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Return on Investment of the CFTP Framework With and Without Risk Assessment

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Abstract

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

In recent years, numerous high tech companies have developed and used technology roadmaps when making their investment decisions. Jay Paap has proposed the Customer Focused Technology Planning (CFTP) framework to draw future technology roadmaps. However, the CFTP framework does not include risk assessment as a critical factor in decision making. The problem addressed in this quantitative study was that high tech companies are either losing money or getting a much smaller than expected return on investment when making technology investment decisions. The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework. Paap's CFTP framework and process to improve technology investments thus served as the theoretical framework for this study. Data were obtained from cloud computing companies using the companies' market risk data and actual returns on investment data. The results and findings of paired sample two-tailed *t* tests for means and equal variances showed that return on investment was positively related to adding a traditional risk assessment model to Paap's CFTP framework. These findings regarding the addition of risk assessment to the technology investment framework may be used by investors to (a) make better and more expeditious decisions, and (b) obtain a high return on technology investment by selecting the highest return value and lowest risk value.

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Dedication

This dissertation was dedicated to my mother, Chi Hing Lee and my father, Dr. Chin Yuan Lee. Also, I would like to dedicate this Doctoral dissertation to my husband, Dr. Alex Lam and our future children.

Acknowledgments

Special thanks to the chairman of my committee, Dr. Mohammad Sharifzadeh, for his exquisite attention to detail and for his demand for excellence in the field of risk management. I am very grateful to my committee member, Dr. Stephanie Hoon, and URR member, Dr. Judie Forbes for their times, their encouragements, and their expertises throughout this project. I would like to thank my faculty coordinator, Dr. Sandy Kolberg for her encouragment on my Ph.D. in Management Program at Walden University.

The completion of this dissertation was dependant as much upon the people who provided emotional support as on those who helped directly with the study. I would like to thanks to my husband, Dr. Alex Lam and my father, Dr. Chin Lee for their emotional supports and encouragements throughout my Doctoral study.

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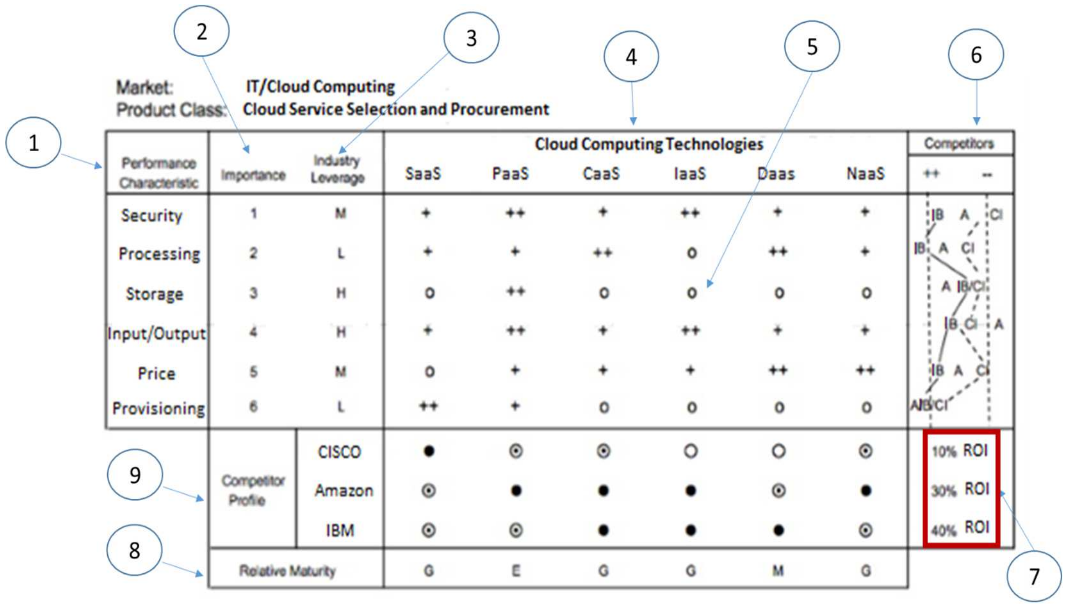
Chapter 1: Introduction to the Study

Introduction

Techonolgy investment frameworks may contribute to the effectiveness of organizational leaders' investment decisions. My research was focused on companies that used the Customer Focused Technology Planning (CFTP) framework (Paap, 2010) to assess companies' technology planning. An example of Paap's CFTP framework without risk assessment is shown in Figure 1. The example showed that organizations using IBM cloud computing services have the highest return on investment (ROI) at 40%. See Appendix C for the steps I took when using Paap's CFTP framework.



Importance: Rank order, **1** is most important

Industry Leverage: **H** = high

M = medium

L = low (refers to customer reaction to performance improvements)

Technology Impact: ++ = technology influences greatly (positive or negative)

\+ = moderate impact

o = low impact

Competitors: **1** = best

2 = second best

3 = third best (ties indicate equal performance)

Competitive profile: ● = strong capability/high investment

⦿ = moderate capability/investment

○ = low capability/investment

Relative maturity **E** = Emerging technology

G = Growing technology

M = Mature technology

Figure 1. Paap's CFTP framework without risk assessment. From *Customer focused technology planning: An overview*, by J. Paap, 2010, p. 15. Retrieved from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

Although Jurimae (2010) and Wilkinson (2009) have stressed the importance of risk assessment when making decisions about technology investment, Paap's framework does not include risk assessment for technology implementation. In my quantitative study, I sought to resolve the gap of missing risk assessment to potentially help organizations reduce monetary loss and increase ROI when making technology investment decisions. An example of Paap's CFTP framework with added risk assessment is shown in Figure 2. In Figure 2, the example showed that organizations using Amazon cloud computing was the best to make your investment decision based on the lowest risk of 4 and medium ROI of 30% compared to IBM Cloud Computing Services with medium risk of 9 and medium ROI of 40%, as well as, CISCO Cloud Computing with high risk of 16 and lowest ROI of 10%. In a perfect scenario, the investment decision would be based on determining the lowest risk and the highest ROI. See Appendix D for how I added risk assessment to Paap's CFTP framework.

Market: IT/Cloud Computing
Product Class: Cloud Service Selection and Procurement

Performance Characteristic	Importance	Industry Leverage	SaaS	PaaS	CaaS	IaaS	Daas	NaaS	Competitors ++ … --	Risk
			Cloud Computing Technologies							
Security	1	M	+	++	+	++	+	+	IB A CI	
Processing	2	L	+	+	++	o	++	+	IB A CI	
Storage	3	H	o	++	o	o	o	o	A IB/CI	
Input/Output	4	H	+	++	+	++	+	+	IB CI A	
Price	5	M	o	+	+	+	++	++	IB A CI	
Provisioning	6	L	++	+	o	o	o	o	A/IB/CI	
Competitor Profile		CISCO	●	⊙	⊙	○	○	⊙	10% ROI	16 High
		Amazon	⊙	●	●	●	⊙	●	30% ROI	4 Low
		IBM	⊙	⊙	●	●	●	⊙	40% ROI	9 Med
	Relative Maturity		G	E	G	G	M	G		

Importance: Rank order, **1** is most important
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Figure 2. Paap's CFTP framework with added risk assessment. Adapted from *Customer focused technology planning: An overview*, by J. Paap, 2010, p. 15. Retreived from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

By adding risk assessment to Paap's CFTP framework, high tech companies and their technologists, investment strategists, and researchers might improve their technology decision making processes for investments, which may result in higher returns on their investments. My quantitative research study might contribute to positive social change by providing information organizational leaders can use to create stronger businesses that may help grow the global economy. Furthermore, the addition of risk assessment to Paap's CFTP theoretical framework could be useful to the risk management field in by helping leaders better understand both investor intent and technology investment relationships.

Chapter 1 contains an introduction to Paap's CFTP framework for drawing future technology roadmaps. Although Jurimae (2010), Wilkinson (2009), Valerdi and Kohl (2004) have stressed the importance of and need for risk assessment when making decisions about technology investment, Paap's CFTP framework does not include risk assessment for technology implementation. The major sections in this chapter include discussions of (a) the quantitative research purpose, (b) the theoretical framework, (c) the nature of study, (d) quantitative measurement tools, (e) data collection techniques, (f) the limitations of the study, and (g) the positive social change implications of the study.

Background

Lopez-Ortega, Concepcion, and Viloria (2006) suggested using technology roadmaps and technology intelligence to improve the technology investment decision-making process. The outcome of this strategic decision-making process must satisfy the following three criteria: (a) the planning process was centered on a specific technological field of interest, (b) the participation in specific fields of interest and clear representation of technological investment objectives; (c) the high tech company developed a technology intelligent system in each specific technological field selected (Lopez-Ortega, Concepcion, & Viloria, 2006). Paap (2010) developed his new framework to provide a better technology roadmap method to improve descision making on technology investment. He proposed the idea of the CFTP framework for drawing future technology roadmaps to help technologists, investment strategists, and researchers make more informed decisions, and to do so as effectively and efficiently as possible. Paap's CFTP framework includes six factors that help companies determine which technology is most beneficial (see Figure 3). The first factor is *Who and Why* box. The *Who and Why* box is used to assess the product class relative to the market segment. Product class refers to a broad range of related products or services used to address a customer need. The market segments are investment decision patterns. The high interest segment means payoff clusters for detailed assessment to save time and cost. Also, the *Who and Why* box provides the comprehensive assessments of high interest segments including: (a) company objectives (image, ROI, share, growth, harvest, etc.), (b) market characteristics (size, growth, profits, image, synergy, etc.), and (c) competition (share, capabilities, intentions, etc.).

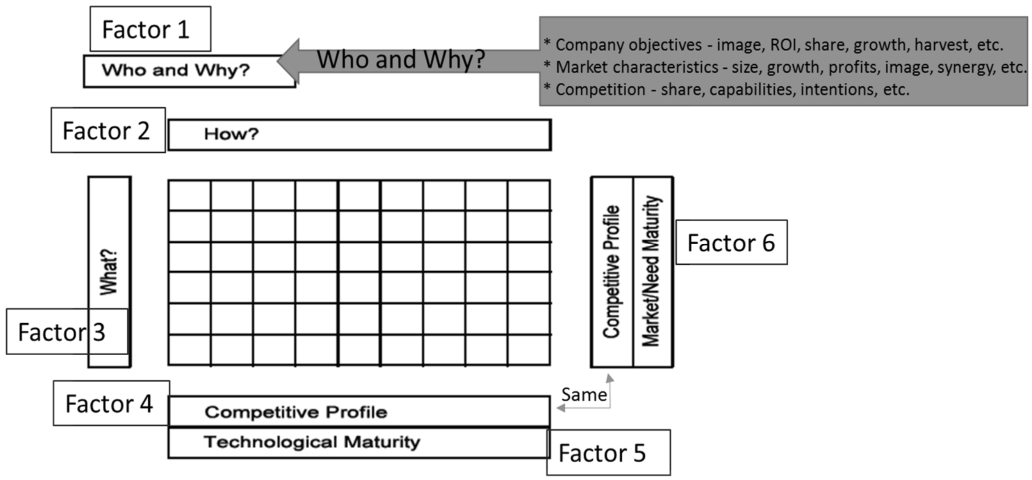

Figure 3. Paap's six factors. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retreived from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

The market segment of my study was informaton technology (IT)/cloud computing, and the product class of my study was cloud computing service selection and procurement.

The second factor of Paap's CFTP framwork is *How* box. The *How* box is used to identify the technology options available to provide, maintain, or improve important and leveragable characteristics. Paap's guidelines for assessing technology options and relationships are:

- Identify technologies that do or might affect important leverage characteristics.
- Rank or rate the potential for the technology to maintain or improve characteristics of importance.
- Estimate relative maturity and anticipate potential for obsolescence or substitution.
- Determine the competitive relationship of technology as: (a) base (necessary and available to all), (b) key (source of competitive advantage), (c) pacing

(technology expected to be future key), (d) exploratory (early stage with unclear potential).

• Use benchmarking to compare competitors and identify "best in class," investment level, experience, strengths, and so on.

The third factor is called *What* box. The *What* box is used to identify what drove the purchase or use decision. In my selected IT/cloud computing market segment, I first assessed the characteristics that drove companies' decisions to use cloud computing services and procure them from a specific product class. The performance characteristics should also include factors important to interested third parties who influence the customers' buying decision, such as the third party's procurement department, regulators, or advocacy groups.

To fully understand what drives the purchase or use decision, it was often necessary for project managers to consider cloud computing product performance characteristics such as security, processing, storage, input/output, price, and provisioning. Papp has divided assessment of performace characteristics into six steps. Step 1 is to think broadly when defining the customer, and to consider users, buyers, decision influencers, and so on. Step 2 is to list decision factors used by customers according to categories on the sample chart as a starting point. This starts with understanding the features they now desire, thinking backward to the needs these are addressing, and then identifying additional features that may also meet those needs. Step 3 is to rank and/or rate the past, present, and future importance of the features and/or needs. Step 4 is to determine whether an improvement in the performance characteristic will increase use of the product or service. The performance characteristic is a function of need maturity, and the extent to which the underlying need is addressed drives decisions. The project manager determine the minimum level of the performance that needs to be offered in order for the product to be taken seriously in the market. The project manager also determine the desired level, because further change was not perceivable, cannot be used, or becomes less important than making improvements in another need or driver. Step 5 is to compare competitors on each characteristic to determine “best in class” through benchmarking. In addition, the most important consideration in this analysis deals with the concept of leverage. Leverage is related to, but different from, importance because importance is an absolute rating or ranking of all features or characteristics.

Competitive Profile box, the fourth factor in Paap’s CFTP, refers to each competitor’s and/or company’s strength in the technology and ability to provide the customers what they want in terms of delivering the right product requirements. Competitive profile is categorized as strong, moderate, or low capability investments.

The fifth factor is *Technology Maturity* box that describes the approximate level of improvement in the product and/or service. The project manager determine the maturity of the technology was based on the Technology Readiness Level (TRL) evaluations. The TRL was based on a scale from 1 to 9 with 9 being the most mature technology. TRL 1 is the basic technology research maturity level. TRL 2 is the technology concept and/or application maturity level. TRL 3 is the analytical and experimental critical function and/or characteristic proof of concept maturity level. TRL 4 is the component and/or breadboard validation in laboratory environment maturity level. TRL 5 is the component and/or breadboard validation in releant environment maturity level. TRL 6 is the system/subsystem model or prototype demonstration in a relevant environment maturity level. TRL 7 is the system prototype demonstration in an operational environment maturity level. TRL 8 is the actual system completed and qualified through test and demonstration maturity level. TRL 9 is the actual system proven through successful mission operations maturity level. In addition, an important task in the CFTP framework is to understand the relative maturity of the technology. Paap categorized relative maturity according to the levels *emerging technology, growing technology*, and *mature technology*. However, the relative maturity of the technology is only part of the technology intelligence needed. The user must ask: Where is the competition relative to you? What new technologies are attempting to replace the current technology base? Will new technology take its place when the technology matures? Or will technology become less important as competitors' capabilities equalize?

The sixth factor is *Market/Need Maturity* box that shows an organization's success in the marketplace. The sixth factor helps technology investors understand the dynamic environment in which needs constantly evolve and technologies mature and are replaced by newer ones. It helps companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the probability for investment success.

The output of Paap's CFTP framework is shown in Figure 4. The CFTP framework helps high tech companies integrate the diverse sources of information needed to decide where to invest to get the greatest return from their technology dollars. Paap's

CFTP framework helps high tech companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the technology investment probability for success. See Appendix B for information on building Paap's CFTP framework.

Market: IT/Cloud Computing
Product Class: Cloud Service Selection and Procurement

Performance Characteristic	Importance	Industry Leverage	Cloud Computing Technologies: SaaS	PaaS	CaaS	IaaS	Daas	NaaS	Competitors (++ / –)
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Processing	2	L	+	+	++	o	++	+	IB A CI
Storage	3	H	o	++	o	o	o	o	A IB/CI
Input/Output	4	H	+	++	+	++	+	+	IB CI A
Price	5	M	o	+	+	+	++	++	IB A CI
Provisioning	6	L	++	+	o	o	o	o	A/IB/CI
Competitor Profile		CISCO	●	⊙	⊙	○	○	⊙	10% ROI
		Amazon	⊙	●	●	●	⊙	●	30% ROI
		IBM	⊙	⊙	●	●	●	⊙	40% ROI
	Relative Maturity		G	E	G	G	M	G	

Figure 4. Paap's CFTP framework development. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retrieved from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

According to the Paap Associates Consulting website (2013), around 350 organizations are currently using Paap's CFTP framework. These organizations are located in North America, Latin America, Europe, Africa, the Middle East, Asia, and the Pacific region. Paap's CFTP framework has been used in both government and commercial organizations from such diverse industries as automotive, computers, electronics, energy, food processing, biotech, pharmaceuticals, oil, telecommunications, consumer products, aerospace, chemicals, defense, and various government agencies and federal labs.

IBM Institute for Business Value (2012) published an executive report on their new Cloud Enablement Framework (CEF) that helps organizations understand the relationship between cloud investments, value propositions, and value chains. The IBM CEF is a competitive framework to Paap's CFTP. Although Jurimae (2010), Wilkinson (2009), Valerdi and Kohl (2004) have stressed the importance of risk assessment when making decisions about technology investment, both the IBM CEF and Paap CFTP frameworks do not include risk assessment of technology implementation. Jurimae introduced the idea that technology risk management can enhance technology procurement, and identified two barriers the stem from not using risk assessment in technology procurement. The first barrier is the issue of failure of new technology because of the increased level of risk during the research and development phase. Another barrier for technology procurement is identifying and managing risk using the technology roadmap (i.e., the technology planning phase). Therefore, Jurimae noted that the process of technology procurement consists of technological risks. Jurimae's primary focus was on technological risks that impact performance of both service and product production from the high tech companies. Other technological risks include contract design and an award evaluation process not adequate for technology. Last but not least, the risks of selecting the wrong technology may create problems, such as compatability issues, if the procurement takes place before the market research is completed. Jurimae

(2010) concluded that an early stage of technology planning can help define some investment options.

Wilkinson (2009) has stressed that technology investment failure results from unrealistic expectations and failure to recognize the risks. Therefore, in this study I sought to enhance strategic decision making using risk assessment. Risk assessment covers the potential impacts and mitigating strategies to impove decision making in technology investment. By using risk assessment in their technology decisions, companies may have increased knowledge of the risks to their decisions.

Statement of the Problem

Jiang and Ruan (2010) recognized that one of the primary reasons for technology investment losses was companies not performing risk assessments when making technology investment decisions. Current studies are missing a robust investment framework with added risk assessment that can be used to reduce profit loss. Bakht (2015) also recognized the problem of the lack of risk assessment in technology investment, such as science risk, technology risk, market risk, and regulatory risk. Without risk assessment, investors have little choice but to make riskier and riskier technology investment decisions that potentially lead to profit loss. The problem I addressed in this study was that high tech companies are either losing money or getting a much smaller than expected ROI when making technology investment decisions.

This quantitative study may resolve the gap of missing risk assessment that may help to reduce monetary loss and increase ROI for firms making technology investment decisions using Paap's CFTP or similar frameworks IBM's CEF. I use a cross-sectional design to determine the ROIs of 35 cloud computing companies located in the United States before and after adding risk assessment to Paap’s CFTP.

Purpose of the Study

The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework. By adding traditional risk assessment to the CFTP framework, high tech companies and their technologists, investment strategists, and researchers might improve their technology decision making processes for investments which may result in a higher return on their investments.

This quantitative study was needed to resolve the gap of missing risk assessment that may help to reduce monetary loss and increase ROI when for organizations making technology investment decisions using Paap’s CFTP or similar frameworks. My findings might be used by stakeholders to improve technology decision-making processes and create a new technology management model. I believed the most important goal for a technology company is making the right decisions that will maximize investment benefits while minimizing risk. I thus sought to examine if Paap’s CFTP framework, when used in in conjunction with risk assessment, contributes to improved ROI for cloud computing technologies.

Quantitative measurement includes dependent and independent variables. In my study, the dependent variable was ROI. The independent variable was market risk. In this study, the risk assessment independent variable was an antecedent condition affecting the ROI dependent variable, and the ROI dependent variable was the outcome.

Research Question

I conducted a study to determine the consequences of adding a traditional risk assessment model to Paap's CFTP framework. The research question was: What is the relationship to the return on investment by adding traditional risk assessment model to Paap's CFTP framework?

Research Hypotheses

The quantitative measurements included a dependent variable and an independent variable. The influence of this market risk assessment independent variable on Paap's CFTP ROI dependent variable yielded the following hypotheses:

The null hypothesis (H_0): The return on investment may not be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The alternative hypothesis (H_1): The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The paired sample two-tailed *t* tests methodology was used to test above hypothesis. The convention mathematical format is:

A two-tailed test: $\begin{matrix} H_o : \mu_1 - \mu_2 = 0 \\ H_1 : \mu_1 - \mu_2 \neq 0 \end{matrix}$, the *p*-value is 0.000 (Reject at $\alpha = 5\%$)

where μ_1 is the mean of first population (Before: No risk) and μ_2 (After: Added risk) is the mean of the second population. The null hypothesis $H_o : \mu_1 - \mu_2$ equals 0 represents the condition that the populations are centered in the same spot. The two sided alternative hypothesis is that the means difference and $H_1 : \mu_1 - \mu_2$ does not equal 0. The additional risk factor was market risk in cloud computing technology.

Theoretical Framework

In this study, I investigated Jay Paap's CFTP framework and process to improve technology investments. Another framework related to technology investment is Benaroch, Lichtenstein, and Robinson's (2006) option-based risk management (OBRiM) theoretical framework. The OBRiM theoretical framework provides IT managers better understanding of which risk mitigation strategy should be pursued in order to effectively assess and handle technology risk. I also researched Lopez-Ortega, Concepcion, and Viloria's (2006) technology intelligence system (TIS) technology investment theory. Lopez-Ortega, Concepcion, and Viloria's (2006) theory provided the basics of competitor behavior, technology management, and strategic decision making on technology investment. Barnier (2014) describes how risk assessment will help investors make better decisions quicker, which will then result in a higher ROI. Barnier's assumption was that world-class organizations are the ones that are able to set up their decision-makings through a standardized technology framework with risk assessment in order to yield a higher ROI.

Jay Paap's CFTP is a planning framework designed to help firms focus their technology investments in areas that will have a significant relationship to their markets, their operations, and their shareholders. CFTP starts with the collection of information on product capabilities, customer needs, technological maturity, and potential competitors.

Given the complexity and diversity of information, Paap's CFTP planning framework uses a structured approach to building technology plans to support new product and service initiatives. The CFTP has four planning steps:

1. Develop market profile.
2. Create a technology roadmap.
3. Identify technology investment opportunities.
4. Select projects and set priorities based on the business and technology strategies.

Paap's CFTP Who and Why box provides the high tech company's ROI dependent variable.

Albright and Kappel (2003) emphasized the importance of risk roadmaps to technology planning. A risk roadmap can be used to identify major risk events for monitoring during technology plan execution. The goal is to minimize the technological risk or to limit its impact on a product investment and development. Albright and Kappel (2003) used new risk management techniques to assess technology risk. These new techniques, that they called neural networks and fuzzy logic (neuro-fuzzy), have three distinguishing areas: (a) active monitoring to ensure the technology investment decision's sensitivity to detecting risk, (b) agility to ensure its flexibility to respond to risk, and (c) adaptive learning to ensure the capability of the technology investment decision's resources to mitigate risk. After I investigated the neuro-fuzzy adaptive risk assessment and realized such an approach would require large data sets for training the neural networks, I decided to use the traditional risk assessment model. The traditional risk assessment model was calculated by Risk = Likelihood × Consequence.

I used the theoretical action research cycle to modify Paap's CFTP technology framework. A pictorial representation of the theoretical action research cycle is shown in Figure 5. Deming (1982) was the first to present the theory and concepts of the action research cycle. The action research cycle was part of the theoretical framework used to develop a solution to a specific issue between experts and researchers involving the change process and the action needed for fact finding.

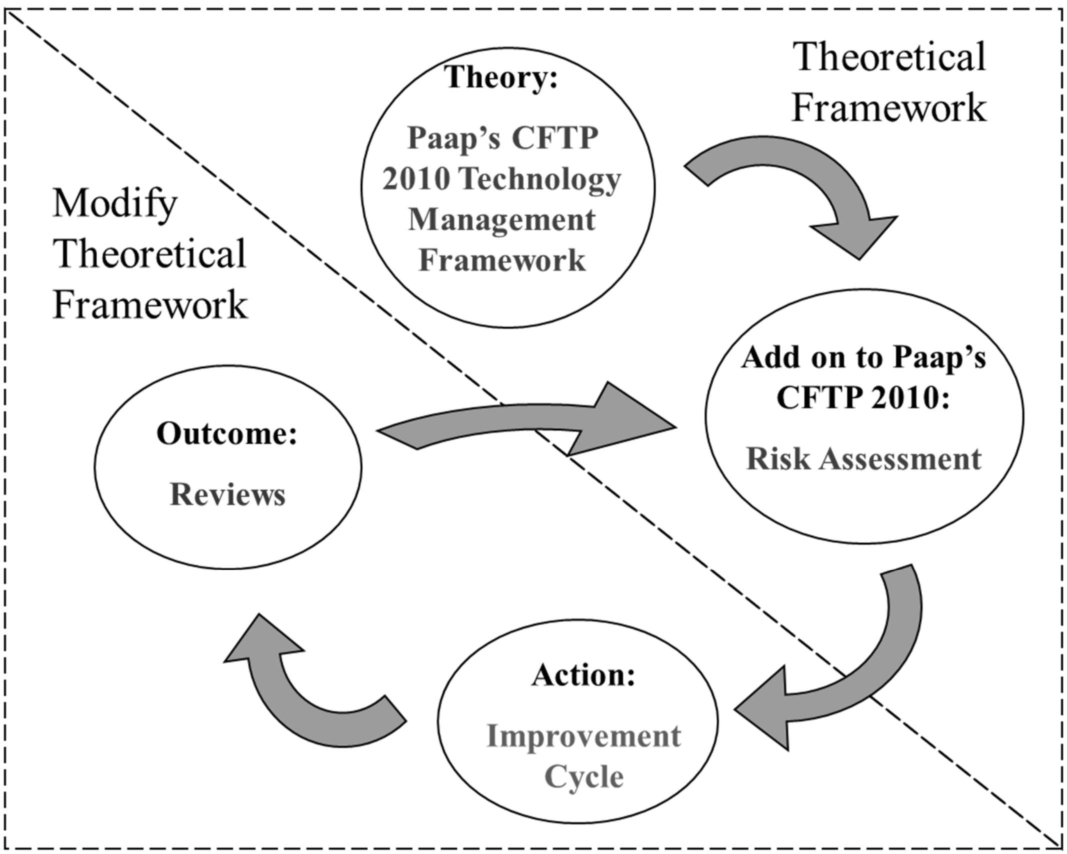


Figure 5. Modify theory and action research cycle.

