6-2010

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2008

A professional paper submitted in partial fulfilment
of the requirements for the

Master of Hospitality Administration
William F. Harrah College of Hotel Administration
Graduate College
University of Nevada, Las Vegas
June 2010

Abstract

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Organizations across all business sectors are making increasing use of IT today. While other industries have understood the consequences of this dependence in the event of IT disasters and placed a large emphasis on disaster recovery plans and technology, the hospitality industry is lagging behind. One of the reasons why the hospitality industry does not place as much of an importance to disaster recovery is the cost. However, IT disaster is a very damaging occurrence, and measures should be taken to mitigate the event. Loss of a property's information technology (IT) functions can cause chaos in a hotel's operations leading to revenue losses and negative publicity that may take years to overcome. Virtualization is a relatively new technology, which is easier to manage, and it is said to be cost effective, and ideal for disaster recovery purposes. However, it may not be suitable to every industry. The purpose of this study is to examine virtualization as a method of disaster recovery for the hospitality industry.

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Acknowledgements

I am very grateful to my professor and chair, Dr. Pearl Brewer, who set me in the right direction on this vast and complex subject, without whose guidance, I would not have been able to complete this paper. Thanks are also due to the professors of the Hotel College, and to Dr. Andy, who helped me to develop a complete view of hospitality management from different functional areas.

Special thanks are due to my fellow students, who had given me encouragement when I needed it most. And lastly, but not least in terms of importance, to my family members for the understanding and support given to me during the course of my studies.

Part One

Introduction

Organisations across all business sectors are making increasing use of IT today. While benefits of IT are well understood, organisations often overlook the pitfalls associated with the dependency. Fires, sabotage, errors, and equipment failures can disrupt the availability of IT resources to support time-critical business processes. In many cases, dependency on IT has increased to a point where the loss of IT resources for even a short period of time, would result in significant negative impact to an organisation, an industry, or even a nation's economy.

Over the last decade, the hospitality industry has seen unprecedented growth, with the hotels and motels in the Asia-Pacific region alone generating total revenues of $116.5 billion, a 21.7% increase, in 2008 (Datamonitor, 2009). In keeping with the practices of the other industries, the hospitality industry too has embarked on computerisation of their core operations for higher productivity and customer satisfaction. Prakash K. Chathoth states that Information Technology (IT) "is the single greatest force affecting change in the hospitality industry", resulting in greater staff/customer ratios, more service offerings, and a wider range of interactions. The impact of IT is therefore, more significant, since more activities need to be coordinated and executed within and across functional areas of business, thereby making transactions more complex (Chathoth, 2006).

To meet the expectations of the customers and the higher demand placed on services by the maturing economies, hotels are faced with the task of providing 24 hours, seven days a week online services. In order to ensure this high level of service, it is important to ensure that the Information Technology (IT) resources are available non-stop 24 hours a day, seven days a week throughout the year. Failing this, organizations tend to lose revenue, opportunities, customers and sometimes even the business itself.

Given the impact of the loss of IT services to an organization, the consequent loss of business, organizations need to be prepared to counter the risk of losing information technology resources. Nonetheless, the hospitality industry is not fully prepared to deal with an IT disaster. Due to the dynamic nature of technology, and the constantly increasing data storage needs of the industry, implementing a disaster recovery plan could be a daunting task.

Technology downtime is becoming increasingly intolerable. Hoteliers are making use of technology to enhance operational efficiency, to provide personalized guest service and control costs, and to provide performance indicators such as profit margins and financial condition. The increasing dependence of a hotel's operations on technology requires individual computer systems to work cooperatively so that the hotel can deliver quality service to its guests. Furthermore, Rob Law and Mary Lau state that cash registers, safes, fire alarm systems, elevators, medical equipment and telephone exchange systems are all linked together through computer-processor systems (Law & Lau, 2000). Therefore, a technology failure could have a disastrous impact on a hotel's ability to function efficiently. Profits may also be greatly impacted. Lyn Ewing is quoted by Terri Hardin as stating that that San Diego Convention Centre "could lose millions of dollars of economic impact for San Diego" should their email systems alone go down (Hardin, 2008).

Nonetheless, to implement systems that minimise downtime costs more than many companies can afford. As the hotel manager of Holiday Inn Singapore Orchard City Centre stated, disaster recovery is like insurance. It is something that the company is paying for but hoping they will never have to use (M.C.Samir, Personal Communication, 2010).

Many organizations in the hospitality industry however, do not see the advantage of, or give importance to, spending on something that they believe they will never need to use. It is considered to be a cost centre. Christian E. Hempell and Nicole R. Wendland (1999) state that in the event of a fire or an explosion, the last thing hotel managers think of is protecting

their data. However, due to the reliance on IT systems, disaster recovery planning is critical. Hempell and Wendland point out that loss of a property's information technology (IT) functions can cause chaos in a hotel's operations leading to revenue losses and negative publicity that may take years to overcome. Technology systems rendered inoperable in one location can affect all other operations and systems in the entire hotel, forcing the company to fall back on manual operations (Hempell &Wendland, 1999).

Purpose

As stated by GSS America (2009), virtualization technology has become the preferred data storage solution in many companies over the last three years (GSS America, 2009). With evolving software and hardware, it has been explored as a method for data storage and disaster recovery. The purpose of this study is to examine virtualization as a method of disaster recovery for the hospitality industry.

