COMPARISON BETWEEN PHYSICAL AND CLOUD INFRASTRUCTURE FOR A SMALL BUSINESS TECHNOLOGY UPGRADE

By

Patrick Horst, BS

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APPROVED:

Seong Dae Kim, Ph.D., Committee Chair
Gary Kretchik, MS, Committee Member
Charity Chamberlain-Reopelle, MS, Committee Member

LuAnn Piccard, MS, Chair
Department of Engineering, Science, and Project Management
Fred Barlow, Ph.D., Dean
College of Engineering

Abstract

Technology makes the business world go ‘round and it does not matter if it is a large corporation or small business, they are both affected equally. While It is true that large corporations have much more complex outcomes around technology decisions, they still must make the same general decisions as a smaller business. These decisions often boil down to a common choice, buy or rent. With the current trend in technology the question of rent versus buy comes down to whether a business wants to purchase and maintain its own infrastructure or rent those services from another company. This paper explores the difference and similarities between the two options and offers some data points to assist in the decision making. There is a comparison between the benefits of each choice as well as a discussion of potential pitfalls that might be encountered. A numerical analysis was performed to determine the cash flow for the two choices as well as an adjusted cash flow to correct for the time value of money. After all the analysis it was determined that while most businesses would find on-site infrastructure to be a competitive option and worth consideration the greater efficiency and safety with the cloud hosted option allows it to have the lower overall cost.

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Chapter 1 Introduction

As more and more business transitions into the digital realm it has become increasingly important for businesses of all sizes to maintain a technology infrastructure to support upward growth. Small businesses make up a majority of the population when it comes to firms in the United States and for that reason are an ever-growing market segment. Many small businesses start out with a very small digital footprint to keep down costs but as they expand the opportunities presented by an upgrade in technology are numerous. As many as 84% of small businesses use a major digital provider to get information and marketing to their customers allowing for greater engagement and faster response to customer needs (U.S. Chamber of Commerce, 2018).

As the use of digital platforms grow so too do the options that are available to small businesses. This makes it progressively easier for any business, large or small, to transition to a cloud environment to increase their productivity. Upwards of 70% of small businesses already use cloud infrastructure in some fashion and that number is expected to continue to rise as the availability of options increases (Sylvester, 2018). The availability of options has also lead to a reduction in prices across the board for almost all cloud services. As prices fall for cloud services the barrier to entry into the market for many businesses will also fall allowing for a growth of small businesses based almost entirely in the digital frontier.

The use of new technologies not only helps a company to increase the productivity of its workers, but it also helps to appeal to consumers. Up to 57% of consumers feel that small businesses are more competitive in the market if they are using more modern technology (Lazor, 2014). This feeling may also translate to an increased level of trust for the company and a willingness to do business. With the amount of data breaches there have been recently it is not unusual for consumers to be concerned with what companies are doing with their information and where they are storing it. A business that can show that it is progressive when it comes to security provides itself a better position to take advantage of that climate and continue to grow itself in the market.

Another factor that can allow a business to grow by availing itself of the latest cloud technology is the growth of alternate payment methods. As of 2015 almost two out of every three dollars spent using contactless payment went through the Apple Pay app (Heikkila, 2017). Any retailer who is able to take advantage of such new forms of payment is able to set themselves up to serve the widest range of possible customers. The new forms of payment also tie into the need for heightened security by allowing the business to delegate responsibility for its customer's financial security to an outside company. Removing the potential pitfall of losing sensitive customer data allows a business to be more secure in its finances and growth.

Despite the potential benefits available from a technology upgrade only about 15% of business owners have plans to hire an IT consultant or firm to assist them (Lesonsky, 2017). Many small business owners are at least moderately capable with technology and with the prevalence of online and phone-based tech support it is a common belief that a professional isn't required. Whether this is true or not typically depends on the type of business and the market sectors they wish to target. Many brick and mortar stores are capable of being successful simply through traditional marketing and business techniques. However, as time goes in it is becoming progressively more important to have some degree of online presence (Gupta, Seetharaman, & Rudolph Raj, 2013).