Nature of the Study

I used a cross-sectional quantitative research design (i.e., ex-post facto design) to compare the ROI using Paap's CFTP framework with and without risk assessment for cloud computing companies. By adding traditional risk assessment to the framework, the high tech companies and their technologists, investment strategists, and researchers may improve their technology decision making processes for investments, which might result in a higher return on their investments. My quantitative study showed an improvement using traditional risk management application.

Quantitative measurement includes dependent and independent variables. The dependent variable in this study was ROI. The independent variable was market risk. In my study, the risk assessment independent variable was an antecedent condition affecting the ROI dependent variable.

ROI is a measure of the profit earned from each investment. To calculate ROI, the return of an investment was divided by the cost of the investment. The result was expressed as a percentage or a ratio in Equation 1:

$$\text{ROI (\%)} = [(\text{Gross Profit} - \text{Investment}) / \text{Investment}] \times 100$$

To get a better idea of how ROI was different from profit, let's compare two investment scenarios and have a look at the profit and ROI of each: an investment of $100,000 that led to a gross profit of $150,000, and an investment of $10,000,000 that led to a gross profit of $15,000,000. In the first scenario the net profit was $50,000, whereas in the second one the net profit was $5,000,000. Using the same two scenarios, we can easily calculate the ROI for each, as follows: ROI = [(150,000 – 100,000) / 100,000] x 100 and

ROI = [(15,000,000 – 10,000,000) / 10,000,000] x 100. The result was 50 in both cases, meaning that both scenarios had a return of investment of 50%.

Risk was measure of a combination of the probability of occurrence of an event (aka. likelihood) and its consequence. The traditional risk assessment was calculated using Equation 2:

Risk = Likelihood × Consequence

I used a paired sample two-tailed *t* tests to compare Paap's CFTP ROI variable with and without traditional risk assessment associated with multiple technology project investments. The alpha level was set at 0.05. See Chapter 3 for specifics regarding the paired sample two-tailed *t* tests.

Operational Definition of Terms

The dependent variable was ROI. The independent variable was market risk assessment.

Assessment of risk: The process of evaluating the potential risks using the measurement of a combination of the probability of occurrence of an event (i.e., the likelihood), multiplied by the consequence (Zavadskas, Turskis, & Tamošaitienė, 2010).

Decision driver: The performance characteristics with the greatest influence on the purchase or use decision (Paap, 2010).

Innovation: The use of an old or new technology to improve the performance of a new or old process, product or service sufficiently valued by potential users that they will adopt it (Paap, 2010).

Risk management: A process to identify, assess, and prioritize risks (Jurimae, 2010).

Market risk: The uncertainty of market competition, such as market prospects, product competitiveness, potential competitors, and marketing abilities (Albright & Kappel, 2003).

Production risk: Uncertainties of production level, such as equipment, production process change, production personnel constitution, and raw material supply (Albright & Kappel, 2003).

Research and development (R&D) risks: The uncertainty of the R&D goal and condition changes during R&D activities (Albright & Kappel, 2003).

Return on investment (ROI): Impact results of creating a new technology over the company investments (Paap, 2010). ROI is a measure of the profit earned from each investment. To calculate ROI, the return of an investment was divided by the cost of the investment; the result was expressed as a percentage or a ratio.

ROI (%) = [(Gross Profit – Investment) / Investment] × 100

Risk limit: The point beyond which the user or purchaser of a product or service no longer values the risk performance improvements (Paap, 2010).

Technology leverage: The extent to which an improvement in a performance characteristic is perceived as having value by the users, purchaser, or influencer (Paap, 2010).

Technology life cycle: The roadmap of future technology and the investment risk over a period of time (e.g., short term investment or long term investment; Jurimae, 2010).

Technology maturity: The stage of technology readiness level (Paap, 2010).

Technology risks: The probability of how mature the technology through the measurement of a technical development in which the outcome was uncertain. (Wilkinson, 2009).

Assumptions

According to Ulieru and Worthington (2006), bias occurs when people make assumptions about preferences or abilities of others based on their cultural, racial, ethnic, and gender characteristics. Therefore, my study was structured by the underlying assumption that the data does not contain cultural, racial, ethnic, and gender biases. Any of these biases may impact my traditional risk assessment model. Another assumption was that the data from the participants can be correctly measured. If the participant data does not satisfy these assumptions, the statistical results will not be a precise reflection of reality. If this assumption was not met, it could affect the way the results are interpreted and could lead to serious errors in the statistical tests.

Scope/Delimitations

My research population was limited to 35 cloud computing companies located in the United States that invested $100 million or more in cloud computing technology. This population carries a temporal limitation, because cloud computing was a technology trend that started in 2009. In practice, the sample size used in this study was determined based on the expense of data collection and the need to have sufficient statistical power. Therefore, I performed a power analysis for my cross-sectional design. The power analysis showed that I needed a total sample size of 24 to determine the probability of detecting an effect of a given size with a given level of confidence, under sample size constraints.

The data I used in developing the revised CFTP framework were from 35 cloud computing companies. The 35 cloud computing companies provided the data to compare the output of Paap's ROI with and without risk assessment. This traditional risk assessment model can potentially be used by any high tech company. The research excluded an investigation of Shortreed, Hicks, and Craig's (2003) generalized risk management framework (RMF). A generalized RMF defines the processes and the order and timing of processes that are used to manage risks.

Limitations

One limitation of this cross-sectional study was that the risk calculations were based on the subjective opinions of people using the 5x5 traditional risk matrix. Therefore, the results of my study are dependent on people's accurate determination of risk. Another limitation was that the data collected for the research was from the economic downturn experienced from 2009 to 2014, which caused a decrease in the amount of money invested in technology research. This, in turn, reduced the number of companies that could participate in this study.

Significance of the Study

The value and benefit of my research is that it may be used to improve technology decision-making processes and create a new technology management model. A quantitative study that added risk assessment to Paap's CFTP framework was necessary to improve investment decision-making, and possibly to protect from another financial crash, such as the 2008 global financial crisis. Being able to incorporate the risk assessment into Paap's CFTP framework may allow for better risk management within investment portfolios involved in these high tech cloud computing companies. The positive social change that may result from this research is better risk control in cloud computing investment portfolios. This may create stronger businesses that grow the global economy. Additionally, the main significance of this study was that the results may help further improve technology planning processes and better meet the needs of the cloud computing companies and their technologists, investment strategists, and researchers. Also, this research can be valuable to economists, policymakers, and market participant.

Importance for Social Change

The positive social change that may result from this research is better risk control in cloud computing investment portfolios. This positive social change may create stronger businesses that may help grow the global economy. Additionally, the main significance of this study was that the results may help further improve technology planning processes and better meet the needs of the cloud computing companies and their technologists, investment strategists, and researchers. Also, this research can be valuable to economists, policymakers, and market participant.

Summary

In Chapter 1, I proposed adding a traditional risk assessment model to Paap's CFTP framework. The problem was that high tech companies are either losing money or getting a much smaller than expected ROI when making technology investment decisions. The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework. The quantitative study resolved the gap of missing risk assessment that helped to reduce monetary loss and increase return on investment when making technology investment decisions. This research may be used to improve technology decision-making processes and create a new technology management framework. In addition, I presented the research question and hypotheses and discussed the theoretical framework, operational definition of terms, assumptions, limitations, and scope, as well as the significance of the study and its consequences for social change. In Chapter 2, I offer a review of the professional and academic literature related to my research problem.

Chapter 2: Review of Literature

Paap's CFTP is a planning framework to help technology investors create a profile of technology investments. The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework . The literature review formed the basis of this quantitative study. The primary research question I addressed in the study was: What is the relationship to the return on investment by adding traditional risk assessment to Paap's CFTP framework? I conducted a review of the academic literature and established the context for the problem statement. The problem was that high tech companies are either losing money or getting a much smaller than expected ROI when making technology investment decisions. Jiang and Ruan (2010) recognized that one of the primary reasons for these losses was that companies were not performing risk assessment when making technology investment decisions. Current studies are missing a robust investment framework with added risk assessment to reduce profit loss. Bakht (2015) also recognized the lack of risk assessment in technology investment, including assesment of science risk, technology risk, market risk, and regulatory risk.

Without risk assessment, investors have little choice but to make riskier and riskier technology investment decisions that leads to profit loss. For example, Merrill and Kang's (2014) research results showed a potential number of hidden costs with cloud computing that many may not have considered. Therefore, they determined that risk assessment was the next step needed to predict the actual costs of cloud computing and the potential ROI. The results of Barnier's (2014) research showed the benefits of risk assessment. The benefits help investors make better decisions and more quickly, and also help them consider the opportunities for cost savings in technology investment. In my quantitative study, I resolved the gap of missing risk assessment that helped to reduce monetary loss and increase return on investment when making technology investment decisions. My research involved adding risk assessment to Paap's CFTP framework in order to help investors: (a) make better decisions, quicker; and (b) obtain a high return on technology investment. By adding traditional risk assessment to the framework, the high tech companies and their technologists, investment strategists, and researchers may improve their technology decision making processes for investments, which might result in a higher return on those investments.

The review of the literature begins with an overview of technology strategic planning framework. The literature review next includes summaries of technology investment profile. The review content includes technology investments opportunities and financial growth. The review also includes discussion of the risk and technology management. The review discussion compared two models for the study: a) Neuro-Fuzzy Risk Assessment Model and b) Traditional Risk Assessment Model. The literature review concludes with a description of the potential relationship on ROI with and without risk assessment.

Literature compiled for the review included peer-reviewed and other scholarly journal articles, published books, technical and business reports. Website content and technology investment articles served as supporting evidence for my study. I also obtained documents from online databases available through the Walden University

Library, with specific databases used including Business Source Complete, EBSCO, IEEE Xplore, National Bureau of Economic Research, SAGE Premier, ProQuest Central, and ScienceDirect. Use of the Google search engine enabled the identification of technical and business reports of relevance to the study topic. Jay Paap Associates website served as the source for 2010 CFTP theoretical framework for the study.

Additionally, the literature review provided background information for my research dependent and independent variables. The dependent variable was ROI. The independent variable was market risk assessment. Also, the new cloud computing technology domains cut across these complex risk assessments and are directly affected by decision making processes on future technology investments. The list of key search terms are technology planning, technology roadmap, adaptive risk assessment, traditional risk assessment, return on investment (ROI), and technology investment.

In this section, I included the scope of literature searches between the year of 2009 and the year of 2014. The review was based on peer-reviewed sources from the Business Source Complete, EBSCO, IEEE Xplore, National Bureau of Economic Research, SAGE Premier, ProQuest Central, and ScienceDirect databases. The following key words were used: *business, technology, risk management, economic and investments*. The source of literature search are business sources, IEEE peer-reviewed technical papers, economic research peer-reviewed papers, technical and business reports, as well as, Jay Paap Associates website served as the source for 2010 CFTP theoretical framework for the study.

Technology Strategic Planning Framework

Jay Paap (2010) designed the CFTP planning framework to help firms focus their technology investments in areas that will have a significant relationship to their markets, their operations, and their shareholders.

Paap's CFTP framework provides six factors that help companies to determine which technology was most beneficial. Paap lists the generic CFTP framework with six factors shown in Figure 6. The first factor was the *Who and Why* box. The *Who and Why* box was to assess the product class vs. the market segment. Product class refers to a broad range of related products or services used to address a customer need. The market segments are investment decision patterns. The high interest segment means payoff clusters for detailed assessment to save time and cost. Also, the *Who and Why* box provides the comprehensive assessments of high interest segments:

- Company objectives - image, ROI, share, growth, harvest, etc.
- Market characteristics - size, growth, profits, image, synergy, etc.
- Competition - share, capabilities, intentions, etc.

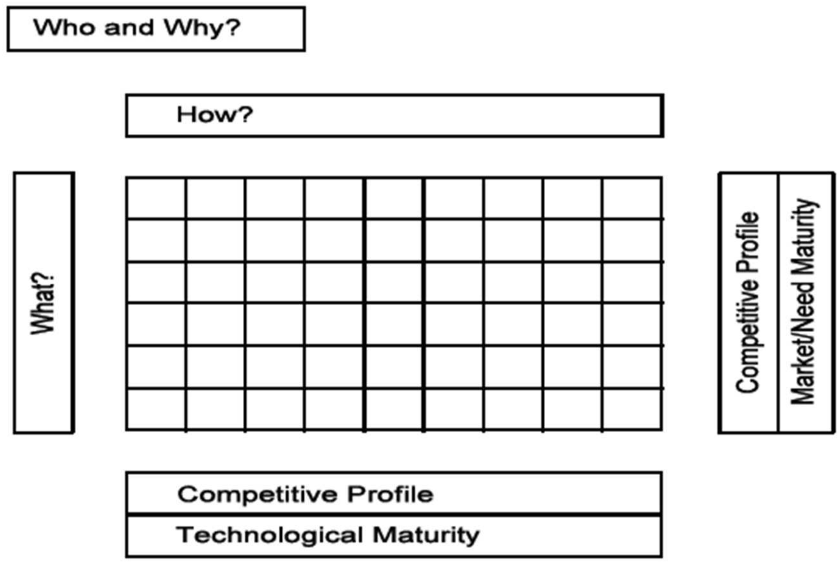


Figure 6. Generic CFTP framework. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retrieved from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

The market segment of my study was Informaton Technology (IT)/Cloud Computing and the product class of my study was cloud computing service selection and procurement.

The second factor was Paap's CFTP How box. The *How box* was to identify the technology options available to provide, maintain, or improve important and leveragable characteristics. The guidelines for assessing technology options and relationships are listed below:

• Identify technologies that do or might affect important leverage characteristics.

• Rank or rate the potential for the technology to maintain or improve characteristics of importance.

• Estimate relative maturity and anticipate potential for obsolescence or substitution.

• Determine the competitive relationship of technology:

- Base - necessary and available to all

- Key - source of competitive advantage

- Pacing - technology expected to be future key

- Exploratory - early stage with unclear potential

• Use benchmarking to compare competitors and identify "best in class", investment level, experience, strengths, etc.

The third factor was called the *What box*. The "What box" states what drove the purchase or use decision. In my selected IT/Cloud Computing market segment, I first assess the characteristics that drive the decision to use cloud computing service slection and procurement product class. The performance characteristics should also include factors important to interested third parties who influence the customers' buying decision, such as the third party's procurement department, regulators, or advocacy groups. To fully understand what drives the purchase or use decision, it was often necessary to consider cloud computing product performance characteristics such as security, processing, storage, input/output, price, and provisioning. The steps on how to assess performance characteristics were listed as: Step 1 is to think broadly when defining customer; consider users, buyers, decision influencers, etc. Step 2 is to list decision factors used by customers using categories on the sample chart as a starting point. This starts with understanding the features they now desire, thinking backward to the needs these are addressing, and then identifying additional features that may also meet those needs. Step 3 is to rank and/or rate the past, present and future importance of the features and or needs. Step 4 is to determine whether an improvement in the performance characteristic will increase the use of your product or service - its leverage. The performance characteristic was a function of need maturity and the extent to which the underlying need being addressed drives decisions. Determine the minimum level of the performance that needs to be offered in order for the product to be taken seriously in the market. Determine the desired level, because further change was not perceivable, cannot be used, or becomes less important than making improvements in another need or driver. Step 5 is to compare competitors on each characteristic, such as determining "best in class" through benchmarking. In addition, the most important consideration in this analysis deals with the concept of leverage. Leverage was related to, but different from importance. Importance was an absolute rating or ranking of all features or characteristics. In addition, the most important consideration in this analysis deals with the concept of leverage. Leverage was related to, but different from importance. Importance was an absolute rating or ranking of all features or characteristics.

The *Competitive Profile* box, also known as Paap's CFTP fourth factor, refers to the strength in the technology by each competitor and/or company, as well as, providing the customers what they want in terms of delivering the right product requirements. Competitive profile was categorized as strong, moderate, or low capability investments.

The fifth factor was the *Technology Maturity* box that described the approximate level of improvement in the product and/or service. The maturity of the technology was defined by the Technology Readiness Levels (TRL). The TRL was based on a scale from

1 to 9 with 9 being the most mature technology. TRL 1 is the basic technology research maturity level. TRL 2 is the technology concept and/or application maturity level. TRL 3 is the analytical and experimental critical function and/or characteristic proof of concept maturity level. TRL 4 is the component and/or breadboard validation in laboratory environment maturity level. TRL 5 is the component and/or breadboard validation in releant environment maturity level. TRL 6 is the system/subsystem model or prototype demonstration in a relevant environment maturity level. TRL 7 is the system prototype demonstration in an operational environment maturity level. TRL 8 is the actual system completed and qualified through test and demonstration maturity level. TRL 9 is the actual system proven through successful mission operations maturity level. In addition, an important task of the Paap's CFTP framework was to understand the relative maturity of the technology. Relative maturity was categorized as emerging technology, growing technology, and mature technology. The relative maturity of the technology was only part of the technology intelligence needed. Where is the competition relative to you? What new technologies are attempting to replace the current technology base? Will new technology take its place, when the technology matures? Or will technology become less important as competitors' capabilities equalize?

The sixth factor was the *Market/Need Maturity* box that states your success in the marketplace. The sixth factor helps technology investors to understand the dynamic environment in which needs constantly evolve and technologies mature and are replaced by newer ones. It helps companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the success investment probability.

The output of the Paap's CFTP framework with six factors needed to understand the link between customers' needs and technology investment options was shown on figure 7. The Paap's CFTP framework helps high tech companies integrate the diverse sources of information needed to decide where to invest to get the greatest return from their technology dollars. Paap's CFTP framework helps high tech companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the technology investment probability. See Appendix B for building Paap's CFTP Framework. A good technology plan should cover technology decisions in the mission of the organization to increase operational efficiency and effectiveness.

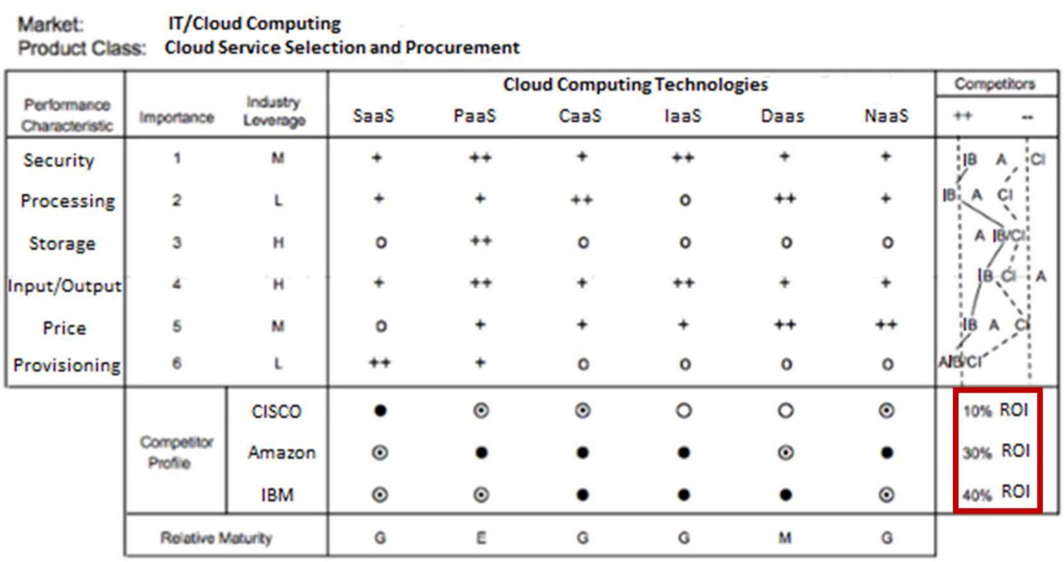


Figure 7. Output of Paap's CFTP framework. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retreived from

http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

Benaroch, Lichtenstein, and Robinson's (2006) developed their OBRiM theoretical framework in a study of 50 IT investments at a large Irish financial services organization (FSO). Their primary concern was to find the risk factors associated with IT and its controlling values or variables, and their secondary concern was to maximize value in IT investment decisions. The authors drew from a theoretical background to support their research in information systems (IS) risk management and the OBRiM framework. Benaroch, Lichtenstein, and Robinson (2006) stated, "two issues in the area of IS risk management are listed as (1) How do we approach IT risk management from an economic perspective? (2) How do we choose adequate mitigations and combine them to effectively address specific risks" (p. 836). The first issue deals with economic impact associated with different risk factors in IT management. The second issue deals with risk, flexibility, and real options to assign a high, medium, or low risk decision relative to the IT managers. The OBRiM framework provided an integrated solution to resolve the two issues. To support the theoretical framework, the authors claimed, "OBRiM formalizes this idea by viewing real options as high-level risk mitigation strategies for building different forms of flexibility necessary to deploy corrective actions when risk occurs. It helps to find a combination of options that adds the most value relative to the risk specific to an investment" (Benaroch, Lichtenstein, & Robinson, 2006, p. 832). Benaroch, Lichtenstein, and Robinson (2006) used regression testing to test the relationship between the risk factors identified and the real options present in projects exposed to these risks. The results indicated a strong relationship between risk factors and return on investments.

Technology Investment Profile

Aggarwal (2010) investigated the economy and business transformations in India. The transformation included global integration, corporate restructure, domestic mergers and acquisition (M&A), and oversea technology investments. India applied three theoretical concepts to increase ROI and lower risk taking. The three concepts were the Indian Foreign Direct Investment (FDI) model, the Ownership Location Internationalization (OLI) paradigm, and the Process Theories of Internationalization (PTI) Uppsala Model. These concepts were used to create a new hybrid theory called Outward FDI improvement. Four types of advantages for oversea markets and businesses, such as low cost production, natural endowment driven technologies, low cost versions of expensive products, and leverage cultural and institutional understanding to reduce the cost and risks of operations. Aggarwal (2010) described the summaries of the globalization of Indian economy development using cross-border M&A, as well as, lower transactions costs through new technology investments. After reading Aggarwal's 2010 economy and business transformations paper, I decided to investigate United States cloud computing companies' ROI with added risk assessment to Paap's CFTP framework.

Risk and Technology Management

The risk roadmap can be used to identify major risk events during execution of technology plan. Albright and Kappel (2003) defined the risk roadmapping process in a concise way. The risk roadmap consists of five major areas: market risks, technical risks, schedule risks, economic risks, and resource risks. Albright and Kappel (2003) presented the risk and technology roadmap that are organized by the return on investment priorities. The goal of Albright and Kappel (2003) research was to minimize the risk or to limit its impact to a product investment and development.

Technology roadmaps are becoming popular as tools to manage the future of technology. Lopez-Ortega, Concepcion, and Viloria (2006) suggested using technology roadmap and technology intelligence to improve the technology procurement decision-making process. Lopez-Ortega, Concepcion, and Viloria (2006) data collection methods are survey and interview questions. The first survery consisted of twelve questions and the second survey only included six questions related to the strategic planning process of the technological research and development center. Lopez-Ortega, Concepcion, and Viloria (2006) research participants were 158 managers of the technological research and development center. But only 21 out of 158 answered the the twelve item questionnaire, yielding 13.3% participation. The second survery was sent to those 21 participants who had participated during the first survery and all 21 participants answered the six item questionnaire, yielding 100% participation. The 21 participants were categorized in three categories: (a) public university, (b) private company, and (c) the research public center. The outcome of Lopez-Ortega, Concepcion, and Viloria (2006) study was that the Institute of Engineering of the National University of Mexico developed a technological roadmap process (Lopez-Ortega, Concepcion, & Viloria, 2006, p. 32). The technological roadmap process can be used to improve Paap's CFTP technology investment framework by adding risk assessment.

Neuro-Fuzzy Risk Assessment Model

Ebrat and Ghodsi (2011) conducted a mixed-method research to evaluate project risk using a new adaptive Neuro-Fuzzy risk assessment model referenced in Appendix A. I used a very similar Neuro-Fuzzy adaptive risk assessment model, but only two layer of calculation. The two layer neural network and fuzzy logic used the generalized Nyquist theorem to solve for training set size reduction between 25 to 28 samples. Choosing the smallest but still sufficient set of training vectors results in a reduced learning time for the network and fuzzy logic. After I computed the two layer Neuro-Fuzzy adaptive risk assessment calculation with 35 raw sampling data, I decided to use traditional risk assessment model. Because trained neural network and fuzzy logic does not have an accurate approximation using 35 data samples. In addition, Ebrat and Ghodsi (2011) suggested to training 70% sample sizes and test 30% sample sizes with 100 to 500 sampling in order to obtain the acceptable error percentages.

