capacity planning and testing phases as this helps to determine the appropriate physical-to-virtual server ratio for the company's environment. However, most organizations fail to do this. Applications with higher utilization rates, greater security risks, and increased performance and availability demands compete for bandwidth, memory, CPU and storage resulting in a server overload, which results in system crashes, which in turn, increases downtime. Even on machines with two quad-core processors, there is a chance for network bottlenecks and performance hits as all the applications fight a common pool of resources. If the physical-to-virtual ratios are overestimated, the result is a need for more server hardware, rack space, cooling capacity and power consumption all of which cost money (Gittlen, 2010).

How Much Does Virtualization Really Cost? Depending on the requirements of the company, the software and hardware and server location, the price of a virtual server varies. The total price factors in the licensing fees, the cost of management infrastructure, the total cost of servers, network and storage, data centre space, power and cooling and cost per application. Taneja Group Technology Analysts found that the price for 51 – 53 virtual machines could be between $143,994 and $174, 413, depending on the supplier (The Taneja Group Technology, Inc., 2009). For a small business with 50 users and 20 virtual machines, and 3 year support, virtualization could cost from $2,639.75 to $199, 645 (Citrix, 2009; Microsoft; VMWare 2010;).

Virtualization is not a one size fits all approach to disaster recovery. Depending on the size of the organization, initial purchase may be very expensive. However, IT professionals should consider that they are adding services and functionality, and these should be compared to the initial costs of providing the same upgrades in the current environment. Money will also be saved as less will be spent on physical servers. If the additions and benefits of the project are understood, long-term savings and potential short-term savings will be quite evident (Worthington, 2009). In addition, virtualization is an effective method of disaster recovery, if managed carefully, and a company's data storage and data security costs can be merged, thus increasing potential savings as well as increasing efficiency and ease of management.

Nonetheless, industry requirements, and the company's size and needs have to be considered when making the decision to implement virtualization as a method of disaster recovery. While disaster recovery is critical to companies in the Hospitality Industry, whether virtualization would be a suitable method of disaster recovery is yet to be explored. This study will examine the suitability of virtualization as a method of disaster recovery in the Hospitality Industry.

Methodology

Total Cost of Ownership (TCO) is a methodology for analyzing IT or other enterprise costs. It is the total cost of packaging, maintaining, delivering, and supporting the enterprise applications over a defined period of time. TCO/ROI analysis gives the customers an estimate of quantifiable business benefits that can be expected from an investment (VMware, 2009). In this section, the Return on Investment (ROI) and the Total Cost of Operation (TCO) will be calculated using the Alinean TCO/ROI Calculator and analyzed to determine if virtualization is a worthy investment for firms with varying numbers of servers. The Alinean TCO/ROI calculator is used by IT executives to present a business case to the senior decision makers in their companies. Deciding to invest in a technology is a difficult and very involved process. In addition, companies are very guarded about their internal affairs, and there is no way to get any insight into how investing in certain technologies might help to improve a company's current standing. Without any comparison, or evidence of how a certain technology might be beneficial, managers are unwilling to allocate budgets to a purchase. Since there is no way to determine the outcomes, managers are often unsure if investing in technology is worth their budgets. As such, the Alinean TCO/ROI Calculator is used to forecast benefits and savings, so that IT personnel can get an idea of the investment might affect them. The calculator uses industry data to provide a neutral, objective perspective to aid in decision-making.

The metrics are tuned for the hospitality industry, location and size to best represent average metrics, and include typical costs for servers, desktops, networking, storage, salaries, power, Datacentre space and services. Pricing information is provided by VMware (VMware, 2009). The generalized data was then compared to more specific data collected from five properties of different sizes in terms of number of rooms and revenue. Through personal communication with the IT managers of the properties, a profile of, and their concerns regarding, their IT environment has been gathered to see if virtualization would be a suitable method for the hotel. The discussions were conducted keeping in mind the conclusions of the literature review, that virtualization is not a one-size-fits-all method, and that the size of a firm is a determinant in the applicability of virtualization.