Classically technology infrastructure for small businesses has consisted of physical hardware on site at the business location. Lately this has become less common as a multitude of options have become available in the realm of cloud hosting for such business ventures. Cloud hosting offers several unique advantages and disadvantages when compared to having an on-site infrastructure for a small business. Ultimately this decision boils down to a rent versus buy scenario and hinges greatly on what risks a business owner is willing to take on themselves or outsource to others (Lesser, 2017).

Chapter 2 Methods

To compare the two options, research was conducted to find out the typical costs for the services that a small business would require. This included looking at quotes from Dell, Rackspace, and Microsoft to balance out the requirements with the appropriate costs. Dell provided the quote for the onsite server option (Dell, 2018), while Rackspace provided the cost information for the cloud hosting option (Rackspace, 2018). Microsoft provided the cost information for both onsite and cloud hosting through the licensing of their operating system and office products (Microsoft, 2018).

A cash flow chart was created (see Figures 1 and 2) for both options to determine the total costs so that they could be compared correctly. These cash flow charts are all in the negative realm as this study only considers the costs associated with the two technologies. The typical lifespan of a physical server is commonly considered to be five years so that period was used as the total length of the comparison. This allowed for an equivalent measure of costs between the options. After creating cash flow charts, the discount rate was incorporated to account for the time value of money since money spent now is not directly equivalent to money spent in the future (See Appendix)