Traditional Risk Assessment Model

The traditional risk assessment was calculated by Risk = Likelihood × Consequence. In addition to traditional risk assessment, Kahneman and Lovallo (2006) pointed out three shortcomings that led to poor decisions in response to risk. The first shortcoming was loss aversion. As a consequence, inaction was favored over action and the status quo over alternatives since loss aversion leads to an avoidance of risks. The second shortcoming was near-proportionality, which the individuals seems to be proportionately risk averse. For example, the cash equivalent that they demand for a 50% chance of winning $ 100 increases close to proportionately as the amount was increased to $ 1000 or $ 10,000 or even $ 100,000.This behavior was not consistent with any well behaved risk aversion function, since the cash equivalent should decrease much more dramatically as the size of the gamble increases. In decision terms, this would imply that managers are unable to differentiate appropriately between small risks vs. large risk. The third shortcoming was narrow decision frames, which was the decision makers tend to look at problems one at a time, rather than consider them in conjunction with other choices that they may be facing now or will face in the future. This would imply that the portfolio effect of a series of risky decisions was not factored in fully when evaluating each decision on its own. Kahneman and Lovallo (2006) research results concluded that managers have trouble dealing with risk because the possibility of losses skews their decision making processes, the inability to separate small risks from large risks and the failure to consider the aggregate effect of risky decisions.

In addition, Chabrow's 2012 cloud computing survey was highly related to my research on adding risk assessments to improve cloud computing investments. Information Security Media Group Survey Results Report (2012) showed cloud computing initiatives are relatively new for many organizations. Nearly 1 in 3 survey respondents say their organizations are not using the cloud, a strikingly high percentage considering how quickly the computing platform was maturing. Also, the survey showed that just over 40 percent of respondents' organizations allocated 10 percent or less of their IT budgets on public, community and hybrid clouds, with just over one-third earmarking money for private clouds. Nearly 40 percent of respondents say their organizations didn't allocate any money for public/community/hybrid clouds; less than a quarter didn’t apportion any funds for the private cloud. Still, cloud computing was perceived to lower costs and provide other benefits to the organization. Therefore, organizations must weigh the benefits against the risks when determining whether to implement a cloud computing solution.

Return On Investment (ROI)

To address the potential cloud computing investment risk, Spínola (2012) proposed a technology investment monitoring system so that an investor an measure the performance, as well as, continuing to measure the ROI. The technology investment monitoring system performs ROI analysis to increase the understanding of the true costs associated with adopting cloud services. Spínola (2012) also considered a comprehensive ROI to show hardware savings and possible infrastructure costs, personnel savings associated with reduced IT support, increased organizational efficiency, as well as monthly service provider subscription costs. Kuo, Bhatia, and Chang (2010) worked on IBM cloud computing return on investment methodology. The ROI methodology are carefully evaluated without risk assessment. Kuo, Bhatia, and Chang (2010) collected the existing IT infrastructure and current operational data to calculated the ROI. With the baseline data, a cost-benefit approach can be used to compare the current environment to the cloud implementation from IBM. The IBM ROI methodology uses a three-step process to calculate the ROI, net present value (NPV), and payback period and the three-step process was listed as:

Step 1. Project the benefits from reduced IT costs. These benefits include cost savings. The cost savings are from hardware, software, maintenance, and IT support. Another benefit was increased user productivity obtained from automated self-service provisioning and overall improved IT resource utilization.

Step 2. Identify the investment made in deploying the solution. This includes the initial cost of the IBM cloud solution, development, implementation services, and support costs.

Step 3. Project the costs and potential savings over a fixed period and calculate the ROI and payback period for the deployed solution. This model uses a standard discounted cash flow method to calculate the net present value (NPV) over three years. The payback period was the time from initial deployment to when the benefits equal the initial investment (Kuo, Bhatia, & Chang, 2010, p. 4).

The ROI analysis showed IBM cloud computing increased server utilization from 36 to 79 percent company wide and reduced resource provisioning time from six hours to less than thirty minutes. Therefore, the IBM cloud computing decreased average time for a user to obtain resources by 48 times from 12 days to two hours.

The results showed an initial investment for eight months were around $1.2 million and the net present value (NPV) was $3.0 million. The IBM investment algorithm estimated an annual ROI at 76% over eight months.

Kornevs, Minkevica, and Holm (2012) performed a cloud computing evaluation based on financial metrics such as Cost Benefit Analysis (CBA), Return on Investment (ROI) and Total Cost of Ownership (TCO). The case study was performed to validate evaluation of the private cloud model because a private cloud has a higher risk of being unsuccessful from an economic point of view. The reason for conducting a case study was to provide a validation to increase private cloud investments. The case study results showed private cloud computing has created significant return on investment. For example, the company spent $100,000 per month on self-hosting an e-commerce site that generates $110,000 per month. That's a 10% ROI. By outsourcing hosting to a cloud provider, and lowering monthly expenses by $20,000 per month, that same $110,000 could still be generated if the application performs at the same level. That's a 37.5% ROI.

Skilton (2014) designed a framework on how to measure return on investment (ROI) for cloud computing. The following are the eight measurements of cloud computing ROI:

(a) The speed and rate of change – Cost reduction and cost of adoption /de-adoption was faster in the cloud. Cloud computing creates additional cost transformation benefits by reducing delays in decision costs by adopting pre-built services and a faster rate of transition to new capabilities. Adopting pre-built services was a common goal for business improvement programs that are lacking resources and skills and that are time sensitive (Skilton, 2014, p. 2).

(b) Total cost of ownership optimization – Users can select, configure, and run infrastructure and applications that are best suited for business needs. Traditionally this has often been decoupled when IT projects are handed off to production services. In cloud computing environments these are joined up (Skilton, 2014, p. 2).

(c) Rapid provisioning – Resources are scaled up and down to follow business activity as it expands and grows or was redirected. Provisioning time compression can go from weeks to hours (Skilton, 2014, p. 2).

(d) Increased margin and cost control – Revenue growth and cost control opportunities allow companies to pursue new customers and markets for business growth and service improvement (Skilton, 2014, p. 2).

(e) Dynamic usage – Elastic provisioning and service management targets real end users and real business needs for functionality as the scope of users and services evolve seeking new solutions (Skilton, 2014, p. 2).

(f) Risk and compliance improvement – Cloud computing green capabilities can be leveraged through shared services (Skilton, 2014, p. 2) .

(g) Enhanced capacity utilization – IT avoids over-and under-provisioning of IT services to improve smarter business services (Skilton, 2014, p. 2) .

(h) Access to business skills and capability improvement – Cloud computing enables access to new skills and solutions through cloud sourcing on demand solutions (Skilton, 2014, p. 2) .

Skilton (2010) said, "The impact on the ROI business case from using Cloud Computing services is directly relevant to sovereignty, security, and management of services risk containment (Skilton, 2010, p. 19)". My research focused on adding risk assessment to Paap's CFTP Framework to improve upon cloud computing technology investment. Skilton's 2010 white paper provided an analysis of how to build and measure cloud computing ROI through ROI savings models that demonstrate cost, time, quality, compliance, revenue, and profitability improvement shown in Figure 8 titled "Cloud computing ROI models and key performance indicators" and Figure 9 titled "Cloud computing ROI saving model". The different between the two figures are the key performance indicators vs. the ROI saving model.

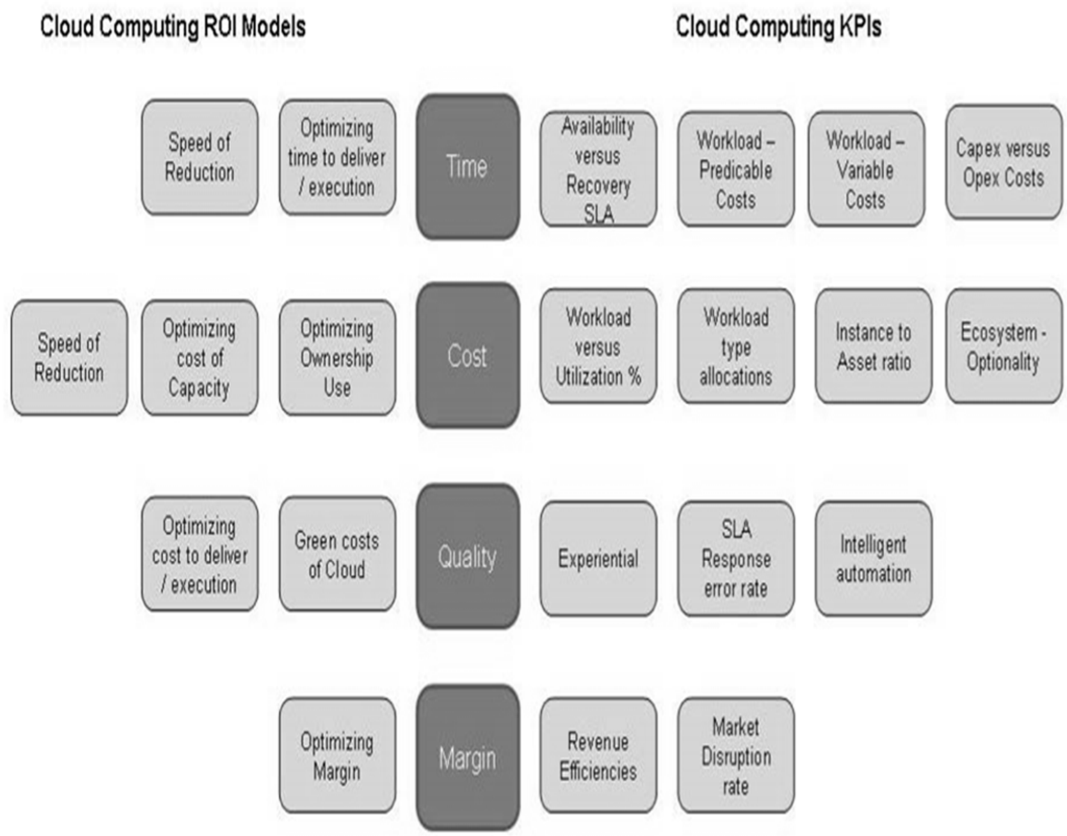


Figure 8. Cloud computing ROI models and key performance indicators. From *Building return on investment from cloud computing*, by M. Skilton, 2010, p. 22. Retreived from The Open Group Techical Report. Reprinted with permission.

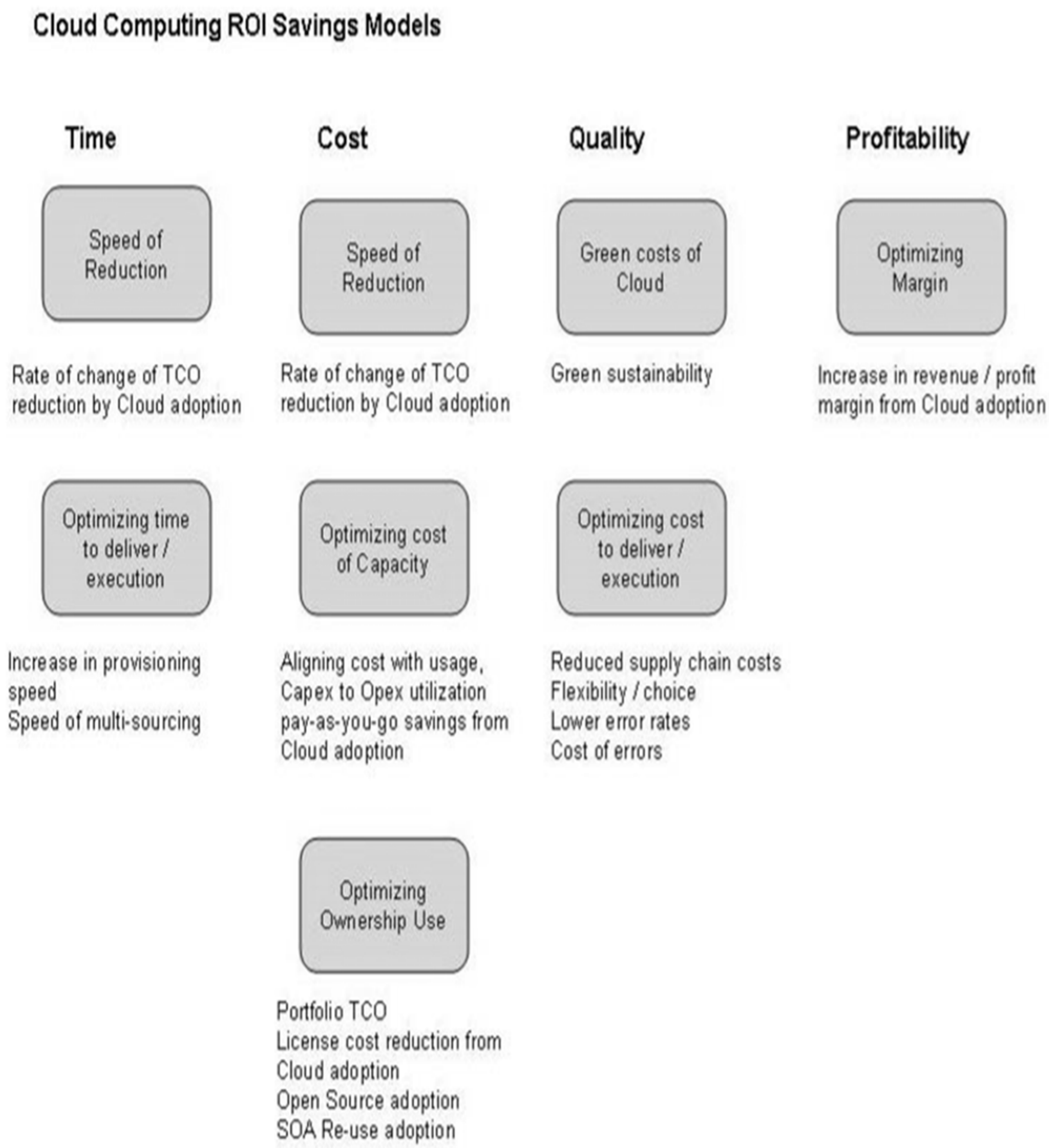


Figure 9. Cloud computing ROI saving model. From *Building return on investment from cloud computing*, by M. Skilton, 2010, p. 22. Retreived from The Open Group Techical Report. Reprinted with permission.

The Skilton's 2010 cloud computing ROI saving model was computed by time, cost, quality, and profitability. Time is the time it takes a supplier to deliver the cloud product using multi-sourcing method. Cost is the optimized cost of a cloud computing product. Quality is the degree of excellence of a cloud computing product delivery. The profitability is the optimized margin. The following sentences listed the cloud computing ROI Model definitions. Speed of time reduction is the decrease in time to adopt to cloud computing technology. Speed of cost reduction is the decrease in cost to adopt to cloud computing technology. It is measured by the rate of change in TCO reduction by Cloud adoption. Optimizing cost of capacity is defined as aligning cost with usage. Cash flow describes revenue, cash, and working capital changes that flow within part of the operating expenses liquidity and available usage of funds. Green costs of Cloud adoption is the benefit to the economic and emission footprint from the use of shared services. Optimizing time to deliver/execution is described as the increase in provisioning speed and reduced supply chain costs with fast speed of multi-sourcing and flexibility of choices. Optimizing margin is the increase in revenue/profit margin from cloud adoption.

Skilton (2010) concluded cloud computing can provide many advantages over conventional approaches to IT provisioning, which can translate into significant improvements in ROI. In addition, Merwe (2014) proposed to use Mosaic approach for cloud computing risk assessment that was developed at the Carnegie-Mellon University Software Engineering Institute. Merwe (2014) stated, “The Mosaic approach builds on and extends traditional risk management to provide a framework for managing complex, systemic risks, where it takes a holistic view of risk to objectives by examining the aggregate effects of multiple conditions and potential events” (Merwe, 2014, 2). Merwe’s 2014 risk assessment provided me a very good understanding of recent cloud computing ROI risks. For example, the key factors to consider when assessing cloud ROI risk probability are the leading indicators, such as utilization, speed, scale, and quality. These factors are built into Mosaic ROI models, and affect the headline figures for investment, revenue, cost, and time to return. But, Merwe's 2014 cloud ROI risk assessment was a guidance with no actual data to prove that risk factor was an improvement in cloud computing technology investment versus my research with 35 cloud computing companies' data to prove that risk assessment might be increase in technology investment decisions using Paap's CFTP framework.

Cloud Computing Enterprise Risk Management Framework and ROI

The cloud computing technology was considered a low risk investment, because the companies use an open architecture that leverages Service Oriented Architecute (SOA) technology capabilities. From an investor perspective that means that technology and product risks are somewhat mitigated (Padnos, 2012, 1). Feuerlicht and Govardhan (2010) documented a potential risk on cloud computing technology investment. The risk included higher costs associated with cloud computing investment model. For example, business continuity and service provider's availability have been identified as a significant relationship to cloud computing cost concern. Chan, Leung, and Pili's 2012 Enterprise Risk Management Framework (ERMF) was to help the computer industry to identify cloud computing risks and relationship to their organizations shown on Figure 10.

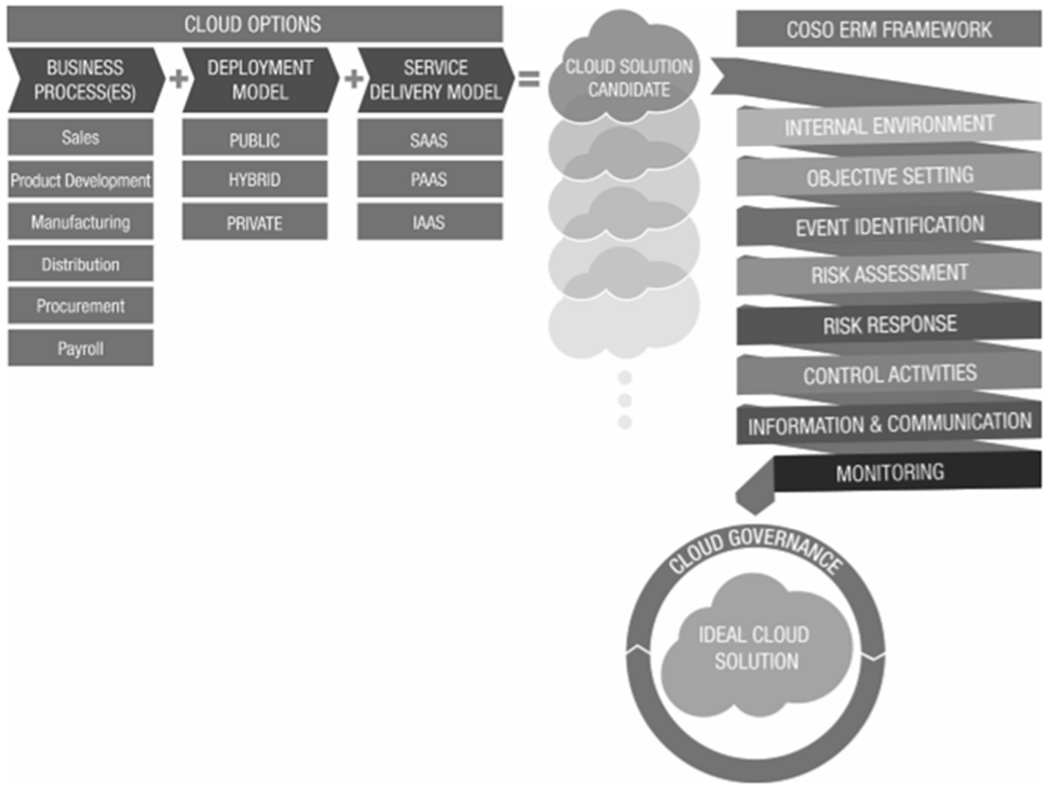


Figure 10. ERMF along with cloud computing options. *From Enterprise risk management for cloud computing*, by W. Chan, E. Leung, E., and H. Pili, 2012, p. 13. Retreived from the Committee of Sponsoring Organizations of the Treadway Commission (COSO) Conference paper. Reprinted with permission.

The COSO's 2012 ERMF was related to my research in terms of risk assessment, where cloud computing risk assessment was to evaluate the risk events associated with its cloud computing technology to determine the potential impact of the risks associated with each cloud computing investment option. Cloud computing can affect the following critical focal points of a risk assessment, such as risk profile, inherent/residual risk, likelihood and impact. Risk profile is a description of a set of potential investment options to estimate return on investment (ROI) while characterizing the risk for each option. The inherent/residual risk is where an organization must assess the inherent risks of the events and then develop risk responses and determine the residual risk. The Likelihood and impact of risk assessment means the likelihood of certain events and the related potential impact change in many cases when cloud solutions are adopted.

According to Merrill and Kang (2014), a potential number of hidden costs with cloud computing that many may not have considered. Therefore, risk assessment was the next step to predict the actual costs of cloud computing and the potential ROI. For example, what are the costs associated with transferring your data and network to another cloud provider? Once a company's data resides on the cloud, the company becomes increasingly reliant on its provider; cloud providers know this and could easily make moving to another provider difficult.

Summary

In Chapter 2, the literature review provided the context and substantiation of the basis of inquiry for the primary research question: What is the relationship to the return on investment by adding traditional risk assessment model to Paap's CFTP framework? In addition, the literature review also provided the background knowledge to my research. The review discussion compared two models for the study: (a) Neuro-Fuzzy Risk Assessment Model, and (b) Traditional Risk Assessment Model. The research in cloud computing technology investment model started two years ago, so very little articles published in this field of study. Chapter 3 provides further detailed description of the quantitative methodology.

Chapter 3: Methodology and Procedure

In this chapter, I discuss the characteristics of the quantitative method I used to construct Paap's CFTP framework with added risk assessment to answer my research question. Quantitative measurement includes dependent and independent variables. The dependent variable in this study was ROI. The independent variable was market risk. I used a paired sample two-tailed *t* tests to determine the differences between ROI without risk assessment and ROI with added risk assessment.

I begin this chapter by justifying the quantitative cross-sectional methodology and the study's independent and dependent variables. Then, the methodology section outlines the target population and sampling. In the data collection and analysis section, I describe variable scales, hypothesis construction, and analytical tools. The reliability and validity section includes discussion of threats to reliability and validity in this research study. The next section covers ethical procedures and confidentiality. Last but not least, I offer a summary of the methodology.

Research Design

I used a quantitative method for this study. The approach was a cross-sectional design which I used to measure companies' ROIs before and after adding adaptive risk assessment to Paap's CFTP. Cross-sectional design involved the analysis of data collected from the 35 cloud computing companies in United States at one specific point in time. The advantage of using cross-sectional design was that it was relatively inexpensive to conduct research using existing cloud computing companies' data sets. In addition, could use the cross-sectional design to estimate prevalence of outcome of interest because the sample was taken from the whole population of 35 cloud companies in the United States. Another advantage of using cross-sectional design was that it was less time-consuming than other potential methods.

The research question was: What is the relationship to the return on investment by adding traditional risk assessment model to Paap's CFTP framework?

The quantitative measurements include a dependent variable and an independent variable. The influence of this market risk assessment independent variable on Paap's CFTP ROI dependent variable yielded the following hypotheses:

The null hypothesis (H_0): The return on investment may not be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The alternative hypothesis (H_1): The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The convention mathematical format is:

A two-tailed test: $\begin{matrix} H_o : \mu_1 - \mu_2 = 0 \\ H_1 : \mu_1 - \mu_2 \neq 0 \end{matrix}$, the p-value is 0.000 (Reject at α = 5%)

where μ_1 is the mean of first population (Before: No risk), and μ_2 (After: Added risk) is the mean of the second population. The null hypothesis $H_o : \mu_1 - \mu_2$ equals 0 represents the condition that the populations are centered in the same spot. The two sided alternative hypothesis is that the means difference and $H_1 : \mu_1 - \mu_2$ does not equal 0. The additional risk factor was market risk in cloud computing technology.