The scope of this analysis revolves around data centre virtualization and management. The total cost of ownership is calculated based on the number of servers to be virtualized, between five and 20. Eric Lingren, International Accounts Manager of FatPipe Networks, stated (2010, personal communication) that while there are companies which do not host any servers, there is no way they can store information internally. If a company is hosting its own email, it will need an exchange server, if it is hosting a database (and most companies have at least two), it will need an SQL server, and if it is hosting multiple facilities(like order taking), it will need a specialized server, etc. Most hotels would have at least five servers, as they engage in all of the above mentioned functions.

There are no known limitations with the tool in terms of data and applicability. It is designed to provide a TCO analysis comparing a company's current environment to a virtualized VMware environment. By answering a few questions related to the existing environment, assumptions are made to determine current costs and projected savings with virtualization.

Results

The data collected through the use of the TCO/ROI calculator has been tabulated:

Table 1
Business Continuity with Virtualization – Savings and Investments

	5 Servers	10 Servers	15 Servers	20 Servers
Total DR infrastructure and management savings	47,974	144,994	249,629	317,074
Total risk reduction savings	2,160	12,000	22,500	36,480

Total investment	40,884	46,248	46,248	68,093

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. In $.

From the calculations, it can be seen that virtualization does present many savings (see Table 1). Due to "combining" several servers into one machine, the hardware required for virtualization is heavily reduced. In addition, since software comes with a specific code, and because of copyright issues, it is impossible to use one for all the machines. With virtualization however, one program software applies to all the virtual machines. Therefore, it reduces infrastructure costs and investment costs (see Table 1). "Risk" refers to the project losses, should the technology fail. With virtualization, risk is reduced, as server downtime is largely minimized due to concurrent accessibility from another location. In addition, data loss is minimized as well, as the stored and incoming data is easily retrievable even if the servers at the main location are down. The management of the technology is also less complex. Once the codes are set and the technology is customized to the company's needs, any changes thereafter are easily executable. Only one machine is being updated or altered, and as such, only one set of the required software are needed.

Table 2

Business Continuity with Virtualization – ROI and IRR

	5 Servers	10 Servers	15 Servers	20 Servers
Overall ROI	23	240	488	419
Internal Rate of Return (IRR)	11	98	180	178

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. In %.

Table 3

Business Continuity with Virtualization – Projected Payback Period

Servers	5	10	15	20
Time	44	12	7	7

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. In months.

While the IRR and ROI (see Table 2) increase with a higher number of servers, and the projected payback period (see Table 3) decreases with a higher number of servers, the benefits of virtualization are visible from five servers itself, with a 23% Return on Investment and 11% Internal Rate of Return when virtualization is applied to five servers. Since the returns cannot be calculated in terms of revenue generated, the calculator uses savings generated instead. The calculator does a general comparison of the expenditures of each method of disaster recovery to arrive at the savings achieved through virtualization. However, it appears that virtualization is optimal for companies with at least ten servers, as can be inferred from the tables above. The total investment in virtualization appears to be directly proportional to the total Disaster Recovery infrastructure and management savings and total risk reduction savings (see Table 1) as well as ROI and IRR (see Table 2), hence, companies benefit in the long run, despite the initial investment.

Table 4

How Virtualization Achieves These Benefits – Servers

Servers for DR Before Virtualization	5	10	15	20
Servers for DR After Virtualization	1	1	1	2

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean.

Each machine has the ability to function optimally while hosting up to 15 servers, far more than what it is being used for in many organizations today. This increase in machine efficiency through the integration of several machines into one reduces the need for numerous physical servers for every function. Virtualization results in a drastic reduction of physical servers (see Table 4).

Table 5

How Virtualization Achieves These Benefits – Labour Costs and Recovery Time

	5 Servers	10 Servers	15 Servers	20 Servers
Reduce in labour costs	42.50	68.70	78.80	76.40
Reduction in recovery time	72	76.90	73.50	72.40

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. In %.