Statement of Problem

While hotels are slowly realising the importance of protecting their IT systems to ensure business continuity, the IT manager of Holiday Inn Singapore explains that cost is an issue, and most hotels are satisfied with the basic of back-ups, which normally take a long time to get the systems back up to date in the event of a disaster (R.Yeong, Personal Communication, 2010). As Hempell and Wendland state, reservations, property management and communications systems must be quickly replaced and guest data recovered to avoid major losses (Hempell & Wendland, 1999).

Statement of Objective

The objective of this study is to evaluate virtualization as a method of disaster recovery and it's applicability to the hospitality industry. Virtualization has been accepted as an appropriate cost effective method of disaster recovery (Geisa, 2006 and Sellers, 2009). However, the issue is that it may not be applicable to every industry.

Justification

It is hoped that the information in this document will educate organizations in the hospitality industry on the importance of Disaster Recovery and Business Continuity Planning, as well as determine if virtualization is appropriate, and if so, provide a guideline and recommendation for adopting virtualization as a method of Disaster Recovery.

Limitation

This study takes a theoretical approach to the implementation of virtualization in the hospitality. Though it is expected that the proposal will be effective, the benefits of virtualization mentioned in this document are anticipated, and not absolute.

Definition of Terms

Alternate Site

A site to maintain the business continuity of an organization's Mission Critical Activities during a Business Continuity event. This type of site is also called as a Recovery Site (VMware, 2007).

Backup

A process by which primary data is copied into another form to be used if the original data is corrupt or destroyed (Abel, n.d.).

Business Continuity Management (BCM)

The process of identifying and managing potential threats to the organization and providing frameworks for building resilience and effective response to safeguard the interest of the organization (Shankar MPB, Personal Communication, 2010).

Business Continuity Plan

A clearly defined and documented plan for use at the time of a Business Continuity Event(Shankar MPB, Personal Communication, 2010).

Cold site

A site (data centre/ work area) which is equipped with the equipment required by key employees to resume business operations(Shankar MPB, Personal Communication, 2010).

Crisis Management

The process by which an organisation manages the wider impact of a crisis until it is contained (Abel, n.d.).

Critical

A resource or process that must be operational at all times or with least interruption as possible (Shankar MPB, Personal Communication, 2010).

Data Mirroring

A process whereby critical data is replicated instantaneously to another location so that it is not lost (Abel, n.d.).

Maximum Acceptable Outage (MAO)

This is the timeframe by which a recovery must be accomplished before the outage compromises the ability of an organisation to achieve its business objectives and or survival (Abel, n.d.).

Mission Critical Activities

The critical business support activities without which the organisation would be unable to achieve its business objective(s) i.e. services and/or products (Abel, n.d.).

Offsite Location

A site which is situated at a distance far from the primary site where critical data (computerised or paper) and equipment is stored. In the case of a disaster from where it can be recovered and used at the time of a Business Continuity if original is lost or unavailable (Abel, n.d.).

Outage

Period of time that a service, system, process or business function is unusable or inaccessible. An outage is different to 'downtime' where process or system failures happen as a part of normal operations, and where the impact merely reduces the short-term effectiveness of processes (Abel, n.d.).

Restart

The procedure that returns applications and data to a known start point.

System Recovery

The process of rebuilding a computer system to the condition where it is in a ready state.

Tape Backup

Operational data being backed up onto tapes at a given point in time.

Third-Party Provider/ Supplier

An external provider of services, goods and solutions.

Part Two

Introduction

As organisations in the hospitality industry become more complex and increasingly reliant upon various technologies to function effectively, they become increasingly exposed to disasters. As the business has become increasingly dependent on data processing and communications, it is imperative that it must be able to recover from the sudden loss of computing and communications resources (Hempell & Wendland, 1999).

As the likelihood of disasters occurring increases, so too does the responsibility of ensuring that business can survive the impact. Increasingly stringent guidelines and codes of good practice from official regulatory bodies and insurance companies means that Business Continuity has now become a matter that has to be addressed (Caserotti , Coutinho, Cagle, Foltyniewizc, Engel, Sachdeva, Qureshi & Parkel, 2001). Business Continuity incorporates advanced planning for unwanted or unexpected events that could damage business. The core theme of Business Continuity is to recognise that every company is unique and is constantly changing. Every business continuity solution must reflect these changes so that the recovery procedures are entirely relevant, current and tailored to meet the recovery requirements (Nicholette & Schmidt, 2001).

Business Continuance planning (also called Disaster Recovery planning, Contingency or backup planning, Business Resumption planning, Continuity of Business planning) is essential to the survival of the business and is, therefore, a fundamental management responsibility for stewardship of the business resources. The Business Continuance Architecture must cover the precautions to take, to prevent, minimise and recover from the sudden loss of computing and communications resources (Cisco Systems, Inc., 2004).

A disaster, in the context of this document, is any "unlikely event" that causes the partial or total unavailability of data processing and communications capability. The Business

Continuance Architecture specifies the structure within which documented plans, procedures and precautions can be implemented to minimise the impact on the corporation and its shareholders of loss of revenue, loss of assets, loss of market share and damage to image (Nicholette & Schmidt, 2001).

The operating areas or users will be responsible for preparing contingency plans addressing the loss of a partial area or the entire physical facility that they occupy. The operating areas should co-ordinate the preparation of these plans with the appropriate application support group while keeping Audit and Business Continuance Planning (BCP) team apprised in order to ensure a consistent recovery effort (Cisco Systems, Inc., 2004).

Each application manager in a line of business has the responsibility for developing and implementing an off-site recovery methodology for every application that supports the line of business. The responsibility for testing and maintenance of a Business Continuance plan, appropriate to the set of applications supported by the cluster, should be with the person or team responsible for maintaining the application. Business Continuance Planning team provides guidance and assistance in the development and implementation of those plans (Nicholette & Schmidt, 2001).