ROI is a measure of the profit earned from each investment. To calculate ROI, the return of an investment was divided by the cost of the investment; the result was expressed as a percentage or a ratio in Equation 3:

ROI (%) = [(Gross Profit – Investment) / Investment] × 100

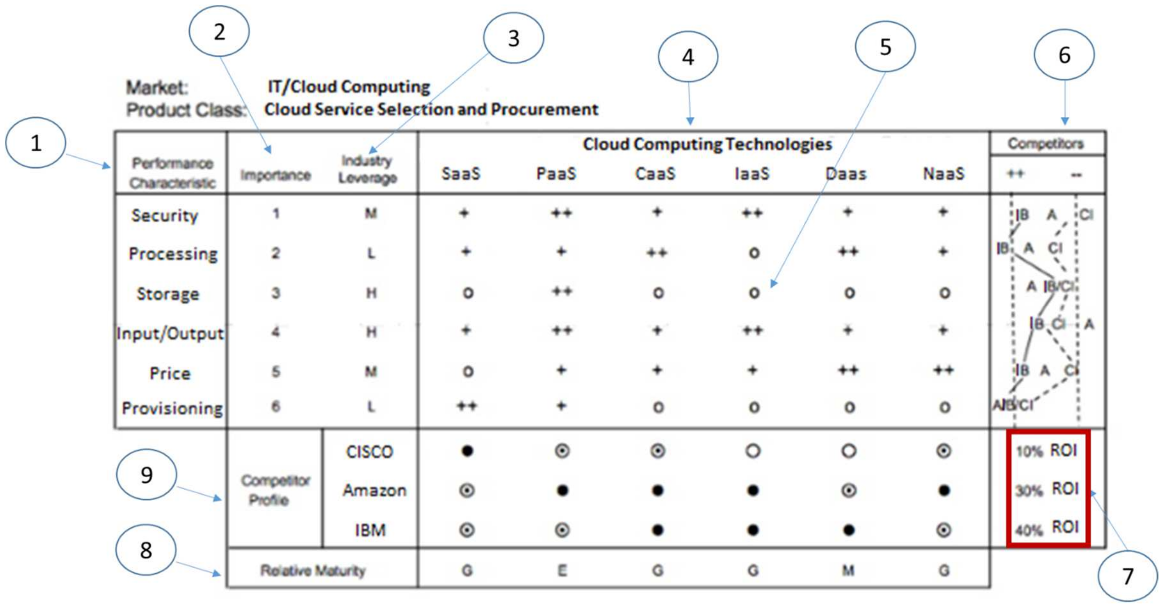
To get a better idea of how ROI was different from profit, let's compare two investment scenarios and have a look at the profit and ROI of each: an investment of $100,000 that led to a gross profit of $150,000, and an investment of $10,000,000 that led to a gross profit of $15,000,000. In the first scenario the net profit was $50,000, whereas in the second one the net profit was $5,000,000. Using the same two scenarios, we can easily calculate the ROI for each, as follows: ROI = [(150,000 – 100,000) / 100,000] x 100 and ROI = [(15,000,000 – 10,000,000) / 10,000,000] x 100. The result is 50 in both cases, meaning that both scenarios had a ROI of 50%.

See Appendix C for how to use Paap's CFTP framework to determine the ROI values. Paap's CFTP has 9 inputs to the framework which I have circled in Figure 11. The following 9 inputs definitions are described below:

1. The performance characteristics input refers to the performance factors that are important in influencing the purchase or use decision.
2. The importance input refers to the rank of the performance characteristic in the purchase or use decision. Higher ranked items generally must be fairly well satisfied before lower ranked items influence the buying or use decision.
3. The industry leverage input refers to the market relationship of an improvement in a technology. High leverage means customers will have a

strong and positive reaction to improvements. Low means they really do not care about improvements, even if the improvements had an important characteristic.

4. The cloud computing technologies input refers to the current and potential technologies that are used in this business area.
5. The technology relationship input refers to which technology affects the performance level of a characteristic.
6. The competitive performance profile input refers to each competitor profile including yourself, and the customers.
7. The ROI input is a measure of the profit earned from each investment. To calculate ROI, the return of an investment was divided by the cost of the investment; the result was expressed as a percentage ROI (%) = [(Gross Profit – Investment) / Investment] × 100. The cloud computing companies' ROI values are an input to Paap's CFTP ROI values.
8. The relative maturity of the technology input refers to TRLs.
9. The competitive technology profile input refers to the strength in the technology by each competitor.



Importance: Rank order, **1** is most important
Industry Leverage: **H** = high
M = medium
L = low (refers to customer reaction to performance improvements)
Technology Impact: ++ = technology influences greatly (positive or negative)
\+ = moderate impact
o = low impact
Competitors: **1** = best
2 = second best
3 = third best (ties indicate equal performance)
Competitive profile: ● = strong capability/high investment
⊙ = moderate capability/investment
○ = low capability/investment
Relative maturity **E** = Emerging technology
G = Growing technology
M = Mature technology

Figure 11. Paap's CFTP ROI for cloud computing investment. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retreived from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

The definitions of cloud computing technologies are listed below:

1. Software as a service (SaaS): Provide to a cloud service user applications running on a cloud infrastructure in a non-real-time environment, such as IT

and business applications. The cloud service user does not manage or control the underlying cloud infrastructure, with the possible exception of limited user-specific application configuration settings.

2. Communications as a service (CaaS): Provide to a cloud service user real-time communication and collaboration services, such as voice over IP, instant messaging, and video conferencing.
3. Platform as a service (PaaS): Provide to a cloud service user user-created or acquired applications and delpoy them on the cloud infrastructure using platform tools supported by the cloud service provider. The platform tools may include programming languages and tools for application development, interface development, database development, storage and testing. The cloud service user does not manage or control the underlying cloud infrastructure, but has control over the deployed applications and, possibly, over the application hosting environment configurations.
4. Infrastructure as a service (IaaS): Provide to a cloud service user provisioning, processing, data storage, intra-cloud network connectivity services (e.g., VLAN, firewall, load balancer, and application acceleration), and other fundamental computing resources of the cloud infrastructure where the cloud service user is able to deploy and run arbitrary application. The cloud service user does not manage or control the resources of the underlying cloud infrastructure, but has control over operating systems, deployed applications,

and possibly limited control of select networking components (e.g., host firewalls).

5. Network as a service (NaaS): Provide to a cloud service user transport connectivity services and/or inter-cloud network connectivity services, such as virtual private network (VPN) and bandwidth on demand.
6. Big data as a service (DaaS): Provide to a cloud service user statistical analysis tools or information by an outside service provider that helps organizations understand and use insights gained from large information sets in order to gain a competitive advantage. These include tools such as a web dashboard or control panel for carrying out the actual analysis and providing reports.

Risk assessment involves the calculation of the magnitude of potential consequences (levels of impacts) and the likelihood (levels of probability) that these consequences will occur. Risk was calculated using the following Equation 4:

$$\text{Risk} = \text{Consequence} \times \text{Likelihood}$$

Likelihood is the probability of occurrence of an impact that affects the environment, and Consequence is the environmental impact if an event occurs. The traditional risk matrix is shown in Figure 12. The traditional risk matrix is a method that combines the scores from the consequence (levels of impact) and the likelihood (levels of probability) to generate a risk score.

Figure 12. Traditional 5x5 risk matrix.

The traditional risk assessment process involves selecting the most appropriate combination of consequence and likelihood levels that fit the situation for a particular objective based upon the information available and the collective knowledge of the group involved in the assessment process. An example of Paap's CFTP Framework added risk asssignment was shown in Figure 13.

Market: IT/Cloud Computing
Product Class: Cloud Service Selection and Procurement

Performance Characteristic	Importance	Industry Leverage	SaaS	PaaS	CaaS	IaaS	Daas	NaaS	Competitors ++	Competitors --	Risk
			Cloud Computing Technologies								
Security	1	M	+	++	+	++	+	+	IB A CI		
Processing	2	L	+	+	++	o	++	+	IB A CI		
Storage	3	H	o	++	o	o	o	o	A IB/CI		
Input/Output	4	H	+	++	+	++	+	+	IB CI A		
Price	5	M	o	+	+	+	++	++	IB A CI		
Provisioning	6	L	++	+	o	o	o	o	A/IB/CI		
Competitor Profile		CISCO	●	⦿	⦿	○	○	⦿	10% ROI		16 High
		Amazon	⦿	●	●	●	⦿	●	30% ROI		4 Low
		IBM	⦿	⦿	●	●	●	⦿	40% ROI		9 Med
Relative Maturity			G	E	G	G	M	G			

Importance: Rank order, 1 is most important
Industry Leverage: **H** = high
M = medium
L = low (refers to customer reaction to performance improvements)
Technology Impact: ++ = technology influences greatly (positive or negative)
+ = moderate impact
o = low impact
Competitors: **1** = best
2 = second best
3 = third best (ties indicate equal performance)
Competitive profile: ● = strong capability/high investment
⦿ = moderate capability/investment
○ = low capability/investment
Relative maturity **E** = Emerging technology
G = Growing technology
M = Mature technology

Figure 13. Cloud computing investment example using Paap's CFTP Framework with added risk assessment.

In Figure 13, the results showed Amazon Cloud Computing Company was the best to make your investment decision based on the lowest risk of 4 and medium ROI of 30% compared to IBM Cloud Computing with medium risk of 9 and medium ROI of 40%, as well as, CISCO Cloud Computing with high risk of 16 and lowest ROI of 10%. In a perfect scenario, the investment decision was based on determining the lowest risk and the highest ROI. See Appendix D for how to add risk to Paap's CFTP framework.

Target Population and Sample

Collins and McAllister (2011) conducted a cloud computing market research and they found U.S. cloud computing investment was anticipated to continue growing at a robust rate over the course of the next five years. Collins and McAllister (2011) predicted that the global cloud services revenues were expected to reach US$148.8 billion in 2014 as shown in Figure 14.

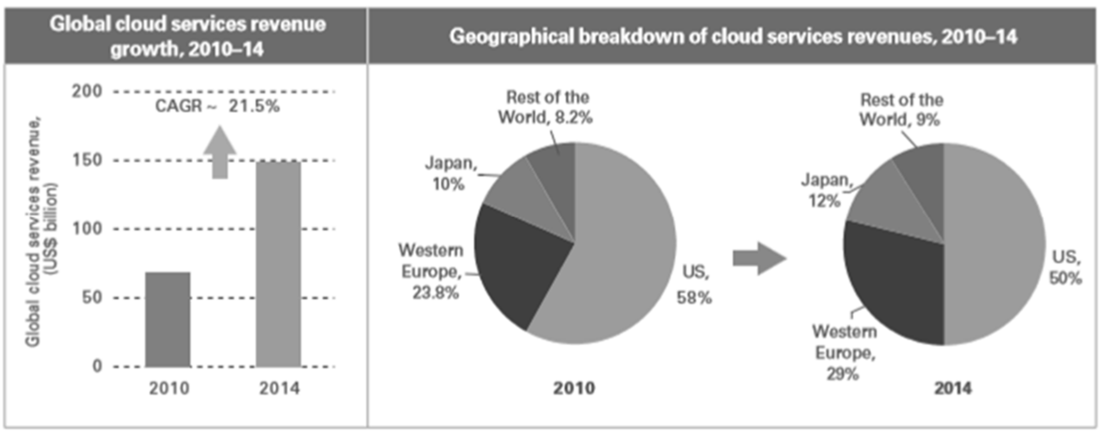


Figure 14. Cloud investment results. From *Telcos advance in cloud computing*, by S. Collins, and D. McAllister, 2011, p. 2. Retreived from KPMG International Cooperative Conference Paper. Reprinted with permission.

The United States was the largest market for cloud services, with a market share of 58 percent in 2010. It was followed by Western Europe with 23.8 percent and Japan with a 10 percent market share. The market research on cloud services revenues between 2010 and 2014 provided me a background on the demographic and population selections. My research population was limited to 35 cloud computing companies located in United States that invested $100 million or more in cloud technology. The data to use in developing the revised Paap's CFTP framework was from 35 cloud computing companies. I collected two data sets. The data sets are (1) cloud computing companies’

ROI values and, (2) cloud computing companies' risk data. The cloud computing companies' ROI values are an input to Paap's CFTP ROI values. Next, I performed a computation using Paap's ROI values with added risk assessment values. Then, I used the paired sample two-tailed *t* tests to determine the differences between ROI with no risk and ROI with added risk, as referenced in Table 1. I used Table 1 to document the results of my analysis. The numerical results was computed in Chapter 4 after conducting my study. The differences calculation determine how much relationship to ROI with and without risk for the 35 cloud computing companies.

Table 1

Paired Sample Two-Tailed T Tests Results of My Analysis

#	Cloud Computing Company	Before (No Risk)	After (Added Risk)	Difference
1	Amazon			
2	AppDirect			
3	Apple			
4	AT&T			
5	BlueLock			
6	BMC			
7	CA Tech			
8	Cisco			
9	Citrix			
10	CloudStack			
11	Datapipe			
12	Dell			
13	Eucalyptus			
14	FUJITSU			
15	Google			
16	HP			
17	IBM			
18	Internap			
19	Micro Focus			
20	Microsoft			
21	Oracle			
22	OpenNebula			
23	OpenStack			
24	Piston			
25	Rackspace			
26	Red Hat			
27	Salesforce			
28	SAP			
29	Savvis			
30	Sage			
31	Ultimate			
32	Tableau			
33	Version			
34	Virtustream (EMC)			
35	VMware			

Data Collection

There are two set of data collections: risk data and actual ROI data. The 35 cloud computing company's ROI data and market risk data are from the 2015 annual report of each company. The 2015 annual report can be found on the company's website, Mergent online database, and/or U.S. Securities and Exchange Commission Form 10-K government website. The federal securities laws require public companies to disclose the annual report on Form 10-K provides a comprehensive overview of the company's business and financial condition and includes audited financial statements. My design instruments was observation and action plans. The observation captures actual ROI applications. Observations are particularly useful in cloud computing projects and are effective when the observer was either invisible or transparent. I reviewed the observation at the end of each formal session with my dissertation chair. The action plans are developed during the project and are implemented after the project was completed. Follow-up on action plans provides evidence of ROI for specific projects. All 35 U.S. cloud computing uses risk management for technology development, but it was not associated with return on investment factor. Therefore, my research was based on cross-sectional design to determine measurement Paap's CFTP ROI before and after added risk assessment may or may not improve upon technology investment.

Data Analysis

I analyzed the sample size required for my cross-sectional design. The results of the power analysis showed that a minimum of 24 data samples are needed. My study involved comparing two groups: (a) before added risk and (b) after added risk. The difference in the means for the two groups was a measure of the effect size (aka. Cohen's *dz* calculation). The effect size provided a measure of the magnitude of the effect. The magnitude can often be used to evaluate the importance or meaning of the effect. In other words, effect size is a measure of how much the ROI changed (aka. dependent variable).

I used effect size *dz* = 0.6, because I would like to follow Cohen's rule of thumb that stated:

Small effect when *dz* = 0.2

Medium effect when *dz* = 0.5

Large effect when *dz* = 0.8

The average effect size over many studies were closer to *dz* = 0.5. My calculation using G*Power 3.0 tool was very closer to *dz* = 0.6, which was slightly above medium effect. The effect size *dz* =0.6 means that one group performed six-tenths of a standard deviation above the other group.

The advantage of paired sample *t* tests was fewer sample size and greater control over external influences. After my power analysis results, as shown in Figure 15, I plan to use paired sample two-tailed *t* tests with 35 total sample size to determine the relationship by adding a traditional risk assessment model to Paap's CFTP framework.

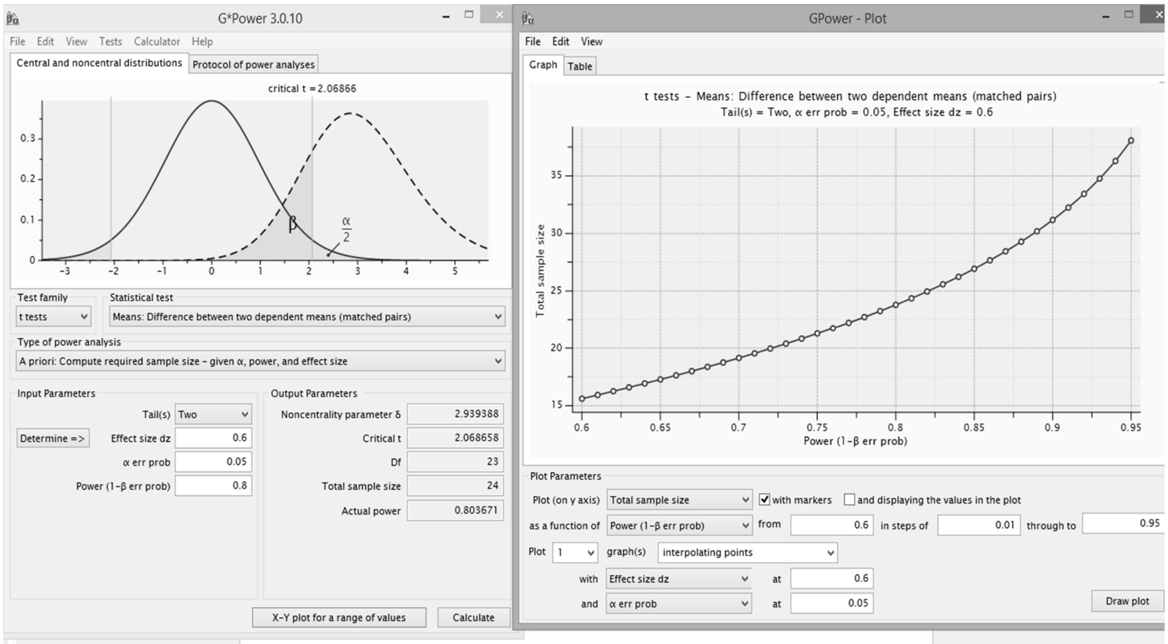


Figure 15. Power analysis results.

Both Jurimae (2010) and Wilkinson (2009) reported risk assessment would increase technology investment returns. To determine if risk assessment improves Paap's CFTP framework, the paired sample two-tailed *t* tests was performed to compare Paap's CFTP 2010 model with and without traditional risk assessment associated with the cloud computing companies. Paired sample two-tailed *t* tests was perform the statistical hypothesis to determine if the alternative hypothesis was supported. When the *p*-value was less than 0.05 then we reject the null hypothesis and provide enough evidence at the 0.05 level to conclude the alternative hypothesis.

Reliability and Validity

In quantitative study, reliability and validity of the analysis instrument are very important for decreasing errors that might arise from measurement problems in the research study. Reliability refers to the accuracy and precision of a measurement procedure (Thorndike, 1997). Mistakes while selecting the sample size could have occurred. Therefore, I performed a power analysis for my cross-sectional design to increase reliability of my sample two-tailed *t* tests.

Validity refers to the degree to which a study accurately reflects or assesses the specific concept or construct that the researcher was attempting to measure (Thorndike, 1997). To increase validity, I plan to use doctoral peer review of my research results with an expert in the field. In order to avoid bias and interpretation of quantitative results, I had double checked to make sure my research question designed to measure a particular trait are indeed measuring the same trait.

Research Permission and Ethical Considerations

Ethical issues was addressed at each phase in the study. In compliance with the regulations of the Walden’s Institutional Review Board (IRB), the permission for conducting the research must be obtained through IRB. The Request for Review Form was filed, providing information about the principal investigator, the project title and type, source of funding, type of review requested, number and type of subjects. Application for research permission will contain the description of the project and its significance, methods and procedures, participants, and research status. All study data, including the data analysis electronic files, cloud computing company's risk data were kept in locked metal file cabinets in the researcher's office and destroyed after a reasonable period of time.

Summary

Chapter 3 include an outline of the research method and design. I selected a quantitative research method using cross-sectional design to determine measurement of Paap's CFTP ROI before and after adding traditional risk assessment. The quantitative measurement includes dependent and independent variables. The dependent variable was ROI. The independent variable was market risk. A paired sample two-tailed *t* tests was performed to compare Paap's CFTP 2010 model with and without traditional risk assessment associated with multiple technology project investments. Chapter 3 also include the study population and sample size used, as well as the data collection, organization, and analysis methods used for the study. In additon, I discussed reliability, validity, credibility, and ethical considerations of the research. Chapter 4 provides further detailed on data collection and quantitative analysis.

Chapter 4: Results

The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework. I used a cross-sectional design to measure companies' ROIs before and after adding adaptive risk assessment to Paap's CFTP. This cross-sectional design involved the analysis of data collected from 35 cloud computing companies in the United States at one specific point in time.

The research question was: What is the relationship to the return on investment by adding traditional risk assessment model to Paap's CFTP framework?

The quantitative measurements included a dependent variable and an independent variable. The influence of this market risk assessment independent variable on Paap's CFTP ROI dependent variable yielded the following hypotheses:

The null hypothesis (H_0): The return on investment may not be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The alternative hypothesis (H_1): The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

The paired sample two-tailed *t* tests methodology was used to test above hypothesis. The convention mathematical format is:

A two-tailed test: $\begin{matrix} H_o : \mu_1 - \mu_2 = 0 \\ H_1 : \mu_1 - \mu_2 \neq 0 \end{matrix}$, the *p*-value is 0.000 (Reject at $\alpha = 5\%$)

where μ_1 is the mean of the first population (Before: No risk), and μ_2 is (After: Added risk) the mean of the second population. The null hypothesis $H_o : \mu_1 - \mu_2$ equals 0 represents the condition that the populations are centered in the same spot. The two sided alternative hypothesis is that the means difference and $H_1 : \mu_1 - \mu_2$ does not equal 0. The additional risk factor is market risk in cloud computing technology. Market risk is the risk that market conditions can negatively impact ROI.

In this chapter I discussed data collection, quantitative analysis, and results from this study. In the first section, I descrive the time frame for data collection, the demographic characteristics of the sample, and how representative the sample is of the population of interest was described. In the second section, I discuss the quantitative analysis and research results. This section also included a report on descriptive statistics that appropriately characterizes the sample, statistical assumptions, and statistical analysis of the findings. In the final section of this chapter, I summarize the answers to the research questions prove them with result findings.

Data Collection

The Walden Unversity Institutional Review Board (IRB) confirmed that my doctoral capstone study met Walden University's ethical standards (IRB #08-05-16-0049972). I started my data collections after the IRB approval on August 5, 2016. I collected two set of data: risk data and actual ROI. The time frame for data collection was a single year in 2015. There were no discrepancies in the data collection from the proposed data collection plan.

The market research done by Collins and McAllister (2011) on cloud services revenues between 2010 and 2014 provided me background on the demographic and population selections.Collins and McAllister (2011) provided a chart representation of the cloud computing companies showing that the United States was the largest market for cloud services, with a market share of 50% in 2014. My research population was limited to 35 cloud computing companies located in United States that invested $100 million or more in cloud technology during the year 2015. I drew the 35 cloud computing company's ROI and market risk data from the 2015 annual reports of each company. The annual report is a comprehensive report on a company's activities, and it is issued to a company's shareholders, creditors, and regulatory organizations following the end of its fiscal year. The 2015 annual report can be found on the company's website, Mergent online database, and/or U.S. Securities and Exchange Commission Form 10-K government website. The federal securities laws require public companies to disclose the annual report on Form 10-K, which provides a comprehensive overview of the company's business and financial condition and includes audited financial statements. For example, the 2015 IBM annual report listed a cloud ROI of 57%. IBM's strategic imperatives grew by 26% and generated $29 billion in 2015, which represented 35% of IBM's total revenue. The 2015 IBM market risk was low. IBM manages this risk, in part, through the use of derivative financial instruments. There were no covariates within this study.

Quantitative Analysis and Research Results

This section I summarize the quantitative analysis and results after the data collection. I condected a power analysis to determine the sample size required for this cross-sectional study and found that a minimum of 24 data samples were required (see Figure 15). Therefore, I conducted the study with a sample size of 35 cloud computing companies located in the United States that invested $100 million or more in cloud technology during the year 2015. An introduction to each of the 35 cloud computing companies follows:

- Amazon is an electronic commerce and cloud computing company with headquarters in Seattle, Washington. Amazon Elastic Compute Cloud (Amazon EC2) is a web service that provides resizable compute capacity in the cloud computing platform.
- AppDirect is an enterprise cloud service commerce company headquartered in San Francisco, California. AppDirect provide cloud software that builds an app store for its clients and buyers.
- Apple is a hardware and digital technology company company with headquarters in Cupertino, California. Apple iCloud is a cloud storage and cloud computing service. The service provides Apple users with data storage for items such as documents, photos, and music on remote servers for download to iOS, Macintosh, or Windows devices, to share and send data to other Apple users, and to manage their Apple devices if lost or stolen.

- AT&T is a telecommunication and cloud computing company headquartered in Dallas, Texas. AT&T cloud services provides computing, storage, software, development, and network resources on demand. AT&T has developed the ability to provide virtual private and hybrid cloud computing to their customers.
- BlueLock is a cloud technology service company headquartered in Indianapolis, Indiana. BlueLock provides cloud computing environments to reduce IT risks and IT costs, and to provide a faster infrastructure to their customers.
- BMC is an IT software solutions and cloud services company headquartered in Houston, Texas. BMC provides Cloud Lifecycle Management, which integrates with TrueSight Capacity Optimization to help IT deliver fast and reliable cloud services. The BMC cloud computing also provides intelligent analytics to improve IT performance and reduce the cloud computing costs.
- CA Tech is an IT software and cloud services company with headquarters in New York, New York. CA Cloud Service Management improves IT efficiency via automated workflows and upgrades. CA Tech creates IT software that runs in mainframe, distributed computing, virtual machine, and cloud computing environments.
- Cisco is a network technology and cloud computing company headquartered in San Jose, California. Cisco cloud solutions reduce the cost of cloud computing, simplify cloud management and operations, and increase IT/network services worldwide.

- Citrix is a software company headquartered in Santa Clara, California, and Fort Lauderdale, Florida, that provides cloud computing technologies, server, application, and desktop virtualization, and IT/network services. Citrix Cloud reduces cost and complexity in infrastructure and software services, and allows customers to deliver a desktop quickly and efficiently.
- CloudStack is an open source cloud computing company owned by Apache Software Foundation with headquarters in Mountain View, California. CloudStack provides open source cloud computing software for creating, managing, and deploying infrastructure cloud services. CloudStack provides computing orchestration, NaaS, user and account management, open application program interface (API), resource accounting, and a user interface (UI).
- Datapipe is an IT and cloud solutions company headquartered in Jersey City, New Jersey. Datapipe provides enterprise cloud services and IT solutions. Datapipe provides managed IT solutions to more than 2,000 customers in 25 data center facilities worldwide.
- Dell is a computer company headquartered in Round Rock, Texas. Dell provides cloud solutions that includes cross-platform infrastructure services, private and hybrid clouds, and heterogeneous cloud management.
- Eucalyptus is an open source cloud computing company headquartered in Goleta, California. Eucalyptus is the acronym for Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems. Eucalyptus' cloud provides computing, storage, and network resources that can be dynamically scaled up or

down as application workloads change. Eucalyptus announced a formal agreement with Amazon Web Services in March 2012 to maintain compatibility.