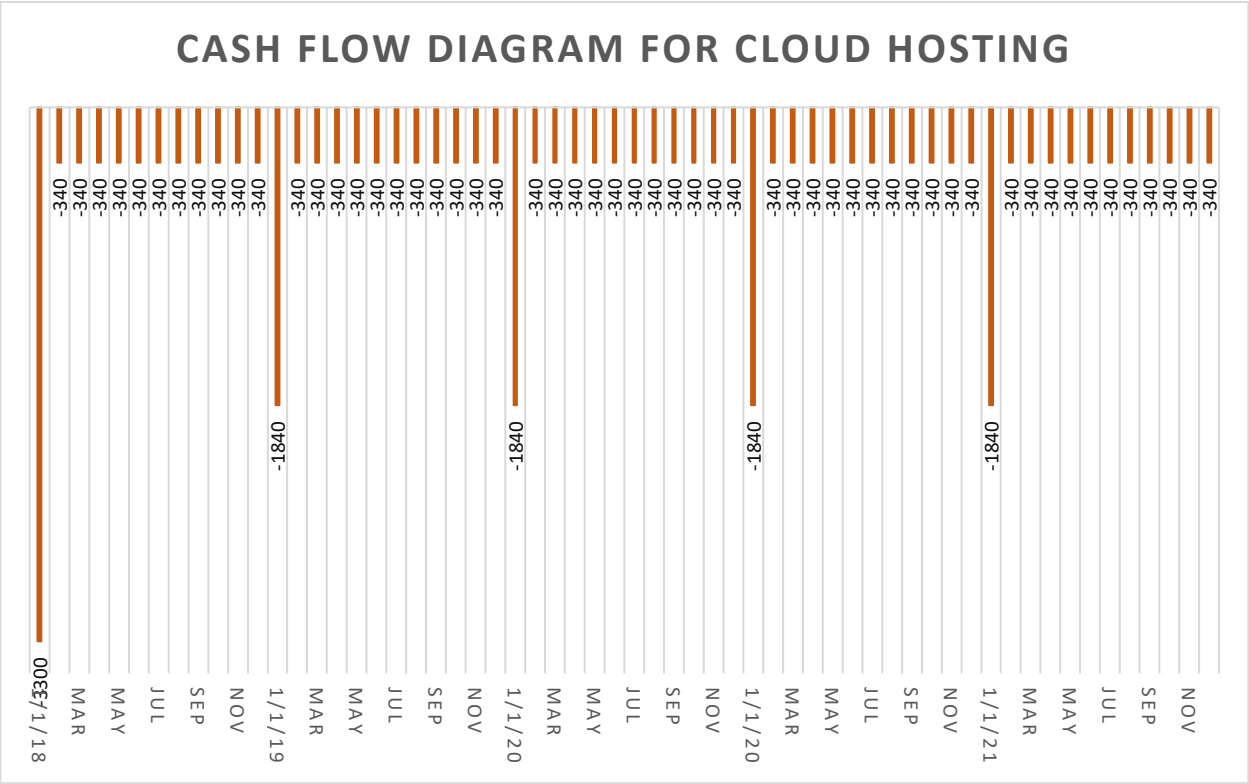

Figure 1: Cash Flow Diagrams for Cloud Hosting

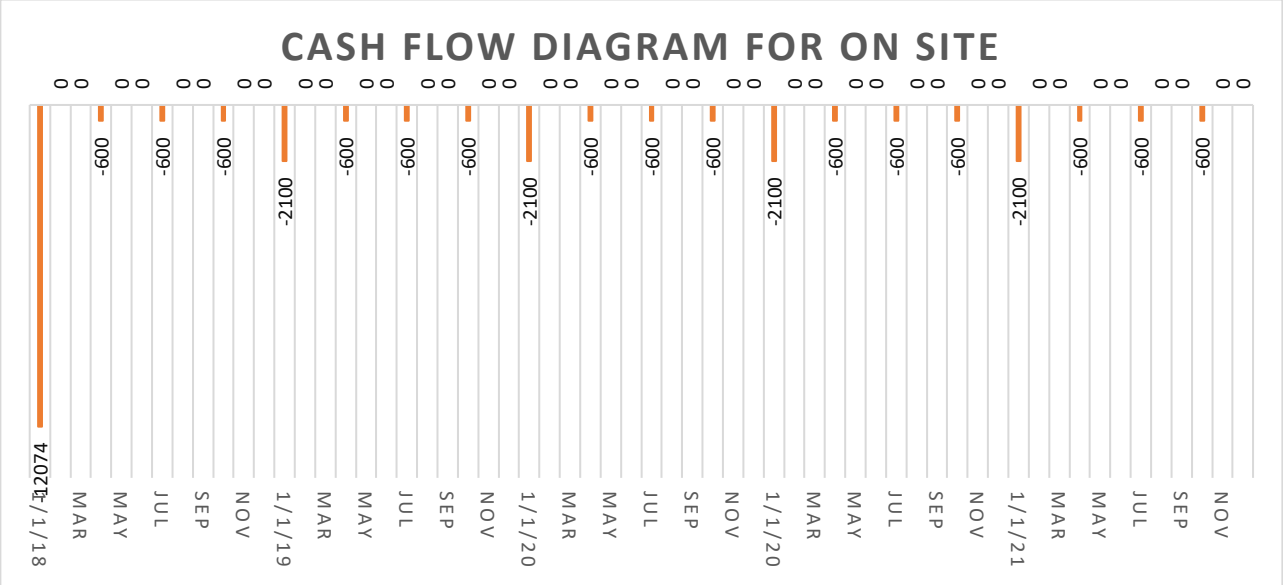

Figure 2: Cash Flow Diagram for On-Site Hosting

Chapter 3 Buying

A business has the option to purchase its own server hardware which has several benefits that are associated with it such as security, longevity, and upfront costs. As should be expected there are also potential negatives to having an on-site server solution such as lack of redundancy, environmental dangers and potentially greater maintenance costs.

3.1 Positives

Owning and operating a server for your company provides a higher degree of security through physical control as well as simple anonymity. This is especially true for companies that deal with sensitive health and financial information as the rules and regulations regarding that data are especially strict. Web hosting companies deal with the data of so many other businesses and this can make a tempting target compared to a single small business (Level Cloud, 2018). This also means that if the cloud hosting site were to be compromised then all the client's data could be lost. This idea also ties in with the concept of anonymity being a shield in that most small businesses are not worth the time or effort for a concentrated assault where a larger site might be. This is not to say that a small business need to worry about physical or digital security, it is simply less a factor than large corporations or hosting facilities.