As part of developing the Business Continuance Architecture, each line of business must establish a Vital Records Program to store key information resources off-site (i.e., in a location which would be unaffected by a disaster involving the line of business's processing cluster) (Shankar MPB, Personal Communication, 2010). Periodic testing of the Business Continuance Plan is required to ensure its complete and accurate functioning (Berenfeld, n.d.).

Business Objectives

Strategic Objectives. A disaster may render inoperative the data processing or communications capability of a business, or render inaccessible the physical facility housing

the data processing cluster or the user operating areas. The objective of Business Continuance Architecture (BCA) is to maintain the viability of the business until full operating capability can be restored in the event of a disaster (Caserotti et. al., 2001).

Shankar MPB (2010), of Datadomain, a company specializing in deduplication and disk-based back up, stated that the Business Continuance Architecture specifies the precautions and defines the structure within which plans and procedures can be developed to:

- minimise loss and disruption to the business,
- protect the Corporation's revenue stream,
- maintain the Corporation's image as a high quality service provider,

Functional Objectives. Shankar (2010) stated that he BCA is the framework within which all contingency planning to restore functional operating capability after a disaster takes place. Functional operating capability provides the Corporation with the means to:

- maintain official corporate and customer records,
- sustain compliance with regulatory reporting and control requirements,
- deliver electronic products to customers,
- create, transmit or process official financial transactions,
- provide direct electronic services to customers,

Restoration of functional operating capability is made possible by the restoration of application systems that provide these facilities. The definition of application restoration must be agreed upon between the application and user areas and clearly stated in all procedures. In some cases a restored application may be one that has been recovered as of the disaster. In other instances, a recovered application may be one that has been recovered as of the start of the business day. The BCA addresses application restoration in the context of several variables (Caserotti et. al., 2001).

Time. The speed with which an application is restored is based on its business criticality. Only those applications necessary to the survival of the Corporation need to be restored within the shortest timeframe. At a later time, additional applications are restored and are again prioritised in accordance with business criticality.

Fall-back Level. There are multiple levels of fallback. Applications can be restored to the start of a previous business day, or as of the point in time when the disaster occurred (as close to the disaster as possible). The business risk associated with the application will determine the fallback level.

Security Infrastructure. Operating conditions during a disaster are far from normal. These conditions are very conducive to unauthorised access and the perpetration of fraud. Therefore, it is critical that baseline security is met at all times during a disaster. The business risk associated with the applications recovered and the timeliness of the recovery will determine if security levels above the baseline need to be implemented prior to restoration.

There are significant costs associated with the implementation of contingency plans. The shorter the restoration time frame, the greater the costs associated with providing the recovery capability. The capability to recover an application as of the moment of the disaster has a much higher cost than recovering from an earlier point in time (Cisco Systems, Inc., 2004)).

Implementing a recovery mode, time and fallback level requires balancing the cost of the contingency against the potential loss or business risk associated with the loss of the records, or the inability to provide a product or service. This analysis must be done at a business level, so that the risk associated with the loss of specific corporate records, products or services can be weighed against the cost of recovering the application.

Technical Objectives. The BCA three technical objectives:

1. Application Recovery: The recovery methodology must be an integral

part of the application's processing capability, so that any one application or group of applications can be restored.

2. Updated Recovery Methodology: Any enhancement or change to an application in the normal course of business should be reflected and validated in the recovery methodology, so that the data and operating integrity of the application will be maintained in a disaster.

3. Re-establish Normal Processing: Resume normal application processing in either the restored or a new facility under the operational control of personnel. The recovery methodology must facilitate the return to a normal processing mode without exposing the Corporation to any risk (Nicholette & Schmidt, 2001).

Conceptual Model

A disaster has been described as an “unlikely event" causing an outage of partial or total processing capabilities. The disaster may affect one or more data centres within a facility while leaving the operating areas unharmed. Conversely, the event may leave the user areas unable to function with no disruption to the associated data centres. There is the possibility of both data centre and operating areas being affected in cases of fire, building evacuation or other unforeseen events. In general, the Architecture attempts to lay the foundation for recovery efforts in these scenarios towards minimising the ultimate impact to the business, it addresses contingency planning from a single facility framework and in no way attempts to address a multiple facility outage. It is possible that some businesses may require multiple facility outages to address the issues relating to primary and secondary site being affected by the same disaster (Cisco, 2004).

Each data processing cluster of servers and nodes, with the co-operation of appropriate line of business management should conduct a review of applications operating in that cluster. Applications should be classified as to the degree of criticality. The evaluation of

criticality should take into account both the type and duration of service outage (Nicholett & Schmidt, 2001).

Following this analysis, each cluster should document, test and maintain a Business Continuance Plan for all aspects of its computing and communications resources that support each business function. The departmental plans form a subset of the overall Business Continuance plan. The interaction with BCP team will ensure that the individual plans are in synchronisation with the overall plan (Shankar, Personal Communication, 2010).

The Business Continuance Architecture consists of the following components:

- identification of application criticality,
- establishment of a vital records strategy,
- selection of an alternative computing strategy,
- selection of an alternative communications strategy,
- development, testing and maintenance of a written Disaster Recovery Plan,
- declaration of disaster,
- resumption of normal processing,

Each Cluster will establish a business continuance team to develop, test and maintain the Business Continuance Plan (BCP). The planning participants need not be the same personnel who execute the plan. The Business Continuance Plan developed for each cluster will address both the loss of availability of the cluster and the loss of the physical facility housing the cluster (Caserotti et. al., 2001).