- Fujitsu is an IT equipment and cloud services company with U.S. headquarters in San Jose, California. Fujitsu provides cloud solutions and services in infrastructure, platform, and software, as well as a hybrid cloud. Fujitsu cloud computing has increased the processing power, storage capability, and IT network infrastructures of its users.
- Google is a web and internet services company that provides online advertising technologies, and search, cloud computing, and software services. Google headquarters are located in Mountain View, California. The Google Cloud platform allow users to build and host applications and websites, store data, and analyze data on Google's scalable infrastructure. Google Cloud provides collaboration and productivity applications online including machine learning tools, APIs, the enterprise Maps APIs, and the Android operating system for phones, tablets, and Chromebooks.
- Hewlett Packard (HP) is a computer company headquartered in Palo Alto, California. HP Helion Eucalyptus cloud provides interoperability with Amazon Web Services (AWS). HP Helion Eucalyptus cloud had a combined storage, servers, networking and software, since HP procured Helion and Eucalyptus open source cloud services in 2014 and end of 2015.
- IBM is a computer company with headquarters in Armonk, New York. IBM SmartCloud consists of the infrastructure, hardware, provisioning, management,

integration and security that serve as the underpinnings of a private or hybrid cloud. IBM SmartCloud Solutions consist of collaboration tools, analytics and marketing software applications. IBM cloud platforms has a built-in support for virtualization and IBM Websphere application infrastructure solutions are supporting the programming models and open standards for virtualization.

- Internap Corp. is an internet and cloud computing company headquartered in Atlanta, Georgia. Internap cloud services provides large-scale and high-performance workloads .Internap cloud solutions uses low-latency IP service for maximum network performance. Internap cloud computing provided services to online retail, online gaming, software, and financial and business industries.
- Micro Focus is an Information Technology (IT), software, and cloud computing company with United States headquarters in Santa Clara, California and Seattle, Washington. Micro Focus cloud provides an enterprise cloud services include platform, software, and infrastructure.
- Microsoft is a software company headquartered in Redmond, Washington. Microsoft cloud computing provides services to Azure products, cybercrime investigation, infrastructure, software, platform, data insights, enterprise mobility, and real time online collaboration.
- Oracle is a database and cloud computing company headquartered in Redwood City, California. Oracle enterprise cloud computing provides software, platform, infrastructure, and database services. Oracle enterprise cloud computing help increase business agility, lowering costs, and reducing IT complexity.

- OpenNebula is an open source cloud computing company headquartered in Cambridge, Massachusetts. OpenNebula cloud computing included infrastructure, software, platform services. OpenNebula cloud provides storage, network, virtualization, monitoring, and security technologies to virtual machines on distributed infrastructures using combined data center and remote cloud resources.
- OpenStack is an open source cloud computing company headquartered in Austin, Taxes. OpenStack cloud computing provides open source software, platform, and infrastructure services. OpenStack cloud consists of interrelated components that control hardware pools of processing, storage, and networking resources throughout a data center. Users either manage it through a web-based dashboard, through command-line tools, or through a RESTful API.
- Piston is an enterprise private cloud software company headquartered in San Francisco, California. Piston Cloud Computing is a subsidiary of Cisco during June 12, 2015. Piston cloud provides software that automate orchestration and deployment of cloud computing distributed systems for running applications on OpenStack.
- Rackspace is cloud computing company headquartered in Windcrest, Texas. Rackspace cloud computing provides web application hosting, Platform as a Service (PaaS), cloud storage, virtual private server, load balancers, databases, backup, and monitoring.
- Red Hat is a software and cloud computing company headquartered in Raleigh, North Carolina. Red Hat cloud computing provides solutions for private, hybrid,

and public cloud services. Red Hat cloud computing helps customers to build and manage a private Infrastructure as a Service (IaaS). Red Hat cloud computing provides Platform as a Service (PaaS) to help customer on quick application development, application hosting, and scalable application method. Red Hat cloud computing also provides Software as a Service (SaaS) application, data storage, and other data sources.

- Salesforce is a cloud computing company headquartered in San Francisco, California. Salesforce provides cloud-based tools that increase customer's productivity. Salesforce cloud computing tools help interfacing the case and task managements to automatically route and escalate customers on event planning includes a social networking site, analytical tools, and other cloud computing services.
- SAP is a cloud computing company with United States headquarters in Newtown Square, Pennsylvania. SAP cloud computing company provides in-memory technology, software, platform (PaaS), and infrastructure services. SAP enterprise cloud security and hosting services enhanced public, private, or hybrid cloud environments.
- Savvis is a social media communications and cloud computing company headquartered in Town and Country, Missouri. Savvis Symphony cloud computing solutions allow customers to deliver cost savings, high performance, scalability and security applications with leading connectivity and cloud storage from the Savvis' 31 global data centers.

- Sage is a business software and cloud computing company with United States headquarters in Atlanta, Georgia. Sage mobile cloud computing provides services to manage human resources and payroll accountings.
- Tableau is a software and cloud computing company headquartered in Seattle, Washington. Tableau cloud computing provides online workbook sharing, online hosting Tableau Server, and access data from databases, data warehouses, Hadoop clusters, Excel files and cloud applications.
- Ultimate is a business software and cloud computing company headquartered in Weston, Florida. Ultimate cloud computing provides human resource and payroll Software as a Service (SaaS) solutions. Ultimate UltiPro is a cloud-based human capital management (HCM) solutions to enable businesses to consolidate, manage, and analyze comprehensive workforce information.
- Version is a telecommunication and cloud computing company headquartered in New York City, New York. Version cloud computing allow users to secure online storage by back up and sync customer’s contacts, photos, videos, music, documents, call logs and text messages.
- Virtustream is an enterprise cloud software and services provider company headquartered in Bethesda, Maryland. Virtustream cloud computing provides enterprise private, public, and hybrid clouds to run complex software and I/O intensive applications. Virtustream also provides cloud storage, planning and migration to their customers. EMC Corporation acquired Virtustream on July 9, 2015 and Dell acquired parent company EMC during January 2016.

- VMware is a software and cloud computing services company headquartered in Palo Alto, California. VMware is a now a subsidiary of Dell and Dell's acquisition of parent company EMC during January 2016. VMware cloud computing uses enterprise capabilities to run, manage, connect and secure online applications across multiple private and public clouds and devices.

The assumption was that the cloud computing companies' ROI values are an input to Paap's CFTP ROI values. Paap's CFTP framework was used to analyze and evaluate the the assumption of the best Cloud Computing ROI in the year 2015. The results are shown in Figure 16.

Paap's CFTP with ROI only

Market: IT/Cloud Computing

Product Class: Cloud Service Selection and Procurement

Performance Characteristic	Importance	Industry Leverage	Cloud Computing Technologies						Competitors
			SaaS	PaaS	CaaS	IaaS	DaaS	NaaS	++ --
Security	1	H	++	++	++	++	++	++	
Processing	2	M	+	+	o	++	++	o	
Storage	3	H	o	++	o	++	++	o	
Input/Output	4	H	+	+	+	+	++	+	
Price	5	M	o	+	o	+	+	o	
Provisioning	6	L	+	+	o	++	+	o	
	Competitor Profile	Amazon	●	●	○	●	⦿	○	98% ROI
		AppDirect	●	●	⦿	●	○	○	65% ROI
		Apple	●	●	●	●	●	○	90% ROI
		AT&T	●	●	○	●	⦿	●	50% ROI
		BlueLock	⦿	⦿	○	●	●	○	30% ROI
		BMC	●	●	○	⦿	●	○	40% ROI

CA Tech	●	●	◉	●	●	○	45% ROI
Cisco	●	●	○	●	○	○	56% ROI
Citrix	●	●	○	●	●	○	72% ROI
CloudStack	◉	◉	○	●	○	●	32% ROI
Datapipe	◉	◉	○	●	●	○	30% ROI
Dell	◉	●	◉	●	◉	○	37% ROI
Eucalyptus	◉	●	○	●	○	○	20% ROI
FUJITSU	●	●	○	●	○	○	55% ROI
Google	●	●	○	●	●	○	98% ROI
HP	●	●	○	●	○	○	61% ROI
IBM	●	●	◉	●	●	○	57% ROI
Internap	●	●	○	●	○	◉	68% ROI
Micro Focus	●	●	○	●	○	○	57% ROI
Microsoft	●	●	◉	●	●	◉	98% ROI
Oracle	●	●	○	●	●	●	98% ROI
OpenNebula	●	●	○	●	◉	◉	70% ROI
OpenStack	●	●	◉	●	○	●	85% ROI
Piston	●	●	○	●	●	○	83% ROI
Rackspace	●	●	◉	●	○	○	68% ROI
Red Hat	◉	●	○	●	○	○	23% ROI
Salesforce	●	●	○	●	◉	○	77% ROI
SAP	●	●	○	●	○	◉	74% ROI
Savvis	●	●	○	●	◉	○	89% ROI
Sage	●	◉	○	◉	○	○	19% ROI
Ultimate	●	●	○	●	○	○	57% ROI
Tableau	●	◉	○	◉	◉	○	51% ROI
Version	◉	●	●	●	◉	●	89% ROI
Virtustream (EMC)	●	●	○	●	○	○	62% ROI
VMware	●	●	○	●	○	◉	86% ROI
Relative Maturity	M	M	G	M	E	G	

Importance:	Rank order, **1** is most important
Industry Leverage:	**H** = high
	M = medium
	L = low (refers to customer reaction to performance improvements)
Technology Impact:	++ = technology influences greatly (positive or negative)
	+ = moderate impact
	o = low impact
Competitors:	**1** = best
	2 = second best
	3 = third best (ties indicate equal performance)
Competitive profile:	● = strong capability/high investment
	⦿ = moderate capability/investment
	○ = low capability/investment
Relative maturity	**E** = Emerging technology
	G = Growing technology
	M = Mature technology

Figure 16. Paap’s CFTP ROI results.

The result description for Paap’s CFTP with ROI only has determined four possibilities on high return on investment. The four companies are Amazon, Google, Microsoft and Oracle. All four companies scored a 98% ROI for year 2015. The competitive profiles of the four companies are very similar. The interpretation of the competitive profiles are evaluated by the definitions of cloud computing technologies listed below:

(a) Software as a Service (SaaS): Provide a cloud service user the applications running on a cloud infrastructure in a non-real-time environment, such as IT and business applications. The cloud service user does not manage or control the underlying cloud infrastructure, with the possible exception of limited user-specific application configuration settings.

(b) Communications as a Service (CaaS): Provide a cloud service user to use real-time communication and collaboration services, such as voice over IP, instant messaging, and video conferencing.

(c) Platform as a Service (PaaS): Provide a cloud service user to deploy user-created or acquired applications onto the cloud infrastructure using platform tools supported by the cloud service provider. The platform tools may include programming languages and tools for application development, interface development, database development, storage and testing. The cloud service user does not manage or control the underlying cloud infrastructure, but has control over the deployed applications and, possibly, over the application hosting environment configurations.

(d) Infrastructure as a Service (IaaS): Provide a cloud service user to provisioning, processing, data storage, intra-cloud network connectivity services (e.g. VLAN, firewall, load balancer, and application acceleration), and other fundamental computing resources of the cloud infrastructure where the cloud service user was able to deploy and run arbitrary application. The cloud service user does not manage or control the resources of the underlying cloud infrastructure but has control over operating systems, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

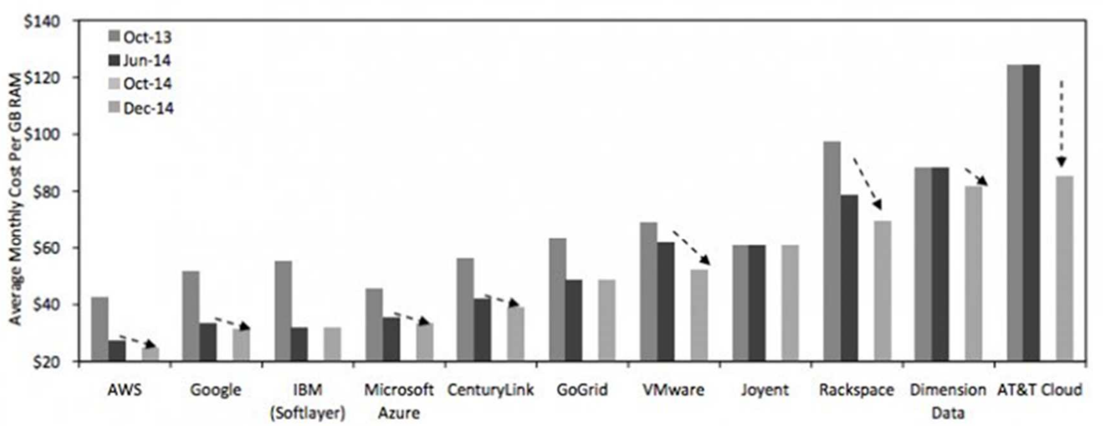
(e) Network as a Service (NaaS): Provide a cloud service user to transport connectivity services and/or inter-cloud network connectivity services, such as Virtual Private Network (VPN) and bandwidth on demand.

(f) Big data as a Service (DaaS): Provide a cloud service user to use statistical analysis tools or information by an outside service provider that helps organizations understand and use insights gained from large information sets in order to gain a competitive advantage, such as a web dashboard or control panel to carrying out the actual analysis and providing reports.

Amazon’s competitive profile listed SaaS with strong capability/high investment, PaaS with strong capability/high investment, CaaS with low capability/high investment, IaaS with strong capability/high investment, DaaS with moderate capability/high investment, NaaS with low capability/high investment. Google’s competitive profile listed SaaS with strong capability/high investment, PaaS with strong capability/high investment, CaaS with low capability/high investment, IaaS with strong capability/high investment, DaaS with high capability/high investment, NaaS with low capability/high investment. Microsoft’s competitive profile listed SaaS with strong capability/high investment, PaaS with strong capability/high investment, CaaS with moderate capability/high investment, IaaS with strong capability/high investment, DaaS with high capability/high investment, NaaS with moderate capability/high investment. Oracle’s competitive profile listed SaaS with strong capability/high investment, PaaS with strong capability/high investment, CaaS with low capability/high investment, IaaS with strong capability/high investment, DaaS with strong capability/high investment, NaaS with strong capability/high investment. The relative technology maturity was analyzed. SaaS was under the mature technology category, PaaS was under the mature technology category, CaaS was under the growing technology category , IaaS was under the mature technology category , DaaS was under the emerging technology, and NaaS was under the growing technology.

The six performance characteristics chosen in this study was security, processing, storage, input/output, price, and provisioning. The importance rank of the six performance characteristics were based on cloud computing experts in the field. Ranking number one on the performance characteristics were cloud computing security and the industry leverage is high. The cloud computing security are defined as the control-based technologies and policies designed to compliances with rulesets and protect information, data applications and infrastructure associated with cloud computing usage. Ranking number two is cloud computing processing and the industry leverage is medium. The cloud computing processing is an internet-based computing that provides shared processing resources and data to computer users, smart phone users, and/or other devices on demand. Ranking number three is cloud computing storage and the industry leverage is high. The cloud computing storage is remote data internet storage and it is maintained, operated and managed by a cloud storage service provider on a storage servers that are built on virtualization techniques. Ranking number four is cloud computing input/output and the industry leverage is high. The cloud computing input/output (I/O) device is an internet device that has the ability to accept inputted, outputted or other processed data. The cloud computing I/O can acquire data as input sent to a computer, smart phone or other devices on demand or send data to cloud computing storage as an output. Ranking number five would be price in cloud computing and this related to how much user buy or acquire the cloud computing services. The industry leverage is medium. Kim (2015) plotted the average pricing for each of the cloud computing companies shown in Figure 17. Based on Figure 17, Amazon Web Services (AWS) dropped prices by 8% from Oct. 2013 to Dec. 2014, while both Google and Microsoft cut their prices to 6% and 5% and other cloud companies who charge more, like Rackspace and AT&T, dropped prices even more significantly (Kim, 2015, p.3). Most of the cloud computing company would like to be competitive in pricing on the United States market. The last ranking is cloud computing provisioning. The cloud computing provisioning involves selecting the applications and services will reside in the internet computing and developing the processes for interfacing with the cloud computing's applications and services, as well as, auditing and monitoring which user accesses and utilizes the resources. The industry leverage of cloud computing provisioning is low due to the customer reaction on performance improvement was required.

Exhibit 14: Average Monthly Cost / GB RAM across various RBC Use Cases (excluding support costs)



(excluding optional support costs)
Average Monthly Cost Per GB RAM across various RBC Use Cases

	Oct-13	Jun-14	Dec-14	Change
AWS	$42	$27	$25	-8%
Google	$52	$34	$32	-6%
IBM (Softlayer)	$55	$32	$32	0%
Microsoft Azure	$46	$35	$34	-5%
CenturyLink	$56	$42	$39	-7%
GoGrid	$63	$49	$49	0%
VMware	$69	$62	$52	-15%
Joyent	$61	$61	$61	0%
Rackspace	$98	$79	$70	-11%
Dimension Data	$88	$88	$82	-8%
AT&T Cloud	$125	$125	$85	-32%

(including high-touch support)
Average Monthly Cost Per GB RAM across various RBC Use Cases

	Oct-13	Jun-14	Dec-14	Change
AWS	$53	$38	$35	-6%
Google	$93	$69	$68	-2%
IBM (Softlayer)	$56	$32	$32	0%
Microsoft Azure	$70	$60	$58	-3%
CenturyLink	$56	$46	$43	-7%
GoGrid	$75	$60	$60	0%
VMware	$79	$71	$61	-13%
Joyent	$72	$72	$72	0%
Rackspace	$108	$89	$70	-22%
Dimension Data	$88	$88	$81	-8%
AT&T Cloud	$129	$129	$88	-32%

* Change Dec-14 vs. Jun-14

Source: RBC Capital Markets, Company Reports

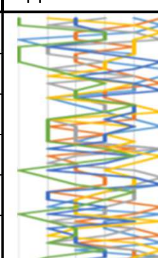
Figure 17. Cloud computing company's pricing. From *This one chart shows the vicious price war going on in cloud computing*, by E. Kim, 2010, p. 3. Retreived from Business Insider. Reprinted with permission.

The highest technology impacts are DaaS and IaaS. The ++ symbol is when the cloud computing technology influences greatly and the - - symbol is when cloud computing technology influences least. For example, Amazon's security, processing, storage, and pricing has the greatly technology influences and the most competitive among the 35 cloud computing companies shown in Figure 16. The least competitive in cloud computing companies was Sage and Enclyptus. This is the reason why both companies had a very small ROI of 19% and 20%. The next step to this research was to use Paap's ROI values with added market risk values.

Paap's CFTP with ROI and market risk assessment

Market: IT/Cloud Computing

Product Class: Cloud Service Selection and Procurement

			Cloud Computing Technologies						Competitors	
Performance Characteristic	Importance	Industry Leverage	SaaS	PaaS	CaaS	IaaS	DaaS	NaaS	++ --	
Security	1	H	++	++	++	++	++	++		
Processing	2	M	+	+	O	++	++	O		
Storage	3	H	O	++	O	++	++	O		
Input/Output	4	H	+	+	+	+	++	+		
Price	5	M	O	+	O	+	+	O		
Provisioning	6	L	+	+	O	++	+	O		**Risk**
	Competitor Profile	Amazon	●	●	○	●	⊙	○	98% ROI	2 Low
		AppDirect	●	●	⊙	●	○	○	65% ROI	9 Med
		Apple	●	●	●	●	●	○	90% ROI	6 Low
		AT&T	●	●	○	●	⊙	●	50% ROI	3 Low
		BlueLock	⊙	⊙	○	●	●	○	30% ROI	15 Med
		BMC	●	●	○	⊙	●	○	40% ROI	12 Med
		CA Tech	●	●	⊙	●	●	○	45% ROI	10 Med
		Cisco	●	●	○	●	○	○	56% ROI	9 Med

	Citrix	●	●	○	●	●	○	72% ROI	8 Low
	CloudStack	⦿	⦿	○	●	○	●	32% ROI	12 Med
	Datapipe	⦿	⦿	○	●	●	○	30% ROI	16 High
	Dell	⦿	●	⦿	●	⦿	○	37% ROI	9 Med
	Eucalyptus	⦿	●	○	●	○	○	20% ROI	20 High
	FUJITSU	●	●	○	●	○	○	55% ROI	9 Med
	Google	●	●	○	●	●	○	98% ROI	6 Low
	HP	●	●	○	●	○	○	61% ROI	9 Med
	IBM	●	●	⦿	●	●	○	57% ROI	6 Low
	Internap	●	●	○	●	○	⦿	68% ROI	16 High
	Micro Focus	●	●	○	●	○	○	57% ROI	15 Med
	Microsoft	●	●	⦿	●	●	⦿	98% ROI	8 Low
	Oracle	●	●	○	●	●	●	98% ROI	10 Med
	OpenNebula	●	●	○	●	⦿	⦿	70% ROI	12 Med
	OpenStack	●	●	⦿	●	○	●	85% ROI	9 Med
	Piston	●	●	○	●	●	○	83% ROI	16 High
	Rackspace	●	●	⦿	●	○	○	68% ROI	12 Med
	Red Hat	⦿	●	○	●	○	○	23% ROI	15 Med
	Salesforce	●	●	○	●	⦿	○	77% ROI	4 Low
	SAP	●	●	○	●	○	⦿	74% ROI	6 Low
	Savvis	●	●	○	●	⦿	○	89% ROI	12 Med
	Sage	●	⦿	○	⦿	○	○	19% ROI	20 High
	Ultimate	●	●	○	●	○	○	57% ROI	6 Low
	Tableau	●	⦿	○	⦿	⦿	○	51% ROI	20 High
	Version	⦿	●	●	●	⦿	●	89% ROI	9 Med
	Virtustream (EMC)	●	●	○	●	○	○	62% ROI	15 Med
	VMware	●	●	○	●	○	⦿	86% ROI	3 Low
Relative Maturity		M	M	G	M	E	G		

Importance:	Rank order, **1** is most important
Industry Leverage:	**H** = high
	M = medium
	L = low (refers to customer reaction to performance improvements)
Technology Impact:	++ = technology influences greatly (positive or negative)
	+ = moderate impact
	o = low impact
Competitors:	**1** = best
	2 = second best
	3 = third best (ties indicate equal performance)
Competitive profile:	● = strong capability/high investment
	⊙ = moderate capability/investment
	○ = low capability/investment
Relative maturity	**E** = Emerging technology
	G = Growing technology
	M = Mature technology

Figure 18. Paap's CFTP ROI with added risk results.

The result description for Paap's CFTP ROI with market risk assessment determined that Amazon has a high ROI of 98% and scored 2 on the lowest risk during the year 2015. Carvalh and Marden (2015) research results provided a five-year ROI of 560% in Amazon cloud computing. Therefore, the results of Paap's CFTP ROI with added risk are aligned with the Carvalh and Marden (2015) study. Amazon's competitive profile listed SaaS with strong capability/high investment, PaaS with strong capability/high investment, CaaS with low capability/high investment, IaaS with strong capability/high investment, DaaS with moderate capability/high investment, NaaS with low capability/high investment.

Amazon's security, processing, storage, and pricing was the most influence in cloud computing technology and the most competitive among the 35 cloud computing companies shown in Figure 18. The least competitive in cloud computing companies was Sage and Enclyptus. This was the reason why both companies had a very small ROI of 19% and 20. Both companies had a very high market risk investment. Returns on

Investments (ROI) is a commonly used approach for evaluating the financial consequences of investments and decisions. If there is no growth in profit this means zero or negative Returns on Investments (ROI). If an investment has a positive ROI, then the investment should be undertaken. A higher ROI means that investment gains compare favorably to investment costs. One limitation of ROI by itself says nothing about the likelihood that expected returns and costs will appear as predicted. A good investment analysis should also consider both the ROI values and the risks. Therefore, Paap's CFTP with added risk assessment was an important tool to determine the current cloud computing investment and forecast the future investment decisions based on a portfolio and planning strategy. The portfolio and planning strategy provided three confidence investment opportunities. The high confidence cloud computing investment opportunity is between 61% ROI to 100% ROI with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the high confidence investment opportunity, then they should either continue to invest or increase investment in cloud computing technology for the future years as long as the increase investment returns a similar ROI or higher ROI. If any of the cloud computing companies are within the boundary of high confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies. The moderate confidence cloud computing investment opportunity is between 21% ROI to 60% ROI with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the moderate confidence investment opportunity, then they should continue to invest in cloud computing technology for the future years. If any of the cloud computing companies are within the boundary of moderate confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies. The low confidence cloud computing investment opportunity is between 0% ROI to 20% ROI with a high risk score. If any of the cloud computing companies are within the boundary of the low confidence investment opportunity, then they should be cautious on investing in cloud computing technology for the future years. It is very important to be cautious on investing, because there might not be a long-term financial growth and competitiveness when ROI is low and risk is high. Paap's CFTP with added risk assessment can help the low ROI and high risk cloud computing to change their investment strategy to increase ROI and lower the risk in the future years. For example, the low ROI cloud computing company can partner with another high ROI cloud computing company. Another example is to use inventory management to reduce costs and lower the risk. If any of the cloud computing companies are within the boundary of low confidence investment ROI, but scored a low or a moderate risk, then these cloud companies should think about diverting their cloud computing investment to other technologies.