The benefit of longevity comes when the business owns the infrastructure as it can choose to keep it for however long makes sense. This allows the initial investment to potentially be spread across a greater number of years than initially expected with minimal further costs. Typically, a server is expected to see production use for approximately five years before replacement becomes something to consider. Most warranties sold with servers only last for five years as well to coincide with the expected life cycle of the hardware and when it should be replaced. While some companies do offer extended warranties beyond five years, they are often prohibitively expensive particularly for a small business. This leaves the option of continuing use of the server beyond the expected five years without a warranty providing support for

the hardware. There is some risk to extending the lifespan of a server in this manner but the flexibility it offers should not be overlooked.

Finally, the payment method for an onsite server is much simpler than the cloud hosted option as the server is paid for up front with the only continuing expenses being maintenance costs. While maintenance costs can be variable over time, most issues are covered by the warranty and so can be mitigated to a greater degree. The Warranty being prepaid also allows for simpler initial budgeting as it front loads the maintenance costs. This makes the payment process easier if a company or group has a situation where they get a lump sum to be spent now rather than a continuous cash flow over time.

3.2 Negatives

Having your company's server physically onsite gives the security of knowing who has access to the machine but the downside can be if something happens to the site or the machine it is much harder to recover. Most small businesses will only have a single machine that they run everything from and if that server were to fail for any reason then at the very least there will be unexpected repair costs, if not the cost of a full replacement. Typically, warranties do not cover physical or environmental damage to a server and so should not be relied on to provide a comprehensive recovery plan.

Environmental dangers are hard to predict for a company and the impact can range from negligible to catastrophic depending on the location and environment. Natural disasters such as hurricanes, floods, and tornadoes can be predicted to some degree and potentially mitigated with the proper preparation. Other dangers such as earthquakes and fires cannot be reasonably predicted and are potentially disastrous to a company (Salesforce UK, 2015). These are risks that need to be considered when making the rent versus buy decision and while hard to quantify they can have a significant impact on a business and its continued existence.

Maintenance costs are one of the major risks of on-site infrastructure and provide the highest level of variability that still falls within an expected or preventable range. Having the physical server

onsite necessitates that maintenance be done regularly, typically on a quarterly schedule. These costs can usually be budgeted for as you only need a small amount of work every few months but the possibility that something will end up costing a great deal more looms as a constant concern. Bundled in with physical maintenance costs is the possibility that something will go wrong with the software installed on the machine rather than the hardware. Having a software issue requires the assistance of a technician, whether from the software's vendor or from a company that provides Information Technology services. Depending on the severity of the issue and any existing service contracts this sort of work can quickly build up to a significant cost. A method of mitigating this sort of issue is to sign a contract with a managed service provider who, for a monthly fee, maintains the server while also troubleshooting any issues that arise. This sort of service incurs an additional cost which is up to the business owner to determine if it fits within their budget and risk acceptance.

Chapter 4 Renting

Cloud hosting provides a very different alternative to the idea of owning and maintaining your own equipment by having someone else own the physical device and your company simply rents space from them. This option provides several key benefits such as redundancy, easy budgeting, and physical security. While cloud hosting offers several major benefits it also has its share of negatives. These include the continuous nature of the costs as well as a lack of control over the data and systems.

4.1 Positives

The benefits of redundancy in a cloud hosting environment cannot be overstated, especially if a company relies on their server for many of their primary functions. Should a cloud hosted server run into issues it is usually a matter of minutes before their functionality is restored and business can resume as normal. This is due to the virtual nature of cloud hosting and how resources can be moved and adjusted as needed (Joshi, Bunker, Jahanian, Moorsel, & Weinman, 2009). The variability in resources also allows for much more flexibility within a business since the virtual server can be upgraded or downgraded depending on changing requirements.

Cloud hosting is also remarkably easy to budget for since the costs are represented as a monthly fee which can be planned for over the expected life of the service. The secondary benefit to the subscription nature of cloud hosting is that the initial costs are also much lower and so provide a lower barrier of entry to businesses looking to use their services (Gupta, Seetharaman, & Rudolph Raj, 2013). This allows companies that have a consistent cash flow but less access to lump sums of money to operate with a similar technological advantage as other businesses. There are additional fees that typically come annually, but they are also easy to plan for as they only occur once a year and are always the same recurring cost.