With fewer servers to manage, and with an increased ease of management, fewer employees need to be maintaining the servers. This helps to mitigate unnecessary labour costs, and employees can be relocated to more critical areas of operation. Since data can be retrieved in minimal time, from any location, reduction time is greatly reduced as compared to the current method of disaster recovery used by many hotels, which is, storing data in tapes in an off site location.

Table 6. *How Virtualization Achieves These Benefits – IT Productivity*

Improve annual IT productivity equivalent to hiring N additional Resources			
Servers	5	10	15	20
Productivity	0.18	0.4	0.6	0.7

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. Units in FTEs.

Since the number of servers are reduced, fewer have to be maintained and monitored, and any updates or changes that have to be made are made on just one server to be applicable to all the virtual servers. Therefore, employee attention is not divided, and this leads to increase in productivity.

Table 7

How Virtualization Achieves These Benefits – Energy Consumption

Reduce annual energy consumption			
Servers	5	10	15	20
Reduction of energy consumption	2.7	6.8	10.8	13.5

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. Units in kWatts.

A reduction in servers leads to lesser energy consumption. It also leads to lesser energy being used to cool the servers. As such, virtualization leads to reduced energy consumption, and therefore, reduced energy costs.

Table 8

How Virtualization Achieves These Benefits – Carbon Emissions

Reduce annual carbon emissions			
Servers	5	10	15	20
Reduction of emissions	11	27	42	54

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. Units in tons.

A reduction is servers leads to lesser carbon emissions. As such, virtualization is a greener technology.

Table 9

How Virtualization Achieves These Benefits – Data Centre Space Savings

Data centre space savings				
Servers	5	10	15	20
Space savings	1.4	1.4	3.5	3.5

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. Units in sqmetres.

Fewer servers take up lesser space. Therefore, data centers can be small. This reduces costs as lesser storage space s required.

Table 10

How Virtualization Achieves These Benefits – Labour Productivity

Improve provisioning and update labour productivity saving				
Servers	5	10	15	20
Productivity savings	3.6	3.6	30	30

Note. Results over five years as calculated by the VMware TCO/ROI Calculator powered by Alinean. Units in person hours/yr.

Reduction of the number of servers reduces the capital costs for DR infrastructure and operation costs, labour costs for DR site server management, annual energy consumption and data centre space costs (See Tables 5 – 10). Furthermore, due to the fact that there are lesser servers to manage, labour productivity increases. Additionally, IT productivity increases because each server that is in use is being utilized to its maximum potential. When comparing five to 15 servers, the benefits are clearly visible.

Though the organizations were willing to discuss their progress in IT disaster recovery, they requested confidentiality. With due respect to the organizations' request for anonymity, none are identified within the study. The information gathered has been tabulated:

Company IT Infrastructure

	Property A	Property B	Property C	Property D	Property E
Type of Property	Serviced apartments	Independent hotel	Multinational hotel brand	Multinational hotel brand	Boutique Hotel
Turnover (S$)	>10mil	>10mil	Undisclosed	1 mil – 10 mil	Undisclosed
No. Of Rooms	900	511	393	319	80
No. Of Servers	>20	15-20	15-20	10-15	0

Note. Information gathered through personal communication with the IT managers and General Managers of 5 properties in Singapore.

All properties, except for Property E, have more than 15 servers, which is above the optimal point for virtualization. The General Manager of Property E stated that boutique hotels do not have any servers or even IT disaster recovery plans because most of their IT functions are outsourced. From this data, it can be inferred that all of the respondents represent small to large sizes in terms of turnover and number of rooms, within the Singaporean context.

The literature review and the information gathered through personal communication were consistent in that IT personnel consider costs as one of the key decision criteria. Based on the study we can see that the benefits of virtualization accrue to all properties which in which IT functions are not outsourced. The TCO/ROI analysis is key to presenting the business case to upper management and justifying the acquisition of virtualization as an appropriate solution. It will help to develop a successful strategic, value-based business case to:

a) increase the sense of urgency and convince the decision-makers that investment is a priority.

b) Show a long-lasting, predictable, and positive business impact.