The last step to the data analysis was using the paired samples two-tailed *t* tests to compare two means that are from the same cloud computing companies. The two means represent two data sets, ROI without risk and ROI added risk with a difference between the two data sets. The purpose of the test was to determine whether there was statistical evidence that the mean difference between paired observations on a particular outcome was significantly different from zero. The paired samples two-tailed *t* tests was a parametric test. Risk values are converted to percentage in Table 2 to form a consistency unit convertion between ROI and risk. The percentage was scaled from 1 to 25 based on the traditional 5x5 risk matrix. The score of 1 is the lowest risk in 0% (0), the score of 2 is a low risk investment in 5% (0.05), the score of 9 is a medium risk investment in 40% (0.4), the score of 16 is a high risk investment in 70% (0.7), and the score of 25 is the highest risk in 100% (1).

Table 2

Risk Values are Converted to Percentage

Company	ROI in %	Risk in %
Amazon	0.98	0.05
AppDirect	0.65	0.4
Apple	0.9	0.25
AT&T	0.5	0.1
BlueLock	0.3	0.65
BMC	0.4	0.55
CA Tech	0.45	0.45
Cisco	0.56	0.4
Citrix	0.72	0.35
CloudStack	0.32	0.55
Datapipe	0.3	0.7
Dell	0.37	0.4
Eucalyptus	0.2	0.9
FUJITSU	0.55	0.4
Google	0.98	0.25
HP	0.61	0.4
IBM	0.57	0.25
Internap	0.68	0.7
Micro Focus	0.57	0.65
Microsoft	0.98	0.35
Oracle	0.98	0.45
OpenNebula	0.7	0.55
OpenStack	0.85	0.4
Piston	0.83	0.7
Rackspace	0.68	0.55
Red Hat	0.23	0.65
Salesforce	0.77	0.15
SAP	0.74	0.25
Savvis	0.89	0.55
Sage	0.19	0.9
Ultimate	0.57	0.25
Tableau	0.51	0.9
Version	0.89	0.4
Virtustream (EMC)	0.62	0.65
VMware	0.86	0.1

I conducted a paired sample two-tailed *t* tests to determine the relationship of adding traditional risk in percentage to Paap's 2010 CFTP ROI in percentage after the completion of Table 2. The paired sample two-tailed *t* tests results are computed by a Mirosoft Excel analysis worksheet. The paired sample two-tailed *t* tests results are listed on Table 3 and Table 4.

Table 3

Results on the Difference Between No Risk and Added Risk

#	Company	Before (No Risk)	After (Added Risk)	Difference
1	Amazon	0.98	0.05	0.93
2	AppDirect	0.65	0.4	0.25
3	Apple	0.9	0.25	0.65
4	AT&T	0.5	0.1	0.4
5	BlueLock	0.3	0.65	-0.35
6	BMC	0.4	0.55	-0.15
7	CA Tech	0.45	0.45	0
8	Cisco	0.56	0.4	0.16
9	Citrix	0.72	0.35	0.37
10	CloudStack	0.32	0.55	-0.23
11	Datapipe	0.3	0.7	-0.4
12	Dell	0.37	0.4	-0.03
13	Eucalyptus	0.2	0.9	-0.7
14	FUJITSU	0.55	0.4	0.15
15	Google	0.98	0.25	0.73
16	HP	0.61	0.4	0.21
17	IBM	0.57	0.25	0.32
18	Internap	0.68	0.7	-0.02
19	Micro Focus	0.57	0.65	-0.08
20	Microsoft	0.98	0.35	0.63
21	Oracle	0.98	0.45	0.53
22	OpenNebula	0.7	0.55	0.15
23	OpenStack	0.85	0.4	0.45
24	Piston	0.83	0.7	0.13
25	Rackspace	0.68	0.55	0.13
26	Red Hat	0.23	0.65	-0.42

27	Salesforce	0.77	0.15	0.62
28	SAP	0.74	0.25	0.49
29	Savvis	0.89	0.55	0.34
30	Sage	0.19	0.9	-0.71
31	Ultimate	0.57	0.25	0.32
32	Tableau	0.51	0.9	-0.39
33	Version	0.89	0.4	0.49
34	Virtustream (EMC)	0.62	0.65	-0.03
35	VMware	0.86	0.1	0.76

Table 3 calculates the difference within each before-and-after pair of measurements. These results are also shown in Figure 18 using a Box Plot to determine the difference measures. In Figure 18, the results determined the difference measures are normally distributed or at least reasonably symmetric.

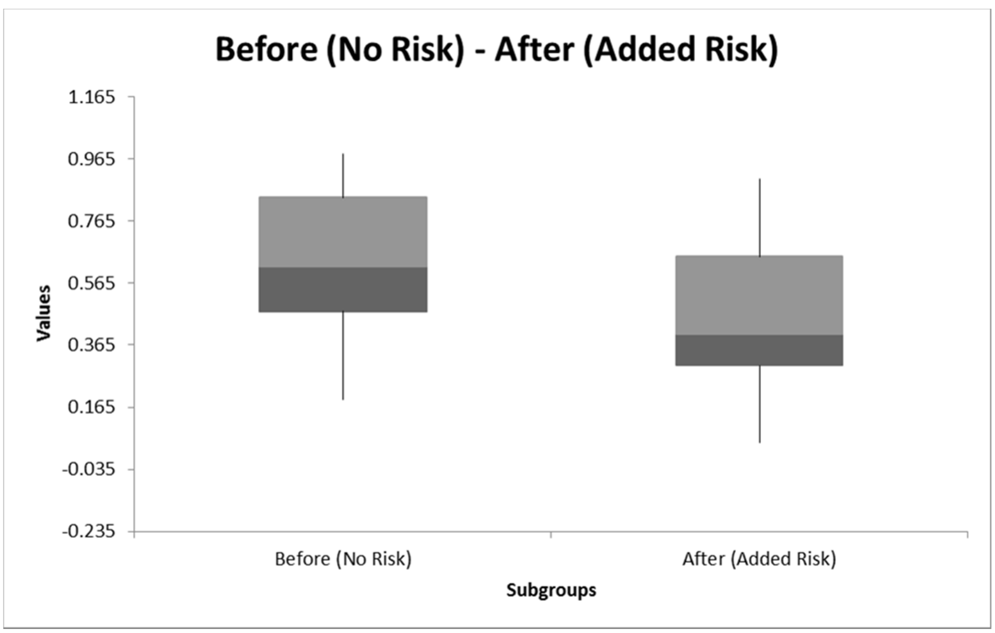


Figure 19. Box plot for difference measures.

The paired sample two-tailed *t* tests for Means data analysis output from the Excel data analysis tool was shown in Table 4. The results summary provided 0.025 *p*-value below the significance level of 0.05. This indicates there was a statistical difference between Before (No risk) and After (Added risk). Therefore, the null hypothesis was rejected. The T critical two tail is 2.032. The means was 0.163 difference between the Before mean of 0.626 and the After mean of 0.463. This was based on a 95% confidence interval values of 0.022 and 0.304. The Before variance was 0.057 and the After variance was 0.051. The Pearson's correlation coefficient is to determine whether the correlation between populations is zero. The Pearson correlation was -0.559. The t-distribution critical values table (df) required 34 values to determine the paired sample two-tailed *t* tests and finally the t-statistics was determined to be 2.347. The *p*-value was compared with the alpha to determine whether the observed data are statistically significantly different from the null hypothesis. In conclusion, the null hypothesis was rejected, since the *p*-value was less than the alpha ($p < 0.05$). The result was statistically significant.

Table 4

Results on Paired Sample Two-Tailed T Tests for Means

t tests: Paired Two Sample for Means   α   0.05

	Before (No Risk)	*After (Added Risk)*	diff	95% Confidence Interval	
Mean	0.625714	0.462857	0.163	0.022	0.304
Variance	0.057296	0.050933			
Observations	35	35			
Pearson Correlation	-0.55865				
Hypothesized Mean Difference	0				
df	34				
t Stat	2.347				
P(T<=t) one-tail	0.012		Reject Null Hypothesis because p < 0.05 (Means are Different)		
T Critical one-tail	1.691				
P(T<=t) two-tail	0.025		Reject Null Hypothesis because p < 0.05 (Means are Different)		
T Critical Two-tail	2.032				

Another test was performed to show the results of differences between two means equal variances (aka. Homoscedastic). Two-tailed *t* tests with equal variances are assumed that the population variances were equal since the sample variances were almost the same. The variances between Before (No risk) and After (Added risk) are relatively similar. Table 5 results showed the Before variance is 0.057 and the After variance is 0.051. The pooled variance is 0.054. The *p*-value was compared with the alpha to determine whether the observed data are statistically significantly different from the null hypothesis. In conclusion, the null hypothesis was rejected, since the *p*-value is less than the alpha ($p < 0.05$). The result was statistically significant.

Table 5

Results on Paired Sample Two-Tailed T Tests for Equal Variance

t tests: Two-Sample Assuming Equal Variances Equal Sample Sizes	α	0.05			
	Before (No Risk)	*After (Added Risk)*	diff	95% Confidence Interval	
Mean	0.625714	0.462857	0.163	0.052	0.274
Variance	0.057296	0.050933			
Observations	35	35			
Pooled Variance	0.054114				
Hypothesized Mean Difference	0				
df	68				
t Stat	2.929				
P(T<=t) one-tail	0.002		Reject Null Hypothesis because p < 0.05 (Means are Different)		
T Critical one-tail	1.668				
P(T<=t) two-tail	0.005		Reject Null Hypothesis because p < 0.05 (Means are Different)		
T Critical Two-tail	1.995				

The null hypothesis was rejected because 0.005 *p*-value is below the significance level of 0.05. The means are 0.163 difference between the Before mean of 0.626 and the After mean of 0.463. This was based on a 95% confidence interval values of 0.052 and 0.274. The *t*-distribution critical values table (df) required 68 values to determine the paired sample two-tailed *t* tests and the *t*-statistics was determined to be 2.929. Finally, the T critical two tail value was 1.995.

My study involved comparing two groups: (a) before added risk and (b) after added risk. The difference in the means for the two groups is a measure of the effect size (aka. Cohen's *dz* calculation). The effect size provided a measure of the magnitude of the effect. The magnitude can often be used to evaluate the importance or meaning of the effect. In other words, effect size is a measure of how much the ROI changed (aka. dependent variable). I used effect size *dz* = 0.6, because I would like to follow Cohen's rule of thumb that stated:

Small effect when *dz* = 0.2

Medium effect when *dz* = 0.5

Large effect when *dz* = 0.8

The average effect size over many studies were closer to *dz* = 0.5. My calculation using G*Power 3.0 tool was very closer to *dz* = 0.6, which was slightly above medium effect. The effect size *dz* =0.6 means that one group performed six-tenths of a standard deviation above the other group was shown in Figure 20. To reduce the threat of reliability, I performed a power analysis to determine the minimum sample size of 24. In conclusion, the sample size of 35 cloud computing companies are listed in this study are very reasonable for my paired sample two-tailed *t* tests.

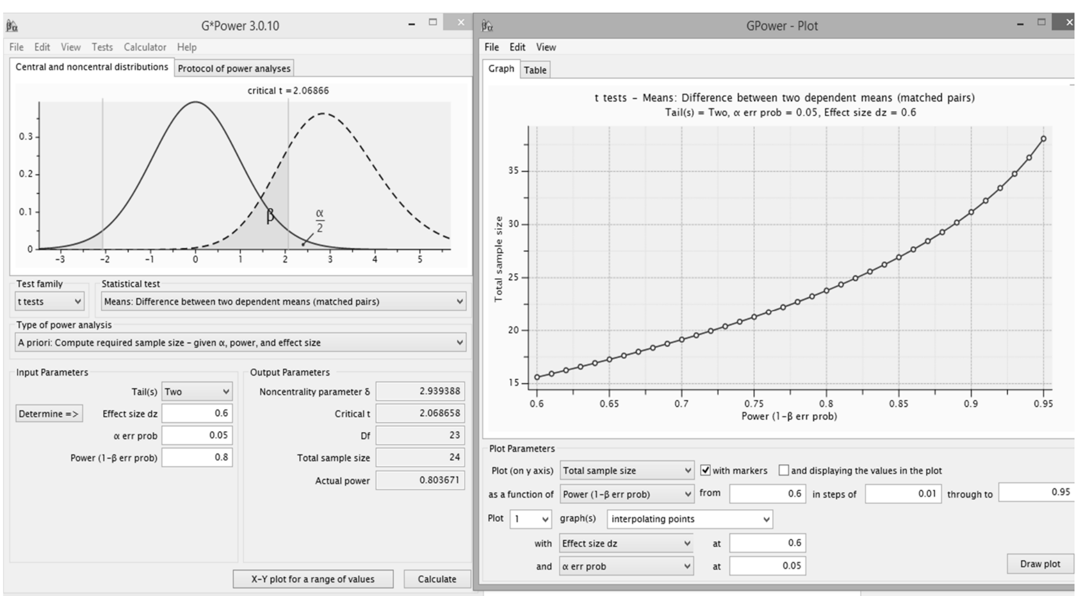


Figure 20. The effect size calculation.

Summary

This section I summarized the answer to research question. The results of paired sample two-tailed *t* tests for means and equal variances showed the null hypothesis rejected because $p < 0.05$. The concluded statement would be the null hypothesis gets replaced with the alternate hypothesis (H1): The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework. The research question was: What is the relationship to the return on investment by adding traditional risk assessment model to Paap's CFTP framework? The answer to my research question was the return on investment was positively related to added traditional risk assement model to Paap's CFTP framework. Chapter 5 provides further detailed interpretation of the findings, limitations of the study, recommendations on future study, and the most important section to cover implications of positive social change of my study.

Chapter 5: Research Conclusion and Positive Social Change

The purpose of this research was to determine the relationship between returns on investment before and after adding risk assessment to the CFTP framework .By adding traditional risk assessment to the framework, the high tech companies and their technologists, investment strategists, and researchers might improve their technology decision making processes for investments, which may result in a higher return on their investments.

This quantitative study was needed to resolve the gap of missing risk assessment that helped to reduce monetary loss and increase ROI when making technology investment decisions in Paap's CFTP framework and other technology investment framework, such as IBM Cloud Enablement Framework. This study may provide information that organizational leaders can use to improve technology decision-making processes and create a new technology management model. I examined and verified that ROI done in conjunction with risk assessment, can benefit cloud computing technology investments using Paap's CFTP framework. The benefits of using risk assessment with the CFTP framework include helpping investors make better and more expeditious decisions while considering the opportunities for cost savings in technology investment.

My key finding was that only four companies had high ROI, when assessed using only Paap's CFTP framework. The four companies were Amazon, Google, Microsoft and Oracle. All four companies scored a 98% ROI for 2015. I also found that, after adding market risk assessment to Paap's CFTP framework, Amazon had a high ROI of 98% and scored 2 on the lowest risk index during the 2015. Carvalh and Marden (2015) research results showed a 5-year ROI of 560% for Amazon cloud computing. Therefore, the results of my study using Paap's CFTP ROI with added risk are aligned with Carvalh and Marden (2015) study. I found that adding risk assessment to the technology investment framework may help investors (a) make better decisions more quickly; and (b) obtain a high return on technology investment by selecting the highest ROI value and lowest risk value. The results of a paired sample two-tailed *t* tests for means and equal variances showed that I should reject the null hypothesis, because $p < 0.05$, and replace it with the alternate hypothesis (H1) that the ROI may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

Interpretation of the Findings

The findings extended knowledge in the risk management discipline by resolved the missing gap of risk assessment that helped to reduce monetary loss and increase ROI when making technology investment decisions in Paap's CFTP framework and other technology investment framework, such as IBM Cloud Enablement Framework. In the literature review in Chapter 2, I noted Jiang and Ruan (2010) recognized that one of the primary reasons for these losses was that companies were not performing risk assessment when making technology investment decisions. Current studies are missing a robust investment framework with added risk assessment to reduce profit loss. Bakht (2015) also recognized the current problem was the lacking of risk assessment in technology investment, such as science risk, technology risk, market risk, and regulatory risk. Investors have little choice but to make riskier and riskier technology investment decisions that leads to profit loss. Another example, Merrill and Kang (2014) research results provided a potential number of hidden costs with cloud computing that many may not have considered. Therefore, risk assessment was the next step to predict the actual costs of cloud computing and the potential ROI. Another example was Barnier (2014) research results provided the benefits of risk assessment. The benefits help investors make better decisions quicker and consider the opportunities for cost savings in technology investment.

I analyzed and interpreted the findings in the context of the theoretical framework. I used the theoretical action research cycle to modify Paap's CFTP 2010 technology framework. A pictorial representation of the theoretical action research cycle is shown in Figure 21. Deming (1982) was the first to present the theory and concepts of action research cycle, which was part of a theoretical framework used to develop a solution to a specific issue between experts and researchers involving the change process and the action needed for fact finding.

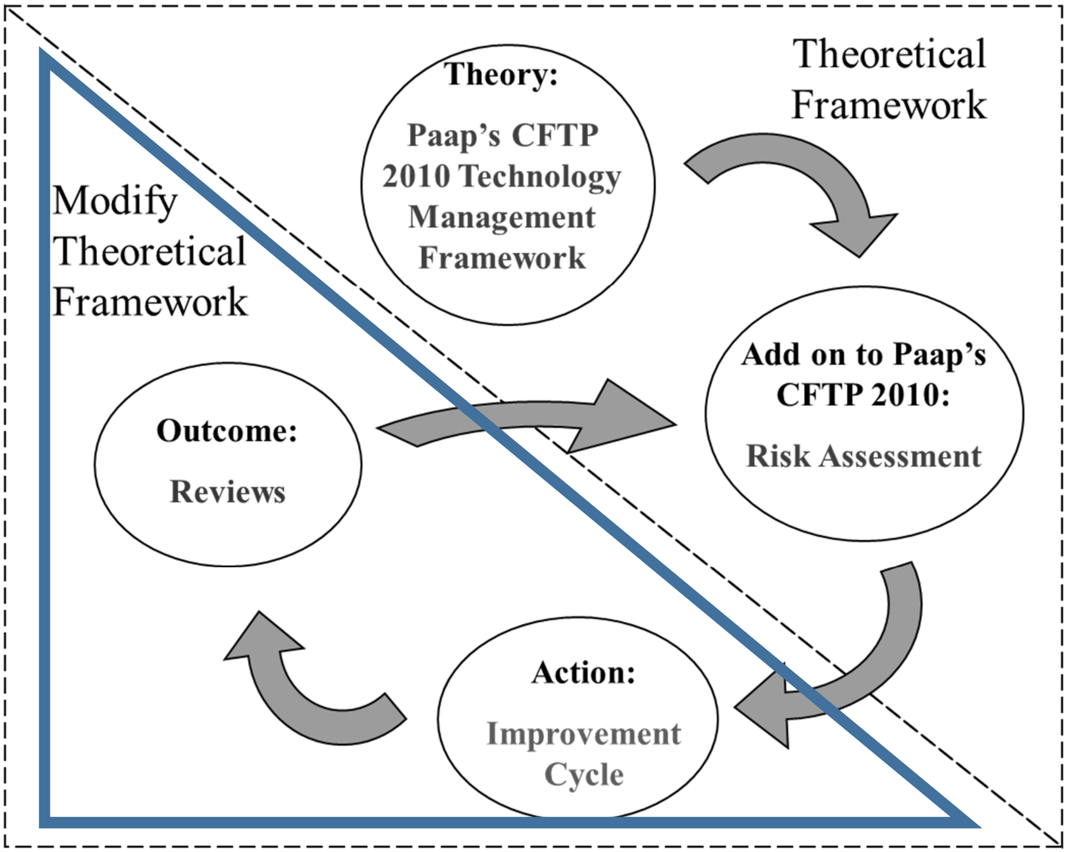


Figure 21. Modified theory using action research cycle.

I have shown with my research that adding risk assessment to Paap's CFTP framework has the potential to improve technology decision-making processes. Further, after reviewing the outcomes of the quantitative analysis, I have examined and verified that there is a need to modify Paap's CFTP framework with added risk assessment. The finding was that only four companies had high ROI, when assessed using only Paap's CFTP framework. The four companies were Amazon, Google, Microsoft and Oracle. All four companies scored a 98% ROI for 2015. I also found that, after adding market risk assessment to Paap's CFTP framework, Amazon had a high ROI of 98% and scored 2 on the lowest risk index during the 2015. Carvalh and Marden (2015) research results showed a 5-year ROI of 560% for Amazon cloud computing. Therefore, the results of my study using Paap's CFTP ROI with added risk are aligned with Carvalh and Marden (2015) study.

Also, I found that Paap's CFTP with added risk assessment was an important tool for determining the current cloud computing investment and forecasting future investment decisions based on a portfolio and planning strategy. The portfolio and planning strategy provided three confidence investment opportunities. The three confidence investment opportunities are:

- The high confidence cloud computing investment opportunity. This was between 61% and 100% ROI, with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the high confidence investment opportunity, then they should either continue to invest or increase investment in cloud computing technology for the future years, as long as the increased investment returns a similar or higher ROI. If any of the cloud computing companies are within the boundary of high confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies.
- The moderate confidence cloud computing investment opportunity. This was between 21% and 60% ROI,with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the moderate confidence investment opportunity, then they should continue to invest in cloud computing technology for the future years. If any of the cloud computing companies are

within the boundary of moderate confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies.

- The low confidence cloud computing investment opportunity. This was between 0% and 20% ROI, with a high risk score. If any of the cloud computing companies are within the boundary of the low confidence investment opportunity, then they should be cautious in investing in cloud computing technology for the future years. It is very important to be cautious when investing, because there might not be a long-term financial growth and competitiveness when ROI is low and risk is high. Paap's CFTP with added risk assessment can help the low ROI and high risk cloud computing to change their investment strategy to increase ROI and lower the risk in the future years. For example, the low ROI cloud computing company can partner with another high ROI cloud computing company. Another example is using an inventory management system to reduce costs and lower the risk. If any of the cloud computing companies are within the boundary of low confidence investment ROI, but scored a low or a moderate risk, then these cloud companies should think about diverting their cloud computing investment to other technologies.

The finding of power analysis provided the minimum sample size of 24. I have examined and verified with my research there is a need to compare two groups: (a) before added risk and (b) after added risk. The difference in the means for the two groups was a measure of the effect size (i.e., Cohen's *dz* calculation). The effect size provided a measure of the magnitude of the effect. The magnitude can often be used to evaluate the importance or meaning of the effect. In other words, effect size was a measure of how much the ROI changed (aka. dependent variable). I selected effect size *dz* = 0.6, because I would like to follow Cohen's rule of thumb that stated:

Small effect when *dz* = 0.2

Medium effect when *dz* = 0.5

Large effect when *dz* = 0.8

The average effect size over many studies were closer to *dz* = 0.5. My calculation using G*Power 3.0 tool was much closer to *dz* = 0.6, which was slightly above medium effect. The effect size *dz* =0.6 means that one group performed six-tenths of a standard deviation above the other group. In summary, the sample size of 35 cloud computing companies are listed in this study was very reasonable for my paired sample two-tailed *t* tests.

The finding of the paired sample two-tailed *t* tests for Means data analysis provided 0.025 *p*-value below the significance level of 0.05. This indicates there was a statistical difference between Before (No risk) and After (Added risk). Therefore, the null hypothesis was rejected. The T critical two tail was 2.032. The means were 0.163 difference between the Before mean of 0.626 and the After mean of 0.463. This was based on a 95% confidence interval values of 0.022 and 0.304. The Before variance was 0.057 and the After variance was 0.051. The Pearson's correlation coefficient is to determine whether the correlation between populations is zero. The Pearson correlation was -0.559. The t-distribution critical values table (df) required 34 values to determine the paired sample two-tailed t tests and finally the t-statistics was determined to be 2.347. The *p*-value was compared with the alpha to determine whether the observed data are statistically significantly different from the null hypothesis. The null hypothesis was rejected, since the *p*-value was less than the alpha ($p< 0.05$). The result was statistically significant. The finding of two paired sample t -test with equal variances are assumed that the population variances were equal since the sample variances were almost the same. The variances between Before (No risk) and After (Added risk) were relatively similar. Table 5 results showed the Before variance was 0.057 and the After variance was 0.051. The pooled variance was 0.054. The *p*-value was compared with the alpha to determine whether the observed data were statistically significantly different from the null hypothesis. The null hypothesis was rejected because 0.005 *p*-value was below the significance level of 0.05. The means are 0.163 difference between the Before mean of 0.626 and the After mean of 0.463. This was based on a 95% confidence interval values of 0.052 and 0.274. The *t*-distribution critical values table (df) required 68 values to determine the paired sample two-tailed *t* tests and the *t*-statistics was determine to be 2.929. Finally, the T critical two tail value was 1.995. The results of paired sample two-tailed *t* tests for means and equal variances showed the null hypothesis rejected because $p < 0.05$. The concluded statement would be the null hypothesis gets replaced with the alternate hypothesis (H1): The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

Limitations of the Study

This research provides the potential for several limitations. The major limitation of this study relates to a one time period data collection in 2015 and a wider time period should be investigated. To mitigate as many limitations as possible, proactive attempts were made to reduce threats to reliability, internal and external validity. To reduce the threat of reliability, I performed a power analysis to determine the minimum sample size of 24. In conclusion, the sample size of 35 cloud computing companies in this study was very reasonable for my paired sample two-tailed *t* tests. The threats to internal validity may compromise my confidence in saying that a relationship exists between the independent and dependent variables. To reduce the threat of internal validity, I used doctoral peer review of my research results with my dissertation chair, who is an expert in the investment and risk management fields. The threats to external validity may compromise my confidence in saying whether the study's results are applicable to other groups. To reduce the threat of external validity, I used doctoral peer review of my research results with an expert in the field from the cloud computing investment industry.