Literature Review

Overview. Compared to other areas in hospitality and tourism development and management research, research on crisis management is relatively limited (Carlsen & Hughes, 2007). This is significant given that tourism is recognised as being highly vulnerable to crises, as

demonstrated by tourism downturns following the 2001 terrorist attacks on the United States, the bombings in Bali, and the tsunami.

While companies in the finance industry had been prepared for business continuity and disaster recovery before the terrorist attacks in the United States on September 11, 2001, there are still many companies in other industries that do not have any type of business continuity or disaster recovery plan in place, in spite of threats of disasters. However, many companies fail to have even data backup plans in place despite the high costs of IT failure, because of a lack of time, resources, a sense of urgency and a process for developing and maintaining a plan (Snedaker, 2007).

This is especially the case in the hospitality industry. Many hotels, especially budget hotels, are unaware of, or are apathetic towards, potential IT problems. Technology has traditionally never played a key role in the hotel industry, often cast to supporting from the sidelines at most. In the event that an IT problem happens, it will likely have a significant impact on the entire hotel operation. However, many hotel managers are still ignorant of this, and have not considered evaluating its likely business impact. Although IT problems have been anticipated to be potentially disastrous, many hospitality companies are still refusing to accept that it is any cause for concern. This is because people in the industry are uncertain as to whether the said problems have been exaggerated by technical consultants or technology suppliers in order to reap profits (Law & Lau, 2000). As people deal reluctantly and cautiously with insurance, so do companies in the hospitality industry with disaster recovery.

A study released by Harris Interactive, Inc. (2006) indicated that of CIOs who participated in the survey, 39% lacked confidence in their disaster readiness, with a fairly high lack of confidence in disaster plans in firms with revenues of $500M or more annually. While this might appear negative, it highlights the increasing awareness of the need for comprehensive disaster readiness and indicates IT professionals, who thought having off-site

backups was a good disaster readiness plan in 2000, now have a more complete understanding of what disaster recovery requires (Snedekar, 2006).

While the hospitality industry is more antiquated, and lagging behind in many IT trends (Samir MC, Personal Communication, 2010) many hotels have already moved major applications offsite, where they may be operated by brand or corporate data centres, application vendors, hosting centres, or third-party providers (Rice, n.d.). In the hospitality industry, disaster recovery means back-ups done on tapes, which are stored in an external location, and shifting to manual operations in the event of systems downtime (Yeong, R. Personal Communication, 2010). However, IT professionals need to realise that off-site backups are but a small component of the overall disaster recovery plan (Snedekar, 2007).

In spite of the awareness, cost and budget distribution is still a major concern for IT professionals, and disaster recovery's expensive price tag is a major consideration (Bort, 2004; Adeshiyan, Attanasio, Farr, Harper, Pelleg, Schulz, Spainhower, Ta-Shma & Tomek, 2009). Disaster recovery solutions require specific hardware, complex configurations, application-specific procedures, highly-skilled employees, and a long, precise testing process. Therefore, the handling of the disaster recovery systems itself works to discourage implementing it as it would take a considerable amount of organization, training, time and preparation, in addition to the deterring cost (Adeshiyan et. al., 2009).

The Hospitality Technology Magazine surveyed more than 260 hotel and restaurant executives, asking them to describe the effect the economic climate on their company's information technology budgets for 2010. The majority of participants expected to see reduced IT budgets in 2010 with 25.5% of participants indicating that their IT budgets have seen a significant reduction over the 2009 budgets and 40.3% of participants indicating that their 2010 IT budgets were only marginally reduced verses their 2009 financials, resulting in the IT departments being forced to control their costs and expenditures more stringently

(Lorden & Volpe, 2009). This budget reduction trend has been observed by Symantec (2009) as well, which saw, also through a survey, that IT professionals expect the 2010 IT budgets to decrease over the 2009 IT budget.

It is established that hospitality organizations remain cautious when allotting money to IT initiatives. Business continuity and disaster recovery planning projects have to compete with other urgent projects for IT dollars, and business continuity and disaster recovery initiatives are normally faced with strong executive resistance or apathy (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)

Financial Impacts of IT Failures. Continuous availability is an important part of business continuity. It's also known as a zero-downtime requirement, and is extremely expensive to plan and implement. The Association for Contingency Planning (ACP) (2000) states that since downtime costs depend on a company's use and reliance on technology, the costs will vary by industry, as not all industries are equally dependant on technology. ACP 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.

Customer and service related issues, such as a temporary loss of sales and a decrease in the levels of service, are the most impending concerns of those responsible for managing risk in the food and drink retail supply chain. However, these issues are likely crucial to businesses in other industries as well, and especially critical to the hospitality industry, which is customer and service oriented. Companies are most exposed to the loss of their IT capability (90%) followed by fires (70%) and loss of sites (67%) (Pendrous, 2006).

Industry	Hourly Downtime Costs
Brokerage Operations	$6,450,000
Energy	$2,817,846
Credit Card Sales Authorizations	$2,600,000
Telecommunications	$2,066,245
Manufacturing	$1,610,654
Financial Institutions	$1,495,134
Information Technology	$1,344,461
Insurance	$1,202,444
Retail	$1,107,274
Pharmaceuticals	$1,082,252
Banking	$996,802
Food/Beverage Processing	$804,192
Consumer Products	$785,719
Chemicals	$704,101
Transportation	$668,586
Utilities	$643,250
Healthcare	$636,030
Metals/Natural Resources	$580,588
Professional Services	$532,510
Electronics	$477,366
Construction and Engineering	$389,601
Media	$340,432
Hospitality and Travel	$330,654
Pay-Per-View TV	$150,000
Home Shopping TV	$113,000
Catalog Sales	$90,000
Airline Reservations	$90,000
Tele-Ticket Sales	$69,000
Package Shipping	$28,000
ATM Fees	$14,500
Average	**$944,395**

Sources: IT Performance Engineering and Measurement Strategies: Quantifying Performance and Loss, Meta Group, Oct. 2000; Fibre Channel Industry Association.