Conclusion and implications

Despite the belief that virtualization may not be a feasible, economical or practical approach to disaster recovery for all companies, due to size being a major consideration, the results gathered through personal communication and calculation of the ROI/TCO show that the size of an organization is irrelevant. Except where IT is outsourced, there is a business case for virtualization. The key factor in determining if virtualization is appropriate is the number of servers. The number of servers hosted by a company is not dependent on the size of the company, but rather, the number of applications the company needs to function. Since the minimum number of applications a regular business needs to operate is five, and virtualization is a better option than other methods of disaster recovery in terms or cost, efficiency, productivity and ease of management, as well as sustainability and increased speed of recovery, it makes sense for companies in the hospitality industry to invest in virtualization as a method of disaster recovery.

The TCO/ROI calculator supports the literature review in stating that virtualization is beneficial to a company in the hospitality industry and shows that virtualization is in fact cost effective due to cheaper technology and a promotion savings through more efficient use of energy, storage space, labor required to operate the machinery, increased employee productivity, and a reduction of the licence fees for the equipment. Virtualization also has positive managerial implications. Reduction in the number of servers makes maintenance and management easier. This increases productivity and the staff can focus on other areas that may be more critical. Furthermore, since the staff is also greatly reduced, the supervision required by the management is reduced also, resulting in increased productivity and efficiency.

Limitation and Recommendations

All the properties evaluated, except Property E, were suitable for the implementation of virtualization. Further research on hotels that fall into the same category as Property E must be conducted before providing conclusive recommendations for its disaster recovery purposes. It is recommended that cloud computing (a technology used to access services offered on the Internet) be explored, specifically for accommodation that falls into the categories of motels, hostels, boutique hotels and bed and breakfasts, which are beyond the scope of this paper, and for companies that do not have servers and applications at all to store their data.

References

(2007). Internet Bookings Taking Over, Say Gulliver Ireland. *Hospitality Ireland*, (39), 9. Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=hjh&AN=27696729&site=ehost-live

(2010, March 2). Htng shows hotel companies way to future is in the 'clouds.'. Retrieved from http://www.hotelbusiness.com/hb/links/news/news.asp?ID=37730

Abel, R. (n.d.). *It Disaster recovery glossary of terms*. Retrieved from http://www.continuitycentral.com/DRGlossaryofTerms.pdf

Adams, B. (2004). Hotel companies' pushing of brand sites leads to meteoric growth in bookings. *Hotel & Motel Management*, *219*(17), 1-51. Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=hjh&AN=14636729&site=ehost-live

Adeshiyan, T., Attanasio, T.R., Farr, E.M., Harper, R.E., Pelleg, D., Schulz, C., Spainhower, L.F., Ta-Shma, P., Tomek, L.A. (2009). Using Virtualization for high availability and disaster recovery. *IBM Journal of Research and Development*, *53*(4), Retrieved from http://www.research.ibm.com/journal/rdimg.html

ACP. (2000, October). Downtime costs by industry. Retrieved from http://www.acp-wa-state.org/resourcedoc/Downtime_Costs.pdf

Berenfeld, M. (n.d.). Disaster preparedness: how to develop a business continuity plan (case study).Retrieved from EMC Databases

Bharadwaj, A., Keil, M., Mähring, M. (2009). Effects of information technology failures on the market value of firms. *Journal of Strategic Information Systems, 18(2),* Retrieved from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VG3-4WBB6WR-1&_user=10&_coverDate=06%2F30%2F2009&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1265954650&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=3d159300c82fd3f678048de636cb87ba

Bolton, D. (2010). *Definition of virtualization*. Retrieved from http://cplus.about.com/od/glossar1/g/virtualization.htm

Bort, J. (2004, August 24). Do-it-yourself disaster recovery. *Network World*, 21(34), Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=14225807&site=bsi-live