Recommendations for Further Study

The scope for future work includes testing of the Paap's CFTP framework with added risk assessment to the international cloud computing companies' data. The current dataset was collected in United States with over $100 million on investment. The study should be expanded with a wider population and sample size to obtain a better understanding of future cloud computing investment in different regions of the world. If the sample size was larger than 500 samples, then traditional risk assessment can be replaced with Neuro-Fuzzy risk assessment to train the neural networks to preform an artificial intelligence assessment. The Neuro-Fuzzy risk assessment have three distinguishing areas: (a) active monitoring to ensure the technology investment decision's sensitivity to detect risk, (b) agility to ensure its flexibility to respond to risk, and (c) adaptive learning to ensure the capability of the technology investment decision's resources to mitigate risk. The Neuro-Fuzzy risk assessment model is referenced in Appendix A. The technique is neural networks with fuzzy logic combined to create a new risk assessment model. The inputs to the model were linguistic and fuzzy values of the probability of risk occurrence and severity of risk occurrence. The fuzzy risk assessment model is shown in Figure 22. The inputs to the model were linguistic and fuzzy values of the probability of risk occurrence and severity of risk occurrence. The risk values are the output to a generic model.

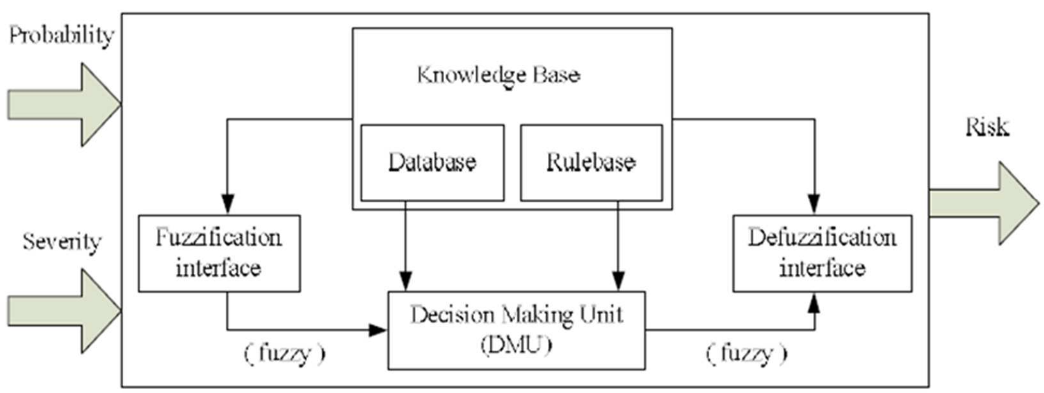


Figure 22. Fuzzy risk assessment. From *Risk assessment of construction projects using network based adaptive fuzzy system*, by M. Ebrat and R. Ghodsi, 2011, p. 414. Retreived from International Journal of Academic Research. Reprinted with permission.

Two parts to the Neuro-Fuzzy adaptive risk assessment model. The first part of the model was a hybrid learning algorithm, and the second part of the model was an error back-propagation algorithm. The Neuro-Fuzzy systems use neural network learning for determination of input and output spaces, as well as, adaptive training samples. The linear relationship between the input variables was shown in Equation 5.

if (x is A1) AND (y is B1) Then (f1 = p1x + q1y + r1),

where x and y are numerical inputs while A and B are numerical variables. The p, q, and r are parameters that determine the relation between input and output (Ebrat & Ghodsi, 2011). The Neuro-Fuzzy adaptive assessment model formed by five layers was shown in Figure 23.

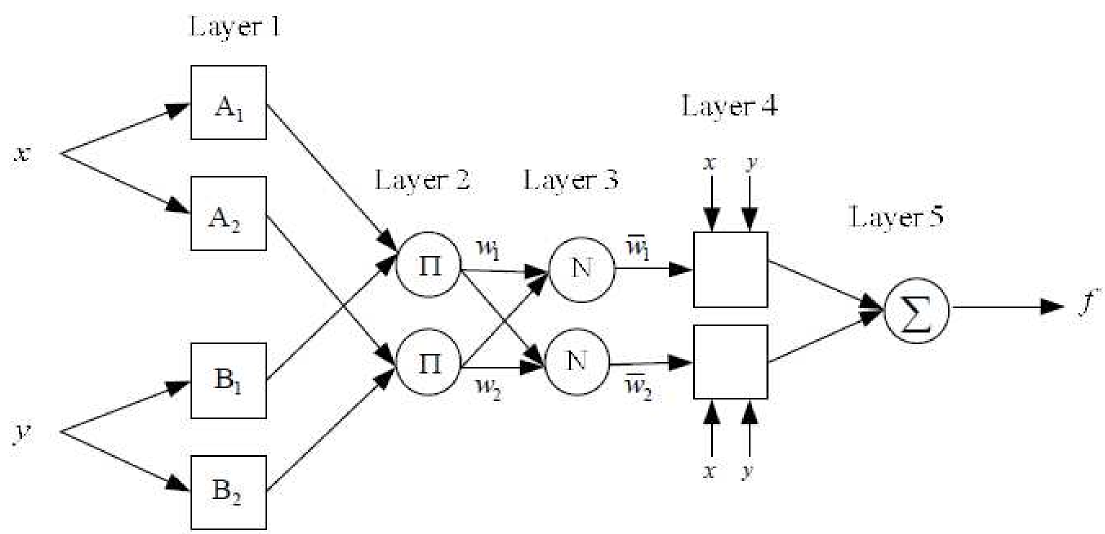


Figure 23. Neuro-fuzzy adaptive assessment model. From *Risk assessment of construction projects using network based adaptive fuzzy system*, by M. Ebrat and R. Ghodsi, 2011, p. 414. Retreived from International Journal of Academic Research. Reprinted with permission.

The first layer indicated how much each numerical input belongs to a different fuzzy set was listed in Equation 6.

$$\begin{cases} O_i = \mu_{A_i}(x) & ;\ i = 1,2; \\ O_i = \mu_{B_{i-2}}(y) & ;\ i = 3,4; \end{cases}$$

Where, $\mu_{A_i}(x)$ and $\mu_{B_i}(y)$ are the membership functions for fuzzy sets of A and B.

The second layer are operators, such as "AND" and "OR" are used for achieving the output which was called firing strength. This value determined how much a special rule was true in different values of inputs. The output of this layer or firing strength was obtained by multiplying the earlier results. These output are calculated by w in Equation 7.

$$O_i = w_i = \mu_{A_i}(x).\mu_{B_i}(x) \ ;\ i = 1,2$$

The third layer was calculated by each of the outputs of the previous layer divided by all outputs of that rule. The outputs are calculated by $\overline{w}$ was shown in Equation 8.

$$O_i = \overline{w}_i = \frac{w_i}{\sum_i w_i}$$

The forth layer was computed by Equation 9.

$$O_i = \overline{w}_i f_i = \overline{w}_i \left(p_i x + q_i y + r_i \right) \ ;\ i = 1,2$$

The fifth layer was the outputs of the previous neurons are summed with each other and finally, by defuzzification, fuzzy outputs are converted to numerical outputs f(x,y) in Equation 10.

$$f(x,y) = \frac{w_1 f_1(x,y) + w_2 f_2(x,y)}{w_1(x,y) + w_2(x,y)} = \frac{w_1 f_1 + w_2 f_2}{w_1 + w_2}$$

The neural network requires training data to learn the adaptive risk computational model and finally, the least square method was used to obtain the best parameters (Ebrat &

Ghodsi, 2011). If the membership functions of inputs are unknown as well, the solution space would be very large and convergence will take more time. This needs a forward step and backward step. In the forward step, errors are calculated and in the backward step, operations are done on the parameters (Ebrat & Ghodsi, 2011). With the assumption a, b, and c are constants. Then Equation 11 and 12 become the following:

$$f = \overline{w}_1\left(p_1 x + q_1 y + r_1\right) + \overline{w}_2\left(p_2 x + q_2 y + r_2\right)$$
$$f = \left(\overline{w}_1 x\right)p_1 + \left(\overline{w}_1 y\right)q_1 + \overline{w}_1 r_1 + \left(\overline{w}_2 x\right)p_2 + \left(\overline{w}_2 y\right)q_2 + \overline{w}_2 r_2$$

Also, the future study to determine the costs and benefits in Cloud Computing ROI with Net Present Value (NPV) and Internal Rate of Return (IRR) may also increase future profits in cloud computing investment. To back up my future study, Misra and Mondal (2011) addressed the cloud computing investment and the time frame in which increased profit was expected, Net Present Value (NPV) and Internal Rate of Return (IRR) can be calculated along with ROI to increase future profits. The ROI with Net Total Benefit (NTB) calculation uses the net total benefit costs over the analysis period, and compares this with the total cost saving and other tangible benefits over the same period. The ROI with NTB is shown in equation 13.

ROI_{NTB} = Net Total Benefit (NTB) / Net Total Cost (NTC)

O'Donnell (2002) suggested ROI with NTB approach provides more flexibility than just NPV because it allows additional intangible benefits to be included. ROI with NTB is most appropriate when there is a need to analyze costs and benefits where technology investment prices do not exist or are inadequate. The ROI with NTB calculation provides a valuable comparison of the net total benefit verses net total cost, a ratio that can point towards a solution that delivers optimum technology investment benefits and the value of ROI with NTB is important when making a technology investment decision because it clearly demonstrates the financial gains of the technology investment, compared to the relative cost (O'Donnell, 2002).

Future research can be conducted with the new Stage-Gate process presented by Cooper and Edgett (2017). The Stage-Gate process is a phase gate model that improves new product development, process improvement, and organizational change by dividing into a series of activities (stages) and decision points (gates). The Stage-Gate process is leaner, faster, more adaptive and risk- based. To manage risk, the parallel activities in a certain stage must be designed to gather vital information, such as technical, market, financial, operations data in order to reduce key project uncertainties and risks. The Stage-Gate process was first developed by Robert G. Cooper. The five stages are defined as, (a) Stage 0 Discovery - activities designed to discover opportunities and to generate new technology investment ideas, (b) Stage 1 Scoping - a quick and inexpensive assessment of the technical merits of the new technology investment and its market risk, (c) Stage 2 Build Business Case - technical, marketing and business feasibility are accessed resulting in a business case which has three main components: technology investment definition; technology investment justification; and technology investment plan, (d) Stage 3 Development - the actual technology investment of the new technology occurs, the investment plan is mapped out, (e) Stage 4 Testing and Validation - the purpose of this stage is to provide validation of the entire investment plan, (f) Stage 5 Launch – making the final investment decisions and fully commercialize the technology (Cooper & Edgett, 2017). The three gates are listed as, (a) Gate 1 - technology investment deliverables, (b) Gate 2 - criteria, (c) Gate 3 - outputs of the investment decision and path forward (Cooper & Edgett, 2017). Gate 3 consists of risk assessment of technology investment. The risk assessment are organized into a scorecard and include both ROI and risk criteria. The benefits of using the new Stage-Gate process are to accelerate speed-to-market decisions, increase likelihood of successful technology investments, and ensure a complete process to assess technology investment ROIs and risks.

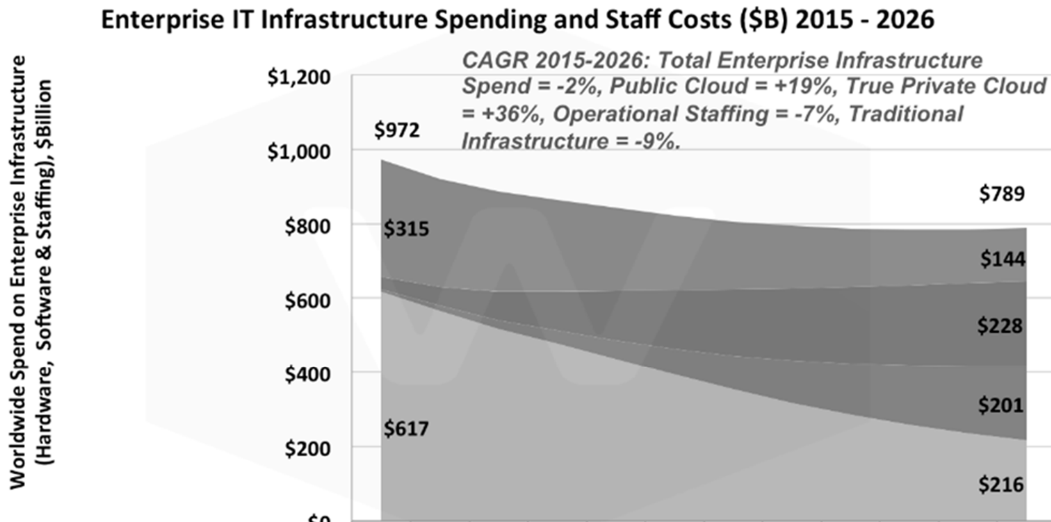
Another future study idea would be using the Paap's CFTP framework with added risk assessment apply to a different industry, such as the car manufacturing industry. For example, the new product risk include high end autonomous self driving feature may or may not be a good ROI for lowest price cars. But, we don't know the results until we apply the Paap's CFTP framework with added risk assessment to the car manufacturing industry.

Cloud computing investments are no longer just about lowering costs and improving efficiency. Cloud computing technology fosters greater collaboration across the company and IT services also call for fewer resources, providing organizations with the opportunity to invest in other business processes and innovations within their organization. A great future study idea would be using Paap's CFTP framework with added risk assessment apply to a 5 year ROI and risk forecasts. This idea will help the company to work on long term investment planning for their organization. Also, many companies are spending time with key business stakeholders and peers on the executive committee to begin laying out a 5 year technology roadmap that aligns with cloud computing investment strategy with corporate strategy. So, the 5 year ROI and risk forecasts will be a very useful tool to help the company to make a better decision on their long term investment strategy.

Another future study idea is to apply Greenwell, Liu, & Chalmers' 2014 Benefits Management tools in conjunction with Paap's 2010 CFTP framework plus risk assessment because this may increase the knowledge and robustness of the cloud computing investment portfolio. Greenwell, Liu, & Chalmers' 2014 Benefits Management tools determine four types of investments in cloud computing. The fours investment portfolio categories are strategic cloud computing investments, the high potential cloud computing investments, the key operation cloud investments, and the support cloud computing investments.

Positive Social Change and Implications

Several potential positive social changes existed in this study. The positive social change in this study created a proactive investment strategy using Paap's CFTP ROI with added risk assessment. The proactive investment strategy allows the United States cloud computing companies to remain competitive in the world market with the lowest risk and highest ROI. Another positive social change was helping cloud computing company manger to make the best investment decisions which might accelerate changes in new high tech start-ups and entrepreneurships. These changes may vary from high tech start-ups in new cloud computing investments, to revolutionizing the large cloud computing companies in their ongoing investments. The Paap's CFTP ROI with added risk assessment framework might assist the cloud computing manager with proper investment decision making. Paap's CFTP ROI with added risk assessment framework was a tool that helps the cloud computing manager to understand the different investment factors, and the potential benefits of risk assessment added to investment strategy. Improve business process, team work and collaboration between investment and strategic departments was another positive social change. The current cloud computing companies are arranged in separate departments to analyze ROI and risk decisions. The ROI portfolios were analyzed by the investment department and the risk factors were analyzed by strategic department. Paap's CFTP ROI with added risk assessment framework was a tool that helps the help the company to make joint department decisions that might improve business process, team work, and collaboration. For investment managers, they could utilize the research findings to focus on a specific cloud computing investment vs. four or more cloud computing investments in their portfolio. For risk managers, they could utilize the research findings to help reduce risky investment in their portfolio. Another major positive social change that the Paap's CFTP ROI with added risk assessment framework can be used and applied in many industries besides cloud computing. Lastly, the United States Government can make use of the Paap's CFTP ROI with added risk assessment framework proposed in this research study or a derivative of it to improve on the acquisition and procurement policy. Instead of using a government contractor and surveys of different industries to understand the government acquisition and procurement process, the Paap's 2010 Paap's CFTP ROI with added risk assessment could be used to analyze government contracting cost effort when using a certain risk factor to improve government budget allocation for each fiscal year. Fiscal year is a period that the government uses for accounting purposes and preparing financial statements. There are two benefits involved in increasing cloud computing investments. The benefit was a positive potential investment opportunity. If any of the cloud computing companies were within the boundary of the high confidence investment opportunity, then they should either continue to invest or increase investment in cloud computing technology for the future years. Wikibon Public and Private Cloud Research Projects (2016) published a projection on how much can be invested in public cloud was $228 Billion in 2026 worldwide and private cloud was $201 Billion in 2026 worldwide shown in Figure. 22. The increase in cloud computing investments is helping the economy grow and create new jobs in the United States and around the world.



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Enterprise IT Operational Staffing Costs	$315	$290	$269	$246	$223	$201	$183	$168	$157	$150	$146	$144
Public Cloud Infrastructure Hardware & Software Spending	$33	$50	$77	$104	$132	$158	$179	$195	$207	$216	$223	$228
True Private Cloud Spending	$7	$15	$24	$35	$50	$69	$90	$114	$138	$161	$183	$201
Traditional Infrastructure Hardware & Software Spending	$617	$565	$517	$479	$437	$394	$354	$318	$286	$258	$235	$216
Total Enterprise Spend on Infrastructure Hardware, Software & Staffing	$972	$921	$887	$864	$842	$822	$806	$794	$787	$784	$785	$789

Source: © Wikibon Public & True Private Cloud Research Projects 2016

Figure 24. Wikibon public and private cloud research projects (2016). From *Wikibon research cloud computing (2015 – 2026)*, by B. Gracely, 2016, p.16. Retrieved from Wikibon Public and True Private Cloud Research Projects 2016 Report. Reprinted with permission.

Conclusion of Study

My research concluded adding risk assessment to Paap's CFTP framework has an improvement upon technology decision-making processes. The key finding was that only four companies had high ROI, when assessed using only Paap's CFTP framework.. The four companies were Amazon, Google, Microsoft and Oracle. All four companies scored a 98% ROI for 2015. I also found that, after adding market risk assessment to Paap's CFTP framework, Amazon had a high ROI of 98% and scored 2 on the lowest risk index during the 2015. Carvalh and Marden (2015) research results showed a 5-year ROI of

560% for Amazon cloud computing. Therefore, the results of my study using Paap's CFTP ROI with added risk are aligned with Carvalh and Marden (2015) study.Therefore, the results of Paap's CFTP ROI with added risk are aligned with Carvalh and Marden (2015) study. The research findings with added risk assessment to technology investment framework yielded two types of benefits: (1) help investors make better decisions quicker; and (2) obtain a high return on technology investment by selecting the highest ROI value and lowest risk value.

Also, Paap's CFTP with added risk assessment was an important tool to determine the current cloud computing investment and forecast the future investment decisions based on a portfolio and planning strategy. The portfolio and planning strategy provided three confidence investment opportunities. The high confidence cloud computing investment opportunity was between 61% ROI to 100% ROI with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the high confidence investment opportunity, then they should either continue to invest or increase investment in cloud computing technology for the future years as long as the increase investment returns a similar ROI or higher ROI. If any of the cloud computing companies are within the boundary of high confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies. The moderate confidence cloud computing investment opportunity was between 21% ROI to 60% ROI with a low or a moderate risk score. If any of the cloud computing companies are within the boundary of the moderate confidence investment opportunity, then they should continue to invest in cloud computing technology for the future years. If any of the cloud computing companies are within the boundary of moderate confidence investment ROI, but scored a high risk, then these cloud companies should think about diverting their cloud computing investment to other technologies. The low confidence cloud computing investment opportunity was between 0% ROI to 20% ROI with a high risk score. If any of the cloud computing companies are within the boundary of the low confidence investment opportunity, then they should be cautious on investing in cloud computing technology for the future years. It was very important to be cautious on investing, because there might not be a long-term financial growth and competitiveness when ROI was low and risk was high. Paap's CFTP with added risk assessment can help the low ROI and high risk cloud computing to change their investment strategy to increase ROI and lower the risk in the future years. For example, the low ROI cloud computing company can partner with another high ROI cloud computing company. Another example was to use inventory management to reduce costs and lower the risk. If any of the cloud computing companies are within the boundary of low confidence investment ROI, but scored a low or a moderate risk, then these cloud companies should think about diverting their cloud computing investment to other technologies.

I have examined and verified with my research there is a need to modify Paap's CFTP framework with added risk assessment after reviewing the quantitative analysis results. The quantitative analysis results of paired sample two-tailed *t* tests for means and equal variances showed the null hypothesis rejected because $p < 0.05$. The concluded statement would be the null hypothesis gets replaced with the alternate hypothesis (H1):

The return on investment may be positively related to adding a traditional risk assessment model to Paap's CFTP framework.

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Appendix A: Neuro-Fuzzy Risk Assessment Model

Ebrat and Ghodsi (2011) conducted a mixed-method research to evaluate project risk using a new adaptive Neuro-Fuzzy risk assessment model. The adaptive fuzzy system was designed to predict future project situations by using a continuous learning technique that learns from past project performances. The risk factors in construction projects are management, project time, cost, operational, design, and external influences. Project cost and time overruns are the highest risk factors of construction projects (Ebrat & Ghodsi, 2011; Zavadskas, Turskis, & Tamošaitienė, 2010). Ebrat and Ghodsi (2011) data collection was based on the survey study of 100 construction projects. Ebrat and Ghodsi (2011) project survey help experts rate the probability of occurrence of risks and the severity of risk. Figure A1 provided the input of linguistic and fuzzy values (Ebrat & Ghodsi, 2011).

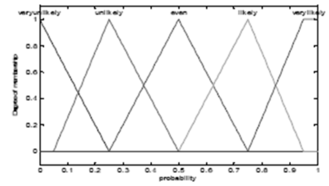
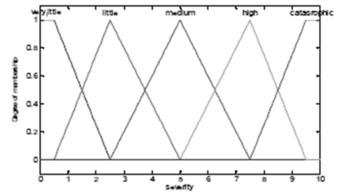
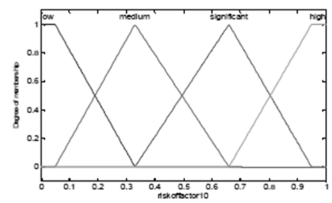
Linguistic value	Fuzzy value	Graphical presentation
Linguistic variables (probability of risk occurrence)		
Very Unlikely	(0, 0.125, 0.25)	
Unlikely	(0.05, 0.275, 0.5)	
Even	(0.25, 0.5, 0.75)	
Likely	(0.5, 0.725, 0.95)	
Very Likely	(0.75, 0.875, 1)	
Linguistic variables (severity of risk occurrence)		
Very Little	(0, 1.25, 2.5)	
Little	(0.5, 2.75, 5)	
Medium	(2.5, 5, 7.5)	
High	(5, 7.25, 9.5)	
Catastrophic	(7.5, 8.75, 10)	
Linguistic variables (risk value)		
Low	(0, 0.165, 0.33)	
Medium	(0.05, 0.355, 0.66)	
Significant	(0.33, 0.64, 0.95)	
High	(0.66, 0.83, 1)	

Figure A1. Linguistic and fuzzy values. From *Risk assessment of construction projects using network based adaptive fuzzy system*, by M. Ebrat and R. Ghodsi, 2011, p. 413. Retreived from International Journal of Academic Research. Reprinted with permission.

In addition, Ebrat and Ghodsi (2011) investigated a new technique called Neuro-Fuzzy. The technique is neural networks with fuzzy logic combined to create a new risk assessment model. The fuzzy risk assessment model was shown in Figure A2. The inputs to the model were linguistic and fuzzy values of the probability of risk occurrence and severity of risk occurrence. The risk values are the output to a generic model.

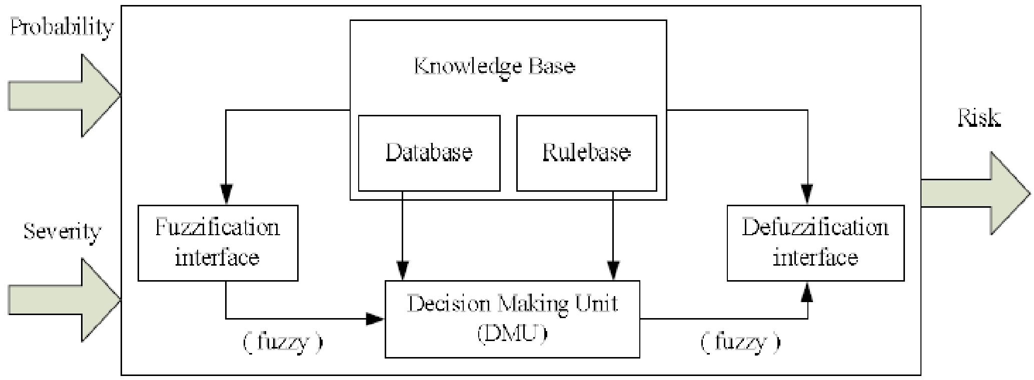


Figure A2. Fuzzy risk assessment. From *Risk assessment of construction projects using network based adaptive fuzzy system*, by M. Ebrat and R. Ghodsi, 2011, p. 414. Retreived from International Journal of Academic Research. Reprinted with permission.

Two parts to the Neuro-Fuzzy adaptive risk assessment model. The first part of the model was a hybrid learning algorithm, and the second part of the model was an error back-propagation algorithm. The Neuro-Fuzzy systems use neural network learning for determination of input and output spaces, as well as, adaptive training samples. The linear relationship between the input variables was shown in Equation A1.

$$\text{if } (x \text{ is } A_1) \text{ AND } (y \text{ is } B_1) \text{ Then } (f_1 = p_1x + q_1y + r_1),$$

where x and y are numerical inputs while A and B are numerical variables. The p, q, and r are parameters that determine the relation between input and output (Ebrat & Ghodsi, 2011). The Neuro-Fuzzy adaptive assessment model formed by five layers was shown in Figure A3.