Figure 1. Hourly cost of downtime per industry, as of 2000. Adapted from "Downtime costs by industry" by ACP, 2007.

For some companies, it may be well worth the investment because the cost of downtime outweighs the cost of implementing continuous availability measures. This is especially so for security and finance companies. Other companies have a greater tolerance for business disruption. For the hospitality industry, however, downtime is more than an inconvenience. While there are other industries which would be more affected by IT downtime, the hospitality industry cannot afford to ignore this threat. For example, a hotel cannot tolerate critical system outages during business hours (Snedaker, 2007). Although hotels can run operations manually, IT-based systems increase the ability of hotels to meet customer's needs and wants over non-IT-based systems, all else being equal (Chathoth, 2007). In addition, as indicated in the table above, 50% of the companies in the hospitality

industry stand to lose at least $330,654 for every hour of downtime. As such, it is critical to the businesses to get their systems back as soon as possible, or they will stand to lose a huge sum of money.

The relationship between IT and business value is not simple. There appears to be a growing interest in strategic management literature in understanding this complex relationship. The studies to date have drawn on Resource Based Views (RBV) to show how IT-based resources can be used to improve firm performance. Previous studies in this area have observed positive stock market reactions to announcements of strategic IT investment decisions. Further research indicated that an unexpected failure of IT resources has a negative impact on the value of a firm, with a decline in market value, of an average of about 2%, when firms experience IT failures (Bharadwaj et. al., 2009). This is probably due to the fact that the interruptions in a company's services or a loss of data, result in a loss of its customers confidence in that firm's ability to survive in a crisis and to meet their needs and protect their personal information. With security issues becoming more prevalent, customers may feel threatened to do business with companies that are prone to IT failures. This is especially the case with companies that deal heavily with customer data, such as banks or hotels.

Furthermore, as technology increasingly becomes an integral part of business operations, companies have come to rely more on services and technologies to do jobs that were previously done by people. When those services or technologies become unavailable, even temporarily, the result is a major loss of productivity, which affects profits, and is a huge cost to the company. In addition, long-term damage can lead to low staff morale and decreased confidence in the organization. The resulting monetary damages can be evident even long after services have been restored (Caserotti et.al., 2001).

Attention has also been drawn to an important stakeholder category: the investors. While investors are often forgotten in IT failure studies, it has been shown that they do care

about IT failures and this might affect the number of investors a hotel might have, and the amount of money they would be willing to invest in the hotel. For a highly leveraged hotel (i.e. a hotel that has more debt than equity, due to heavy investments), IT failures will increase financial risk by affecting cash flows and liquid asset availability, thus increasing risk of bankruptcy (Bharadwaj, Keil & Mähring, 2009).

In addition, it has also been shown that the market considers the circumstances under which failure occurs. It was found that investor reaction to implementation failures tends to be more negative than to operating failures. In addition, a more severe failure results in a greater penalty. Firms with a history of IT failures (i.e., those that had multiple failures during the time period) tend to suffer a more severe impact. These indicate that investors are reasonable and rational in their assessment of IT failures. The reason for the increased criticism of investors of implementation failures is that implementation failures cause operational problems and indicate deficits in IT deployment capability, which damages the firm's reputation, and in doing so, reduces its profits due to reduced patronage. Because implementation failures indicate deficiencies in capabilities that put the firm's ability to generate revenue in question, it makes sense that investors become cautious and revaluate their decision to invest in the firm upon hearing news about implementation failures (Bharadwaj et. al., 2009; Cisco, 2008)

Recurring failures prove capability deficiencies and result in customer and investor withdrawal, as both groups are not highly tolerant of firms that have failed to learn from past mistakes. Finally, more severe failures can impede the firm's operations and future growth options a lot more than less severe failures. As such, firms should be more attentive to IT disaster recovery planning and implement a system to minimize down time, because the market is neither ignorant nor apathetic and is able to assess IT failures differently depending

on their nature and circumstances (Bharadwaj et. al., 2009; Caserotti et. al., 2001; Cisco, 2008).

It is important to consider, when involving in business continuity planning, how much of a disruption to business is tolerable and what the company is able and willing to spend to avoid disruption. Ideally, every business using technology should, and would want to, implement fully redundant, zero down-time systems. However, that would be very costly, and more than what most companies would be able to afford (Cisco, 2008).

For example, a small bed and breakfast, or even a medium sized hotel may not be able to afford spending several millions of dollars on fully redundant systems when their revenue stream for the year is five million dollars. The cost of a business disruption for a company of that size might be $100,000 and would not justify a million dollar investment. On the other hand, a million dollar investment in fully redundant systems for a company doing $5 billion annually might be worth it, especially if the cost of a single disruption would cost $330,654 (taking the average hourly cost of downtime for the hospitality industry in the year 2000, as indicated in Table 1), which is more than $1 million invested in the system. As such, the business continuity and disaster recovery plan is not a one size fits all plan, but must be appropriate to an organization's size, budget, and other constraints (Snedaker, 2007).