Caserotti, L., Coutinho, N., Cagle, S., Foltyniewizc, R., Engel, P., Sachdeva, G., Qureshi, B., Parkel, B., et. al. (2001, September 7). Business continuity and disaster recovery: reference guide (white paper). Retrieved from EMC Databases

Cisco Systems, Inc. (2004). EMC and Cisco: building disaster recovery and business continuance solutions (white paper). Retrieved from EMC Databases

Citrix. (2009, June). Technical and commercial comparison of citrix xenserver and vmware (white paper). Retrieved from http://www.citrix.com/site/resources/dynamic/salesdocs/XS_vs_VMware_comparison.pdf

Chathoth, P.K. (2006). The Impact of information technology on hotel operations, service management and transaction costs: a conceptual framework for full-service hotel firms. *International Journal of Hospitality Management*, 26(2), Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=hjh&AN=24087911&site=ehost-live doi: 10.1016/j.ijhm.2006.03.004

Chickowski, E. (2009, September). Evolution of virtualization. *Baseline*, (29), Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=44104087&site=bsi-live

Dorion, P. (2010, January 10). IT disaster recovery strategies: dr planning trends for 2010. Retrieved from http://searchdisasterrecovery.techtarget.com/news/article/0,289142,sid190_gci1378070,00.html

Dubie, D. (2009, May 20). Virtualization cost savings hard to come by, interop survey finds. Retrieved from http://www.infoworld.com/d/virtualization/virtualization-cost-savings-hard-come-interop-survey-finds-196?r=461

Finance New Mexico. (2010). *Glossary*. Retrieved from http://www.financenewmexico.org/glossary.html

Geisa, E. (2006). Data centre virtualization q&a. Retrieved from
    http://www.f5.com/pdf/white-papers/dc-virtualization-wp.pdf

Gittlen, S. (2010, February 8). Virtualization: beware of server overload. *Computerworld*,
    44(3), Retrieved from
    http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?dire
    ct=true&db=buh&AN=48169800&site=bsi-live

Greiner, L. (2009, August). *Virtual computing overview (white paper).* Retrieved from
    http://www.faulkner.com.ezproxy.library.unlv.edu/products/faulknerlibrary

GSS America. (2009, November 13). Is Virtualization for everybody?. Retrieved from
    http://www.gssamericainfo.com/is-virtualization-for-everybody/

Hardin, T. (2008). In Case of Disaster, Your E-Mail Will Survive. *Meeting News*, *32*(13), 15.
    Retrieved from
    http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?dire
    ct=true&db=hjh&AN=33869185&site=ehost-live

Hempell, C.e., Wendland, N.R. (1999). *Disaster recovery in hospitality... the risks in
    computerization and information management*. Retrieved from http://www.hotel-
    online.com/Trends/Andersen/1999_DisasterRecovery.html

Law, & Lau, R. (2000). The computer millennium bug's impact on the hotel industry: a case
    study of the Kowloon Hotel. *International Journal of Contemporary Hospitality
    Management*, *12*(3), 170. Retrieved from
    http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?dire
    ct=true&db=hjh&AN=4728470&site=ehost-live

Lorden, A.A., & Volpe, C. (2009, October 10). Industry outlook 2010: hotel & restaurant
    trends for the year ahead. *Hospitality Technology Magazine*, Retrieved from
    http://www.htmagazine.com/ME2/Sites/dirmod.asp?sid=&nm=&type=MultiPublishin
    g&mod=PublishingTitles&mid=3E19674330734FF1BBDA3D67B50C82F1&tier=4
    &id=F6DE6C6B712244E7AE7E705A02A3F966&SiteID=AAED287C668148CCB1
    0E4FBA73326A07

Marks, G. (2009, October 30). Dell exec: straight talk on virtualization. *BusinessWeek
    Online*, Retrieved from
    http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?dire
    ct=true&db=buh&AN=44944555&site=bsi-live doi: 44944555

MasterBase. (2009). *Glossary*. Retrieved from
    http://www.en.masterbase.com/support/glossary.asp