Physical security is a considerable benefit in favor of cloud hosting and can't be overstated how important it can be for some businesses. There can be significant costs required for true physical security in an on-site infrastructure from things such as access control and proper mounting. These issues are completely negated by using the option for cloud hosting as the server exists somewhere physically removed from the business location. Proper maintenance and upkeep of the server is also taken care of by the cloud hosting service so there are no concerns about giving a local company access to potentially sensitive data. This is especially true of companies that deal with health care data which has a higher standard of care than other forms of information. Maintaining the proper security of such sensitive data can make or break a business and cloud hosting allows that risk to be offloaded to another company.

4.2 Negatives

Continuous costs represent the greatest negative for cloud hosting as they will always exist and are extremely difficult to mitigate. No matter how long the service is in use there will always be fees to pay where having an onsite server allows you to mitigate the initial costs by extending the lifespan. As mentioned before this helps with the budgeting of business but over time the fees will add up to a considerable expenditure for something that ultimately the business does not own.

The lack of control also provides an issue for some businesses, especially those in the health fields. The security of personal health information is paramount for the companies that deal with that kind of data and having the possibility that someone else has access to that data can be troublesome (Müller, Ludwig, & Bogdan, 2017). This can be mitigated to a degree by using services that include provisions for health data in their contracts but ultimately, it is a judgement call on the part of the business owner. Another issue that arises from the lack of control is if something happens to the service then a business has little recourse but to wait for the provider to resolve the issue (Moreno-Vozmediano, Montero, & Llorente, 2013). This typically does not pose a significant issue as providers of this sort of service should be well prepared for such eventualities, but it is something that should be considered when making a decision.

Chapter 5 Analyses

For the onsite option, it was determined that the initial costs would be $12,074. This included the purchase of the physical server, the initial setup of the server by a technician, and the appropriate licenses for the software used. Maintenance costs ended up at $600 quarterly for the life of the server which represented visits by a technician to ensure proper upkeep. These costs calculated out to a net cost of $29,474 over the course of the five-year life of the server. As mentioned previously this lifespan could potentially be extended, which could alter the results tremendously.

Cloud hosting was determined to have an initial cost of $3300 for the setup and licensing of the virtual servers. This included the purchase of appropriate licenses for all the users as well as the services of a technician to do the initial configuration. Continuing costs were determined to be $340 a month for the service fees, based on quote from Rackspace, with an annual cost of $1500 to continue the licensing of the software. The total cost was calculated at $29,360. These costs would scale linearly with the number of users depending on the needs of the company and so could increase or decrease.

A calculation to determine the present worth of the options was applied to the numbers so as to better represent the costs and spending power required for each choice. An average annual rate of 3.34% was used as the discount rate based on an average calculated from the Congressional Budget Office. This calculation included the quarterly estimate of the Federal Reserve Rate from Quarter one of 2018 until Quarter one of 2023 so as to include the total period of this study (Congressional Budget Office, 2017). The Federal Fund Rate is used for a number of different interest rate related functions and so represents the minimum return rate that could be expected if the funds for this project were used for market related activities. The annual rate was divided into a monthly rate for the calculations and was determined to be 0.278%. The formula $P = F_n(P|F, i, n)$ was used to convert each cash flow into present values where P is the present value, F_n is the cash flow at period n, i is the discount rate, n is equal to the number of periods, and $(P|F, i, n)$ is the value conversion factor defined as $\frac{1}{(1+i)^n}$. Since monthly compounding is

assumed, i is the monthly discount rate and n is the number of months. After conversion the on-site option was determined to have a net present worth of $28,096.74 after the five-year period. The data for the cloud option was similarly converted and was found to represent a net present worth of $27,299.66 after the same five-year period. The net present worth for the cloud hosting option was calculated using the formula series of $NPW = -3300 - 340(P|F,i,1) - 340(P|F,i,2) - \cdots - 340(P|F,i,59) - 340(P|F,i,60) - 1500(P|F,i,12) - 1500(P|F,i,24) - 1500(P|F,i,36) - 1500(P|F,i,48)$. The Net Present Worth of the Cloud Hosting option was calculated using the formula series of $NPW = -12{,}074 - 600(P|F,i,3) - 600(P|F,i,6) - \cdots - 600(P|F,i,55) - 600(P|F,i,58) - 1500(P|F,i,12) - 1500(P|F,i,24) - 1500(P|F,i,36) - 1500(P|F,i,48)$ (See Appendix).