While larger companies are able to afford disaster recovery systems, small to medium enterprises are just as much in need of highly available systems and the ability to recover in the shortest time possible in the event of a disaster, as they are becoming more and more dependent on IT for their operations. Data loss due to disaster has been guilty of driving more than half of small/medium enterprises (SMEs) out of business within two years after that disaster, and 25 % of companies experiencing an IT outage of two to six days went bankrupt immediately (Berenfield, n.d.).

However, due to budget constraints, which are more an issue this year due to budget cuts, these companies are rethinking the necessity of disaster recovery systems for their business. They need systems that would mitigate the effects of an IT disaster, but at a modest cost (Adeshiyan et. al., 2009). Server virtualization is a technology that is now being increasingly used for disaster recovery. Businesses found this technology appealing not only because of its immediate cost savings, but also because of its flexibility (Caserotti et.al., 2001). Companies wanting to cut costs or maximize efficiency, or both, might wish to consider virtualization as a method of disaster recovery.

How does virtualization work? Virtualization refers to the process of installing multiple "virtual" servers on a single computer. Instead of having several machines operating at only a fraction of their potential capacity, one machine is used to its full capacity (Marks, 2009). Virtualization as a form of disaster recovery is a more hi-tech version of backing up data onto tapes and storing them in another location. It involves the duplication of the virtual server infrastructure and data at remote facilities for recovery. The added benefit of this over tapes is that the date is still accessible even if the primary site is not. While disaster recovery is very involved and structured, virtualization simplifies it in many ways. This is because server workloads packaged as virtual machines are easier to transport and restart on remote systems (Citrix Systems, Inc., 2009).

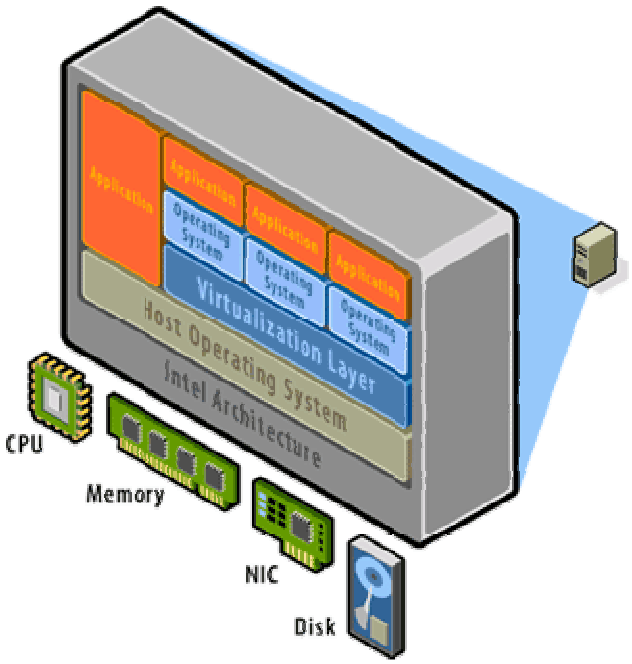

Figure 2. Diagram of a virtual machine, with its hardware and software. Adapted from VMware, 2010.

By making proper use of virtual machines as secondary servers in a standard replication and failover scenario, each virtual machine is its own self-contained, unmodified server image. Many of these virtual machines can be run at the same time on a single server, allowing many physical production servers to be protected by a single piece of hardware in a disaster recovery facility.

Because each virtual machine is isolated and functions separately from others, and workloads do not need to be integrated, the management of applications and services during the recovery process is no more difficult than managing them in production (VMware, 2007).

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 change and development 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, Nick Price, chief information officer and chief technology officer for Mandarin Oriental Hotel Group states (according to Hotel Business Magazine) that the hospitality industry has still not embraced it. Another hotel group praising the benefits of virtualization is the Intercontinental Hotels Group (IHG). Both groups however, just like many other companies big and small within the hospitality industry, have yet to explore virtualization as a method of disaster recovery (Hotel Business, 2010), with the exception of Marriott International, which revised its disaster recovery plan to include virtualization technology in 2009 (Silwa, 2008).

Nonetheless, Pierre Dorion (2010) predicts that virtualization as a method of disaster recovery will pick up in 2010. The upcoming trends are predictability and automation of disaster recovery which are made possible with tools such as VMware's Site Recovery Manager (SRM), which offers automation that further enhances server virtualization and

system instance mobility, and Vizioncore's vRanger Pro offering P2VDR capability, assists in disaster recovery by converting a physical server to a virtual server.

Besides EMC Corp.'s VMware and Virtual Cloud Environment, other vendors and products such as Acadia and NetApp's Dynamic Data Centre 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,
- 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. For example, if virtual machine 1, which shares the same physical server as several virtual machines, is hacked into and the physical server has been very liberal with permissions and allowed easy access, further attacks from virtual machine 1 could lead to the remaining machines being hacked as well. 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).

Gartner analyst Rene Millman explained the reason for the higher than expected cost of managing virtual environments. She reasons that as utilization increases, the cost of managing servers may stay the same or increase as organizations implement technologies they are unfamiliar with (Chickowski, 2009). Andi Mann, analyst at Enterprise Management Associates Inc., is said that 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;).

Conclusion

It appears that while virtualization has plenty of benefits, it does come with its share of problems as well. However, with proper implementation, most of these problems can be avoided. Nonetheless, virtualization is not guaranteed to save money but if implemented right, the full short- and long-term commitments are understood, it is very likely. In the long term less money will be spent on hardware and electricity. However, these savings will be will be partially offset by the additional money spent on software licensing and infrastructure upgrades, which are essential to the maintenance and proper functioning of the infrastructure.