Mello,Jr., J.P. (2009, August 3). Virtualization makes disaster recovery cheaper. Retrieved
    from
    http://www.enterprisestorageforum.com/continuity/features/article.php/11570_38329
    71_2/Virtualization-Makes-Disaster-Recovery-Cheaper.htm

Microsoft. (2010, March 24). Microsoft license advisor :: product configuration. Retrieved
    from http://www.microsoft.com/licensing/MLA/product.aspx

Nicholette, C., & Schmidt, J. (2001, April). Business continuity planning framework and
    description (white paper). Retrieved from EMC Databases

Nysveen, H., & Lexhagen, M. (2001). Effects of the Internet as a Channel for Bookings. A
    Study Among Swedish Hotels. *Information & Communication Technologies in
    Tourism 2001: Proceedings of the International Conference in Montreal, Canada,
    2001*, 335-345. Retrieved from
    http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?dire
    ct=true&db=hjh&AN=18827368&site=ehost-live

Pendrous, R. (2006, January). It failures continue to pose the biggest risk for firms. *Food
    Manufacture*, *81*(1), Retrieved from

http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=19872049&site=bsi-live

Rice, D. (n.d.). Broadband and the hospitality industry. Retrieved from http://10yearsofbroadband.com/public/images/pdf/Douglas%20Rice%20Hotel%20Technology%20Next%20Generation.pdf

Sellers, W. (2009, October). How Virtualization can affect the it budget. *Health Management Technology*, 30(10), Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=44515992&site=bsi-live

Schultz, B. (2009, August 24). Storage virtualization aides disaster recovery. Retrieved from http://www.infoworld.com/d/hardware/storage-virtualization-aides-disaster-recovery-725

Sellers, W. (2009, October). How Virtualization can affect the IT budget. *Health Management Technology*, 30(10), Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=44515992&site=bsi-live

Silwa, C. (2008, July 11). Marriott goes underground with disaster recovery, virtualization effort. Retrieved from http://www.cio.com/article/433665/Marriott_Goes_Underground_With_Disaster_Recovery_Virtualization_Effort

Snedaker, S. (2007). Business continuity and disaster recovery planning for it professionals. Burlington, MA.: Syngress.

Symantec . (2009, June). Disaster recovery global data. Retrieved from http://www.symantec.com/about/news/resources/press_kits/detail.jsp?pkid=disasterrecovery

Taneja Group. (2009, March). The True cost of virtual server solutions (white paper). Retrieved from http://www.vmware.com/files/pdf/technology/True_Cost_Virtual_Server_Solutions.pdf

Tiller, James. (2006). Virtual security: the new security tool?. *Information Security Journal: A Global Perspective*, 15(3), Retrieved from http://www.informaworld.com/smpp/ftinterface~content=a768430625~fulltext=713240930 doi: 10.1201/1086.1065898X/46183.15.3.20060701/94181.1

Vanover, R. (2009, February 3). *Disaster recovery on the cheap*. Retrieved from http://virtualizationreview.com/blogs/everyday-virtualization/2009/02/disaster-recovery-on-the-cheap.aspx

VMware. (2007). Disaster recovery virtualization (white paper). Retrieved from http://www.vmware.com/files/pdf/DR_VMware_DoubleTake.pdf

VMware. (2009). *Vmware thinapp : total cost of ownership faq*. Retrieved from http://www.vmware.com/files/pdf/VMware-ThinApp-TCO-FAQ-EN.pdf

VMware. (2010). Vmware infrastructure foundation. Retrieved from http://store.vmware.com/servlet/ControllerServlet?Action=DisplayPage&Env=BASE&Locale=en_US&SiteID=vmware&id=ProductDetailsPage&productID=83581600&resid=S6ouEgoHAkUAAALvljAAAAAX&rests=1269444115042

Worthington, L. (2009). Shifting To Virtualization. *Hospitality Upgrade*, 116-117. Retrieved from Hospitality & Tourism Complete database. Retrieved from http://ezproxy.library.unlv.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=hjh&AN=45341385&site=ehost-live