Both options had significant areas of sensitivity that would alter the outcome if the situation were to change. For the onsite option the biggest areas of sensitivity were the lifespan of the server and the risk of unforeseen technical difficulties. If the lifespan of the server were to be extended due to the option of increasing the length of the warranty or the willingness to forego the warranty altogether then the onsite server's average annual cost would go down considerably due to the expenditure being spread across a greater area. Alternatively, if any sort of additional maintenance or troubleshooting is required then the costs could increase drastically depending on the length of time it takes to resolve the issue.

Cloud hosting's areas of sensitivity were determined to be the number of users and the storage requirements of the business. Since the licensing costs scale linearly depending on the number of users a reduction, or addition, to the user base would have a direct effect on the annual costs incurred. This would allow the business to change its expected cash flow in a very easy to calculate way but if the business were to grow rapidly it could potentially cause large costs to accumulate quickly. Cloud storage tends to be a significant factor in the costs of service so if a company were to need a large volume of storage then the monthly costs could increase significantly, leading to a change in the best option.

A SWOT analysis was also performed to determine the Strengths, Weaknesses, Opportunities, and Threat that come with each option presented. (See Figure 3 and 4) This allowed for a more detailed view of the two options and what factors affected the decision-making process.

INTERNAL FACTORS					
STRENGTHS (+)		IMPORTANCE	WEAKNESSES (–)		IMPORTANCE
1	Physical Control	3	1	Maintenance Costs	1
2	Up Front Costs	1	2	Static Capabilities	2
3	Potentially longer term solution	2	3	Requires higher technical skills	3
4			4		
EXTERNAL FACTORS					
OPPORTUNITIES (+)		IMPORTANCE	THREATS (–)		IMPORTANCE
1	Technology increases productivity	1	1	Environmental Damage	3
2	Multiple Vendors for Support	2	2	Rising maintenance costs	1
3			3	Moving towards cloud based technologies	2
4			4		

Figure 3: On-Site Infrastructure SWOT

INTERNAL FACTORS					
STRENGTHS (+)		IMPORTANCE	WEAKNESSES (–)		IMPORTANCE
1	Redundancy	1	1	Continuous Costs	1
2	Expandability	3	2	Lack of Direct Control	2
3	Consistent Cost	2	3		
4	Physical Security	4	4		
EXTERNAL FACTORS					
OPPORTUNITIES (+)		IMPORTANCE	THREATS (–)		IMPORTANCE
1	Costs are going down	1	1	Hacking attempts on Datacenters	2
2	Performance is improving	2	2	Privacy Violations	1
3			3		
4			4		

Figure 4: Cloud Infrastructure SWOT

The SWOT analysis for the on-site option came up with several strengths that are relevant to a technology upgrade such as this. In order of importance these were physical control, up-front costs, and potential for longer term use. Several weaknesses were also determined by the analysis such as maintenance costs, static capabilities, and a requirement for higher technical skills. Physical control and up-front costs are strengths due to the greater influence over decisions they provide to a company and ability to plan for future costs. The potential for the on-site option to be a longer-term solution is also a strength due to the flexibility it offers a company in deciding when to upgrade their infrastructure again and how they would like that upgrade to be carried out. Maintenance costs are a weakness due to the

company having to continue paying for work to be done on the equipment and if unexpected costs arise then they must be dealt with regardless of the financial situation. The static nature of on-site equipment is also a weakness as it cannot easily adjust to changing circumstances or different business situations. Finally, the higher requirement for technical skill can be a weakness of on-site equipment as the employees of the business may need to troubleshoot problems and if they are not familiar with the equipment more damage may occur.