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.

Finally, virtualization need not be applicable to every company. The 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.

Part Three

Introduction

It has been established that virtualization has many benefits, not only in disaster recovery, but in systems and hardware management, and environmental initiatives and energy conservation as well. However, it was stated that virtualization is not for every industry and every company. Its implementation should be determined based on the company size and needs.

It has also been suggested that virtualization might not make sense for small companies, and would serve to be more of a cost which would offset the savings brought by virtualization. However, it was also stated that disaster recovery, while exorbitantly priced, is crucial to a business.

Every business, regardless of industry, has a process for evaluating technology investment. TCO or Total Cost of Ownership is a methodology for analyzing IT or other enterprise costs. In the application management context, 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.

Methodology

A TCO/ROI calculator (powered by Alinean) is used to derive potential cost savings obtained through virtualization. Alinean is the leading provider of ROI/TCO research, modelling and software, founded by leading IT value experts formerly of Gartner. Alinean has researched all of the metrics in the tool. The metrics are tuned for industry, location and

size to best represent average metrics. These metrics include typical costs for servers, desktops, networking, storage, salaries, power, Datacentre space and services. Third party metrics are also used in select areas from IDC, Gartner, and other sources. Pricing information is provided by VMware (VMware, 2009).

The business objectives addressed in this virtualization analysis are:

- improvement of existing hardware utilization to reduce costs,
- reduction of software licensing requirement,
- leveraging of scarce IT resources,
- reduction of energy costs and driving green initiatives,
- driving of improvements through,
    - increased adaptability to business changes,
    - delivery of services on demand,
    - increased availability of applications,
    - increased protection of data and infrastructure from risks.

The scope of this analysis revolves around data centre virtualization and management, and is personalized to the hospitality industry. The total cost of ownership is calculated based on the number of servers to be virtualized, starting with five and ending at 20.The reason for this range is that almost all companies have a minimum of five servers. 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. However, 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 a form of Citrix software program (like order taking) between multiple facilities, it will need a Citrix server, etc. Most hotels, even small hotels would have at least five servers, as they engage in all of the above mentioned functions.

There are no known limitations of issues with the tool in terms of data and applicability. The tool is designed to provide a total cost of ownership analysis comparing a company's current environment to a virtualized VMware environment. By answering a few questions related to the existing environment, including the number of servers intended to be virtualized, default assumptions are made based upon Alinean Research (2009), to determine current costs and projected savings with virtualization.

The generalized data was then compared to more specific data collected from five properties of different sizes in terms of number of rooms and the scope and requirements in terms of their target market through a survey of their present system of disaster recovery. The study was conducted to understand if virtualization is an appropriate method of disaster recovery for the hospitality industry. The information was collected through personal communication with the IT managers or the General Managers of the properties, and 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. Five hotels over four hotel categories were chosen based on the number of rooms, ranging 80 to 900, so as to give a comparison of size, in order to address the issue that size is a factor that affects the feasibility and business sense of virtualization. The four hotel categories are: Independent Hotel, Multinational Hotel, and Service Apartment and Boutique Hotel. Questions were asked to gain an insight into the aspects of the DR system currently in place, effectiveness, and efficiency. The number of rooms of a property and its turnover in the last year were asked to determine the size of the business.

Through the communication with the IT Managers and GMs, a better understanding of the companies' IT infrastructure and their IT environment was gained. Information on the type of high availability methodology used for recovery, and occurrence of failures in the last

12 months, and what the maximum downtime experienced due to any failure in the last 12 months was, was also gathered. In the event where there was no system in place, conclusions were drawn based on the present requirements of the company in terms of disaster recovery and analyzed from a virtualization perspective, to see if virtualization would be a suitable method for the hotel.

The size of the hotel business cannot be based on number of employees (Shankar MPB, 2010, personal communication) because there is a heavy use of part-timers, whose attendance and number tends to fluctuate depending on the need of the hotel. As such, considering them as full-timers would give very inconsistent results, while excluding them would not give a full representation of the hotel's workforce. Hence, the size of the hotel was deemed to be dependent on the turnover of the business and the number of rooms.

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 cut down. 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 as a result, the investment costs (see Table 1).

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 Internal Rate of Return (IRR) and ROI (see Table 2) increase with a higher number of servers, and the project payback period (see Table 3) decreases with a higher number of servers, the benefits of virtualization are visible from five servers itself. 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 DR 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, in spite of the initial investment, which is not the case with other methods of disaster recovery.

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 is capable of far more than what it is being used for in many organizations today. One machine has to ability to function optimally while hosting up to 15 servers. 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, as can be observed from 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 %.

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.

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.

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.

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.

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.

Referring to the tables, it can be seen that virtualization provided benefits even for a company with as few as five servers.

The reason for the above mentioned savings is due to the reduction in the number of servers. Since virtualization reduces the number of servers dramatically (see Table 4), it reduces the capital costs for DR infrastructure, DR infrastructure operation costs, labour costs (fewer employees are required to manage fewer servers) for DR site server management, annual energy consumption and data centre space costs, as reflected in tables 5 through 10. With fewer servers, energy consumption is heavily cut down, as instead of more than five servers, the company now only has one or two servers, consuming energy required to operate those servers. In addition, one or two servers generate a lot less heat than five or more servers, and as such, the energy consumed to cool the data centre is also greatly reduced, resulting in over all reduced energy bills. Furthermore, due to the fact that there are lesser servers to manage, labour productivity increases. Additionally, IT productivity increases as well, 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. From the data in the table, we can infer that 15 servers can be virtualized and hosted by one physical server. As such, the server is more efficiently used and its utility is maximised, as compared to a virtualized machine hosting five or ten servers, and definitely more than one server hosting just one application, as is the present situation is most hotels.