The opportunities presented by an on-site infrastructure shouldn't be ignored and are things such as the increase in productivity provided by modern technologies as well as the ability to source from many different vendors so as to provide the best possible costs. There are also threats that come from on-site infrastructure as well such as the potential for environmental damage, rising maintenance costs, and the general trend of technology towards cloud environments.

The SWOT analysis for the cloud option provided several strengths such as redundancy, expandability, consistent costs, and physical security. The weaknesses highlighted by the analysis were continuous costs and lack of direct control. A cloud environment provides a high degree of redundancy due to the dispersed nature of the technology and so an infrastructure based on it gains that same level of redundancy. The ability to expand or contract the amount of resources expended by the infrastructure is also a key benefit of a cloud solution. Continuous costs are a weakness of any cloud infrastructure due to the subscription nature of working with cloud providers. There will never be a point at which the business wholly owns the infrastructure that it is using. This point plays into the other major weakness, lack of direct control. If something happens to the infrastructure there is very little a business can do except wait for the vendor to fix the issue.

There are a number of opportunities which also come with the option for cloud infrastructure such as declining costs and improving performance. The potential threats to a cloud environment are things such as hacking attacks on datacenters as well as potential privacy violations resulting from mishandled data. Declining costs are providing constant opportunities for businesses to improve their

infrastructure at a lower investment level, thus allowing for more flexibility in the long term. Businesses are also able to get more power for their money as performance is constantly improving alongside the reduction in costs. Those benefits do come with the potential threat of security breaches beyond the business' control. Should the datacenter housing the company's information be hacked then there is the possibility of data loss or even theft. There is also the possibility that one of the administrators that is paid to oversee the infrastructure could cause a privacy issue for a business.

Chapter 6 Conclusions

The situation that was chosen is a small business with ten employees which only needed one server to do their work. Quotes were generated for equivalent capacities in both the physical and virtual servers so that they could be compared directly. All other costs outside of the server, licensing, and maintenance costs were approximately equivalent between the two options and were therefore removed from the calculation. After taking all these factors into consideration it was determined that neither option is significantly better than the other and so no "best" option existed for this small business. The two options were very close with cloud hosting having a Net Present Worth of $27,299.66 compared with the Net Present Worth of the on-site hosting option at $28,096.74 (See Figure 5). There are several other factors that are difficult to quantify which might influence what decision a business owner might make. However, based purely on the comparison in the net cost over the five-year period the two options are approximately equal.

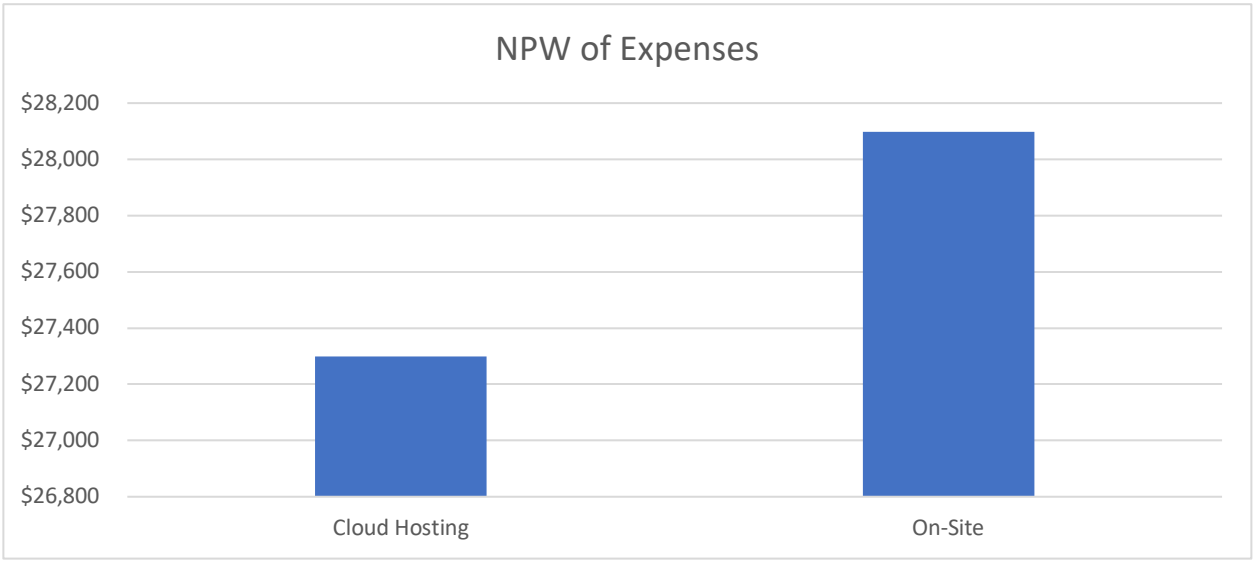

Figure 5: Final Net Costs

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Appendix

		Cloud Hosting	On Site Hosting	Cloud Hosting	On Site Hosting
Date	months	cash flow	cash flow	PV	PV
1/1/18	0	-3300	-12074	-3,300.00	-12,074.00
Feb	1	-340	0	-339.06	0.00
Mar	2	-340	0	-338.12	0.00
Apr	3	-340	-600	-337.18	-595.02
May	4	-340	0	-336.24	0.00
Jun	5	-340	0	-335.31	0.00
Jul	6	-340	-600	-334.38	-590.08
Aug	7	-340	0	-333.45	0.00
Sep	8	-340	0	-332.52	0.00
Oct	9	-340	-600	-331.60	-585.18
Nov	10	-340	0	-330.68	0.00
Dec	11	-340	0	-329.76	0.00
1/1/19	12	-1840	-2100	-1,779.64	-2,031.11
Feb	13	-340	0	-327.93	0.00
Mar	14	-340	0	-327.02	0.00
Apr	15	-340	-600	-326.12	-575.50
May	16	-340	0	-325.21	0.00
Jun	17	-340	0	-324.31	0.00
Jul	18	-340	-600	-323.41	-570.72
Aug	19	-340	0	-322.51	0.00
Sep	20	-340	0	-321.62	0.00
Oct	21	-340	-600	-320.72	-565.98
Nov	22	-340	0	-319.83	0.00
Dec	23	-340	0	-318.94	0.00
1/1/20	24	-1840	-2100	-1,721.26	-1,964.49
Feb	25	-340	0	-317.18	0.00
Mar	26	-340	0	-316.30	0.00
Apr	27	-340	-600	-315.42	-556.62
May	28	-340	0	-314.54	0.00
Jun	29	-340	0	-313.67	0.00
Jul	30	-340	-600	-312.80	-552.00
Aug	31	-340	0	-311.93	0.00
Sep	32	-340	0	-311.07	0.00
Oct	33	-340	-600	-310.20	-547.42
Nov	34	-340	0	-309.34	0.00
Dec	35	-340	0	-308.48	0.00
1/1/20	36	-1840	-2100	-1,664.80	-1,900.04
Feb	37	-340	0	-306.77	0.00
Mar	38	-340	0	-305.92	0.00
Apr	39	-340	-600	-305.07	-538.36
May	40	-340	0	-304.22	0.00
Jun	41	-340	0	-303.38	0.00
Jul	42	-340	-600	-302.54	-533.89
Aug	43	-340	0	-301.70	0.00
Sep	44	-340	0	-300.86	0.00
Oct	45	-340	-600	-300.03	-529.46
Nov	46	-340	0	-299.19	0.00
Dec	47	-340	0	-298.36	0.00
1/1/21	48	-1840	-2100	-1,610.19	-1,837.71
Feb	49	-340	0	-296.71	0.00
Mar	50	-340	0	-295.89	0.00
Apr	51	-340	-600	-295.06	-520.70
May	52	-340	0	-294.25	0.00
Jun	53	-340	0	-293.43	0.00
Jul	54	-340	-600	-292.61	-516.38
Aug	55	-340	0	-291.80	0.00
Sep	56	-340	0	-290.99	0.00
Oct	57	-340	-600	-290.18	-512.09
Nov	58	-340	0	-289.38	0.00
Dec	59	-340	0	-288.58	0.00
		-29360	-29474	-27,299.66	-28,096.74
			difference =	797.08	