Through personal communication with the IT managers of five well established properties in Singapore a profile of, and their concerns regarding, their IT environment has been gathered. Though the organizations were willing to discuss their progress in IT disaster recovery, they would only share their information if the employees and company remained anonymous. With due respect to the organizations' request for anonymity, none are identified within the study. The properties shall be labelled Property A, Property B, Property C, Property D and Property E in order to maintain confidentiality. Property A is the largest group of service apartments in the world. It is also has the largest representation of service apartments in Singapore, with seven properties and 900 rooms. The information gathered through the communication is representative of all seven properties in Singapore. Property B is an independent 5-star hotel. Property C and D are major multinational chain brands. Property E is a boutique hotel.

Table 11

Company IT Infrastructure

	Property A	Property B	Property C	Property D	Property E
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 have more than 15 servers (see Table 11), which is above the optimal point for virtualizations, except for Property E, which does not have any servers at all. The General Manager of Property E stated that boutique hotels and small 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 (see Table 11).

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.

The personal communications also provided an insight into the IT infrastructure of the companies, all of which, with the exception of 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. The other properties however, also expressed at least one concern that would be addressed the implementation of virtualization. While this information does not affect the conclusion that the success of virtualization in an organization is not dependent on size, it does show that at least a few companies are aware of the limitations and room for improvement in their current data centres, showing that they should explore other options (such as virtualization) to promote efficiency, improve productivity and drive savings.

Conclusion and implications

In spite of 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, it can be concluded 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(which were all concerns addressed in the literature review) and increased speed of recovery (a concern of IT managers as realised through the interviews), it makes sense for companies in the hospitality industry to invest in virtualization as a method of disaster recovery.

As was pointed out earlier, there are companies that do not deal with servers and applications at all. This however, does not disqualify companies from considering virtualization as a method of data storage and disaster recovery. Since, without servers and/or applications, there is no way data can be stored internally, there is a high risk of data loss, due to a lack of security (Lingren, 2010, personal communication). As such, it is advisable for such companies to also invest in virtualization as a method of disaster recovery to prevent and/or mitigate future possibilities of IT threats. Through virtualization, servers and desktop infrastructure can be consolidated resulting in a significant reduction in costs, as well as improvements in service levels, reduction in risks and improvements in business agility, all of which are critical to the smooth operation of the companies in the hospitality industry (VMware, 2009).

The TCO/ROI calculator has also shown that virtualization is in fact cost effective. This is not only because the technology is cheaper than the technology used for other

methods of disaster recovery, but also because virtualization promotes savings through more efficient use of energy (a result of lesser machines being used), savings on storage space, savings through lesser number of employees required to operate the machinery and increased employee productivity, and a reduction of the licence fees for the software and hardware. The company also gains good will due to its reduced impact on the environment, which is a result of the reduced energy in use, which leads to a greener IT environment. Ultimately, the results of the TCO/ROI calculator support the literature review in stating that virtualization is beneficial to a company in the hospitality industry.

Virtualization also has positive managerial implications. While a reduced cost and positive publicity benefit the entire company, virtualization does not add to the duties of the management in order to achieve this. Since the number of servers are greatly reduced, they are easier to maintain and manage. 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. Companies wishing to improve their data centres, implement an efficient disaster recovery system and improve productivity and manageability of the IT department and functions, and reduce cost and environmental impact should consider virtualization.

Further study

The popularity of the internet has seen many travel and hotel reservations agencies migrate their reservations online (TravPR.com, 2010). Hospitality Ireland (2007) states that according to tourist reservations company Gulliver Ireland, booking hotels over the telephone and through face-to-face travel agents is an obsolete practice, as almost all accommodation bookings are completed on the internet (Hospitality Ireland, 2007). Bruce Adams (2004) states that the number of reservations made through the internet continues to grow at an astounding pace as hotel companies are channelling reservations to their own Web sites.

Hoteliers are displaying a trend of booking through their own branded Web sites as this method is cheaper to process than reservations made through call centres resulting in branded hotel sites accounting for 75% of internet reservations. Herbjørn Nysveen and Maria Lexhagen (2001) state that internet as a channel for bookings also affects customer relationships. Hotels are aware that with high quality relationships with customers being a critical component in competitive advantage for hotels, ensuring a good and sustained relationship with customers is imperative, and are also using the internet as an effective tool in building stronger relationships with customers through enabling more personalized services.

This extensive exchange of data between parties around the globe raises datasecurity concerns, not only due to the higher risk of IT failure and increased severity of the consequences of the occurrence, but also because of the lack of control over all the data that is being circulated around the Web and its accessibility. With the increasing dependence on the internet for bookings, adaptation of cloud computing might be advisable for hotels, as a complement to their virtualization technology. Cloud computing is a technology used to access services offered on the Internet cloud (MasterBase, 2009). Cloud computing utilizes distant servers for data storage and management, allowing the device to use smaller and more efficient chips that consume less energy than standard computers (Finance New Mexico, 2010). According to Rohan MC, Systems Engineer at Infosys Technologies Limited (2010, personal communication), as most of the data exchanged online in booking processes is text based, it would be cheaper to store online and would take up lesser space as compared to other types of files, such as music or videos. It is recommended that further research in this area and its applications to the hospitality industry be conducted, 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.

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