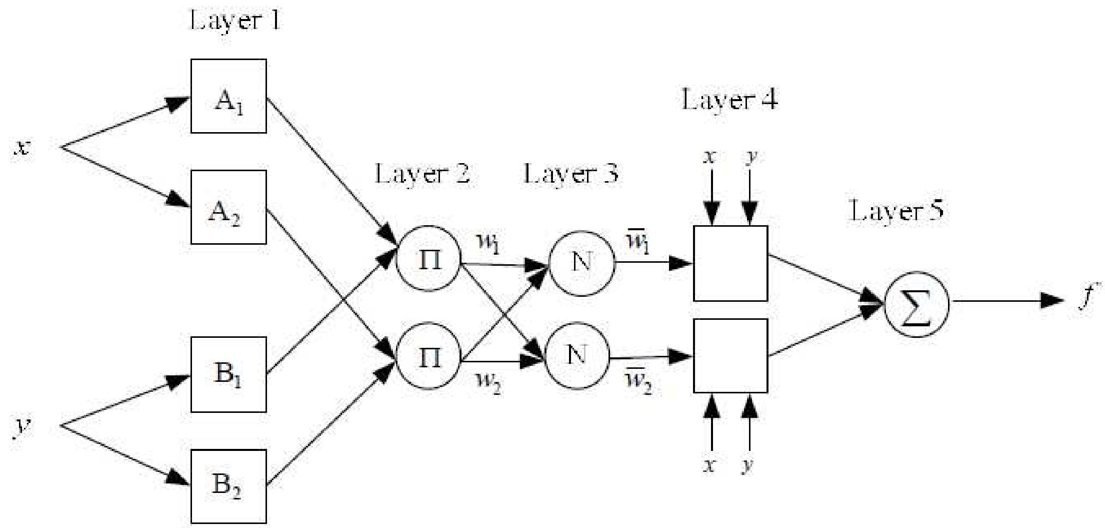


Figure A3. Neuro-fuzzy adaptive assessment model. From *Risk assessment of construction projects using network based adaptive fuzzy system*, by M. Ebrat and R. Ghodsi, 2011, p. 414. Retreived from International Journal of Academic Research. Reprinted with permission.

The first layer indicated how much each numerical input belongs to a different fuzzy set was listed in Equation A2.

$$\begin{cases} O_i = \mu_{A_i}(x) & ; \; i = 1,2; \\ O_i = \mu_{B_{i-2}}(y) & ; \; i = 3,4; \end{cases}$$

Where, $\mu_{A_i}(x)$ and $\mu_{B_i}(y)$ are the membership functions for fuzzy sets of A and B.

The second layer are operators, such as “AND” and “OR” are used for achieving the output which was called firing strength. This value determined how much a special rule is true in different values of inputs. The output of this layer or firing strength was obtained by multiplying the earlier results. These output are calculated by w in Equation A3.

$$O_i = w_i = \mu_{A_i}(x).\mu_{B_i}(x) \;\; ; \;\; i = 1,2$$

The third layer was calculated by each of the outputs of the previous layer divided by all outputs of that rule. The outputs are calculated by $\overline{w}$ was shown in Equation A4.

$$O_i = \overline{w}_i = \frac{w_i}{\sum_i w_i}$$

The forth layer was computed by Equation A5.

$$O_i = \overline{w}_i f_i = \overline{w}_i \left(p_i x + q_i y + r_i \right) \quad ; \quad i = 1,2$$

The fifth layer was the outputs of the previous neurons are summed with each other and finally, by defuzzification, fuzzy outputs are converted to numerical outputs f(x,y) in Equation A6.

$$f(x,y) = \frac{w_1 f_1(x,y) + w_2 f_2(x,y)}{w_1(x,y) + w_2(x,y)} = \frac{w_1 f_1 + w_2 f_2}{w_1 + w_2}$$

The neural network requires training data to learn the adaptive risk computational model and finally, the least square method was used to obtain the best parameters (Ebrat & Ghodsi, 2011). If the membership functions of inputs are unknown as well, the solution space would be very large and convergence will take more time. This needs a forward step and backward step. In the forward step, errors are calculated and in the backward step, operations are done on the parameters (Ebrat & Ghodsi, 2011). With the assumption a, b, and c are constants. Then Equation A7 and A8 become the following:

$$f = \bar{w}_1 \left(p_1 x + q_1 y + r_1 \right) + \bar{w}_2 \left(p_2 x + q_2 y + r_2 \right)$$
$$f = \left(\bar{w}_1 x \right) p_1 + \left(\bar{w}_1 y \right) q_1 + \bar{w}_1 r_1 + \left(\bar{w}_2 x \right) p_2 + \left(\bar{w}_2 y \right) q_2 + \bar{w}_2 r_2$$

Ebrat and Ghodsi (2011) evaluated the performance of the designed system for risk in technical skill and knowledge. The technical skill and knowledge data are computed in the neural network, where 80% of the data are located in the training database and the remaining 20% are used for testing the system. Ebrat and Ghodsi (2011) concluded, if the project increases in probability and risk severity, the risk value also increases.

Appendix B: How to Build Paap's CFTP Framework

Paap (2010) proposed the idea of the Customer Focused Technology Planning (CFTP) framework to draw future technology roadmaps to help technologists, investment strategists, and researchers to make more informed decisions, and to do so as effectively and efficiently as possible. Paap's CFTP 2010 framework provides a break down important dimensions into smaller levels of analysis with six factors that help companies to determine which technology was most beneficial. Paap lists the six factors shown in Figure B1. The first factor was the *Who and Why* box. The *Who and Why* box was to assess the product class vs. the market segment. Product class refers to a broad range of related products or services used to address a customer need. The market segments are investment decision patterns. The high interest segment means payoff clusters for detailed assessment to save time and cost. Also, the *Who and Why* box provides the comprehensive assessments of high interest segments:

- Company objectives - image, ROI, share, growth, harvest, etc.
- Market characteristics - size, growth, profits, image, synergy, etc.
- Competition - share, capabilities, intentions, etc.

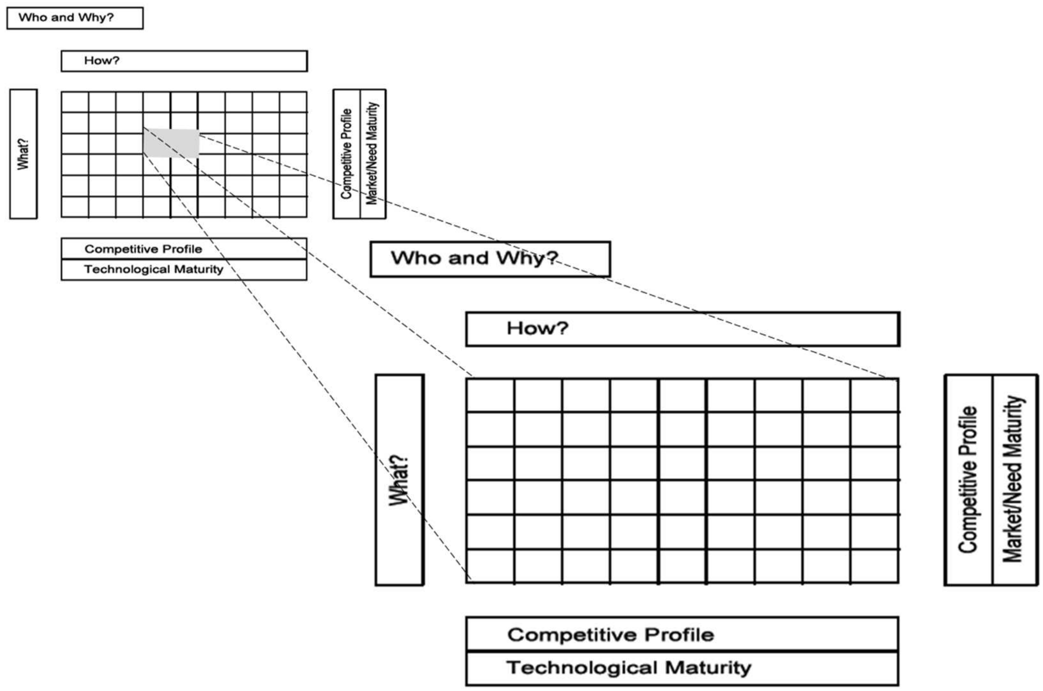


Figure B1. Paap’s CFTP smaller levels of analysis with six factors. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retreived from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

The market segment of my study was Informaton Technology (IT)/Cloud Computing and the product class of my study was cloud computing service selection and procurement.

The second factor was Paap’s CFTP How box. The *How box* was to identify the technology options available to provide, maintain, or improve important and leveragable characteristics. The guidelines for assessing technology options and relationships are listed below:

- Identify technologies that do or might affect important leverage characteristics.
- Rank or rate the potential for the technology to maintain or improve characteristics of importance.

• Estimate relative maturity and anticipate potential for obsolescence or substitution.

• Determine the competitive relationship of technology:

- Base - necessary and available to all
- Key - source of competitive advantage
- Pacing - technology expected to be future key
- Exploratory - early stage with unclear potential

• Use benchmarking to compare competitors and identify "best in class", investment level, experience, strengths, etc.

The third factor was called the *What box*. The "What box" states what drove the purchase or use decision. In my selected IT/Cloud Computing market segment, I first assess the characteristics that drive the decision to use cloud computing service slection and procurement product class. The performance characteristics should also include factors important to interested third parties who influence the customers' buying decision, such as the third party's procurement department, regulators, or advocacy groups. To fully understand what drives the purchase or use decision, it was often necessary to consider cloud computing product performance characteristics such as security, processing, storage, input/output, price, and provisioning. The steps on how to assess performance characteristics were listed as: Step 1 is to think broadly when defining customer; consider users, buyers, decision influencers, etc. Step 2 is to list decision factors used by customers using categories on the sample chart as a starting point. This starts with understanding the features they now desire, thinking backward to the needs

these are addressing, and then identifying additional features that may also meet those needs. Step 3 is to rank and/or rate the past, present and future importance of the features and or needs. Step 4 is to determine whether an improvement in the performance characteristic will increase the use of your product or service - its leverage. The performance characteristic was a function of need maturity and the extent to which the underlying need being addressed drives decisions. Determine the minimum level of the performance that needs to be offered in order for the product to be taken seriously in the market. Determine the desired level, because further change was
not perceivable, cannot be used, or becomes less important than making improvements in another need or driver. Step 5 is to compare competitors on each characteristic, such as determining "best in class" through benchmarking. In addition, the most important consideration in this analysis deals with the concept of leverage. Leverage was related to, but different from importance. Importance was an absolute rating or ranking of all features or characteristics. In addition, the most important consideration in this analysis deals with the concept of leverage. Leverage was related to, but different from importance. Importance is an absolute rating or ranking of all features or characteristics.

The *Competitive Profile* box, also known as Paap's CFTP fourth factor, refers to the strength in the technology by each competitor and/or company, as well as, providing the customers what they want in terms of delivering the right product requirements. Competitive profile was categorized as strong, moderate, or low capability investments.

The fifth factor was the *Technology Maturity* box that describes the approximate level of improvement in the product and/or service. The maturity of the technology was defined by the Technology Readiness Levels (TRL). The TRL was based on a scale from 1 to 9 with 9 being the most mature technology. TRL 1 is the basic technology research maturity level. TRL 2 is the technology concept and/or application maturity level. TRL 3 is the analytical and experimental critical function and/or characteristic proof of concept maturity level. TRL 4 is the component and/or breadboard validation in laboratory environment maturity level. TRL 5 is the component and/or breadboard validation in releant environment maturity level. TRL 6 is the system/subsystem model or prototype demonstration in a relevant environment maturity level. TRL 7 is the system prototype demonstration in an operational environment maturity level. TRL 8 is the actual system completed and qualified through test and demonstration maturity level. TRL 9 is the actual system proven through successful mission operations maturity level. In addition, an important task of the Paap's CFTP framework was to understand the relative maturity of the technology. Relative maturity was categorized as emerging technology, growing technology, and mature technology. The relative maturity of the technology was only part of the technology intelligence needed. Where is the competition relative to you? What new technologies are attempting to replace the current technology base? Will new technology take its place, when the technology matures? Or will technology become less important as competitors' capabilities equalize?

The sixth factor was the *Market/Need Maturity* box that states your success in the marketplace. The sixth factor helps technology investors to understand the dynamic environment in which needs constantly evolve and technologies mature and are replaced by newer ones. It helps companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the success investment probability.

Paap's representative CFTP landscape roadmap with six factors needed to understand the link between customers' needs and technology investment options was shown on Figure B2. The Paap's CFTP framework helps high tech companies integrate the diverse sources of information needed to decide where to invest to get the greatest return from their technology dollars. Paap's CFTP framework helps high tech companies anticipate shifts in market needs and technological capabilities that alter the current competitive environment, and increase the technology investment probability

Paap's CFTP Landscape Roadmap

Market: Consumer
Product Class: Convenience desserts

Performance Characteristic	Importance	Industry Leverage	Ingredient Technologies				Process Technologies		Competitors
			Sweeteners	Fats and substitutes	Shelf life enhancers	Flavorings	Formulation	Mixing	++ --
Flavor	1	M	+	++	+	++	+	+	B A CI
Appearance	2	L	+	+	++	o	++	+	B A CI
Fat Content	3	H	o	++	o	o	o	o	A B/CI
Texture/ Mouthfeel	4	H	+	++	+	++	+	+	B CI A
Price	5	M	o	+	+	+	++	++	B A CI
Calories	6	L	++	+	o	o	o	o	A/B/CI
	Competitor Profile	Constar Inc.	●	⊙	⊙	○	○	⊙	10% share
		A	⊙	●	●	●	⊙	●	30% share
		B	⊙	⊙	●	●	●	⊙	40% share
	Relative Maturity		G	E	G	G	M	G	

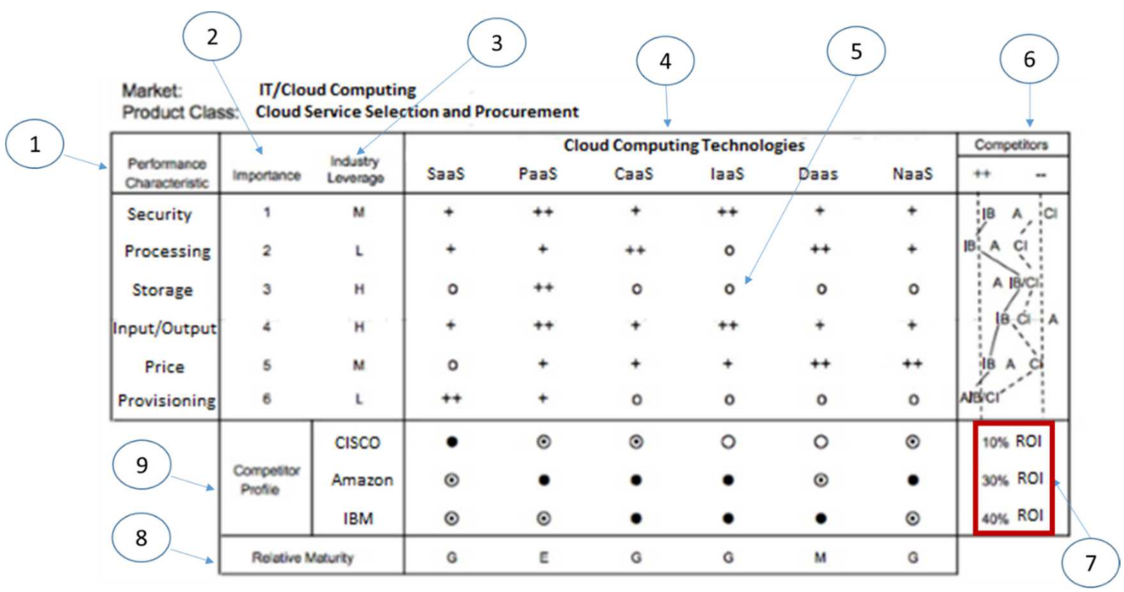
Figure B2. Paap's representative CFTP landscape roadmap. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retrieved from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

Appendix C: How to Use Paap's CFTP Framework

Return on Investment (ROI) was defined as the results of creating a new technology over the company investments (Paap, 2010). An example on how to input the cloud computing companies' ROI values to input number 7 of Paap's CFTP ROI, was shown in Figure 8. In this example, IBM cloud computing was the best technology to invest in due to the highest ROI of 40% on input number 7 and has the best competitor profile in both input number 6 and input number 9. Paap's CFTP has 9 inputs to the framework and it was circled in Figure C1. The following
9 inputs definitions are described below:

1. The performance characteristics input refers to the performance factors that are important in influencing the purchase or use decision.
2. The importance input refers to the rank of the performance characteristic in the purchase or use decision. Higher ranked items generally must be fairly well satisfied before lower ranked items influence the buying or use decision.
3. The industry leverage input refers to the market relationship of an improvement in a technology. High leverage means customers will have a strong and positive reaction to improvements. Low means they really do not care about improvements, even if the improvements had an important characteristic.
4. The cloud computing technologies input refers to the current and potential technologies that are used in this business area.

5. The technology relationship input refers to which technology affects the performance level of a characteristic.
6. The competitive performance profile input refers to each competitor profile including yourself, and the customers.
7. The ROI input is a measure of the profit earned from each investment. To calculate ROI, the return of an investment was divided by the cost of the investment; the result was expressed as a percentage ROI (%) = [(Gross Profit – Investment) / Investment] × 100. The cloud computing companies' ROI values are an input to Paap's CFTP ROI values.
8. The relative maturity of the technology input refers to TRLs.
9. The competitive technology profile input refers to the strength in the technology by each competitor.



Importance:	Rank order, **1** is most important
Industry Leverage:	**H** = high
	M = medium
	L = low (refers to customer reaction to performance improvements)
Technology Impact:	++ = technology influences greatly (positive or negative)
	+ = moderate impact
	o = low impact
Competitors:	**1** = best
	2 = second best
	3 = third best (ties indicate equal performance)
Competitive profile:	● = strong capability/high investment
	⦿ = moderate capability/investment
	○ = low capability/investment
Relative maturity	**E** = Emerging technology
	G = Growing technology
	M = Mature technology

Figure C1. Paap's CFTP ROI for cloud computing investment. From Customer focused technology planning: An overview, by J. Paap, 2010, p. 15. Retreived from http://www.jaypaap.com/articles/CFTP-2016-06.pdf. Copyright 2016 by J. Paap. Reprinted with permission.

The definitions of cloud computing technologies are listed below:

1. Software as a service (SaaS): Provide to a cloud service user applications running on a cloud infrastructure in a non-real-time environment, such as IT and business applications. The cloud service user does not manage or control the underlying cloud infrastructure, with the possible exception of limited user-specific application configuration settings.
2. Communications as a service (CaaS): Provide to a cloud service user real-time communication and collaboration services, such as voice over IP, instant messaging, and video conferencing.
3. Platform as a service (PaaS): Provide to a cloud service user user-created or acquired applications and delpoy them on the cloud infrastructure using platform tools supported by the cloud service provider. The platform tools

may include programming languages and tools for application development, interface development, database development, storage and testing. The cloud service user does not manage or control the underlying cloud infrastructure, but has control over the deployed applications and, possibly, over the application hosting environment configurations.

4. Infrastructure as a service (IaaS): Provide to a cloud service user provisioning, processing, data storage, intra-cloud network connectivity services (e.g., VLAN, firewall, load balancer, and application acceleration), and other fundamental computing resources of the cloud infrastructure where the cloud service user is able to deploy and run arbitrary application. The cloud service user does not manage or control the resources of the underlying cloud infrastructure, but has control over operating systems, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).
5. Network as a service (NaaS): Provide to a cloud service user transport connectivity services and/or inter-cloud network connectivity services, such as virtual private network (VPN) and bandwidth on demand.
6. Big data as a service (DaaS): Provide to a cloud service user statistical analysis tools or information by an outside service provider that helps organizations understand and use insights gained from large information sets in order to gain a competitive advantage. These include tools such as a web

dashboard or control panel for carrying out the actual analysis and providing reports.

Appendix D: How to Add Risk to Paap's CFTP Framework

Risk assessment involves the calculation of the magnitude of potential consequences (levels of impacts) and the likelihood (levels of probability) of these consequences to occur. Risk was calculated by the following Equation D1:

$$\text{Risk} = \text{Consequence} \times \text{Likelihood}$$

Likelihood is the Probability of occurrence of an impact that affects the environment; and, Consequence is the environmental impact if an event occurs. The traditional risk matrix was shown in Figure D1. The traditional risk matrix was a method that combines the scores from the consequence (levels of impact) and the likelihood (levels of probability) to generate a risk score.

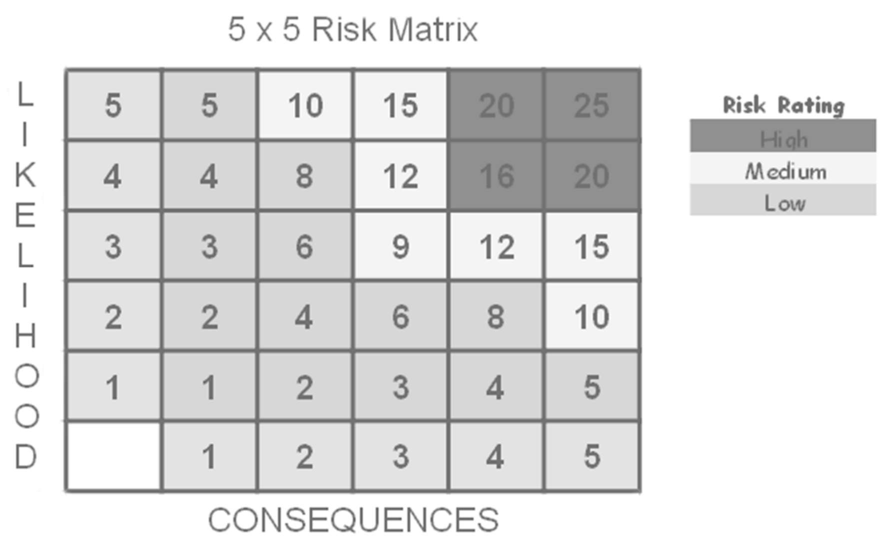


Figure D1. Traditional 5x5 risk matrix.

The traditional risk assessment process involves selecting the most appropriate combination of consequence and likelihood levels that fit the situation for a particular objective based upon the information available and the collective knowledge of the group involved in the assessment process. An example of Paap's CFTP Framework added risk asssignment was shown in Figure D2.

Market: IT/Cloud Computing
Product Class: Cloud Service Selection and Procurement

Performance Characteristic	Importance	Industry Leverage	SaaS	PaaS	CaaS	IaaS	Daas	NaaS	Competitors (++ … --)	Risk
Security	1	M	+	++	+	++	+	+	IB A CI	
Processing	2	L	+	+	++	o	++	+	IB A CI	
Storage	3	H	o	++	o	o	o	o	A IB/CI	
Input/Output	4	H	+	++	+	++	+	+	IB CI A	
Price	5	M	o	+	+	+	++	++	IB A CI	
Provisioning	6	L	++	+	o	o	o	o	A/B/CI	
Competitor Profile		CISCO	●	⊙	⊙	○	○	⊙	10% ROI	16 High
		Amazon	⊙	●	●	●	⊙	●	30% ROI	4 Low
		IBM	⊙	⊙	●	●	●	⊙	40% ROI	9 Med
Relative Maturity			G	E	G	G	M	G		

Importance: Rank order, **1** is most important
Industry Leverage: **H** = high
M = medium
L = low (refers to customer reaction to performance improvements)
Technology Impact: ++ = technology influences greatly (positive or negative)
\+ = moderate impact
o = low impact
Competitors: **1** = best
2 = second best
3 = third best (ties indicate equal performance)
Competitive profile: ● = strong capability/high investment
⊙ = moderate capability/investment
○ = low capability/investment
Relative maturity **E** = Emerging technology
G = Growing technology
M = Mature technology

Figure D2. Cloud computing investment example using Paap's CFTP framework with added risk assessment.

In Figure D2, the results showed Amazon Cloud Computing Company was the best to make your investment decision based on the lowest risk of 4 and medium ROI of 30% compared to IBM Cloud Computing with medium risk of 9 and medium ROI of 40%, as well as, CISCO Cloud Computing with high risk of 16 and lowest ROI of 10%. In a perfect scenario, the investment decision was based on determining the lowest risk and the highest ROI.

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From: Anne Lee <anne.lee@waldenu.edu>

Date: Sat, Oct 15, 2016 at 8:28 PM

Subject: Reprinted with permission

To: Brian.Gracely@wikibon.org

Mr. Brian Gracely,

I'm trying to complete my Ph.D. dissertation at Walden University. I would like permission to reprint a chart titled, "Wikibon research cloud computing (2015 – 2026)" on Wikibon Public and Ture Private Cloud Research Projects Report published in the year 2016. Can you please grant me the permission to reprint? Thank you so much.

Anne Lee

Ph.D. Student

Walden University

On Tue, Oct 18, 2016 at 1:24 PM, Brian Gracely <Brian.Gracely@wikibon.org> wrote:

Ms. Lee,

You have my permission to reprint the Wikibon research cloud computing chart. Wish you the best on your Ph.D. study.

Brian

From: Anne Lee <anne.lee@waldenu.edu>

Date: Thu, Aug 18, 2016 at 9:24 AM

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To: ekim@businessinsider.com

Eugene,

I'm working on my Ph.D. dissertation and I came across a chart published by RBC Capital's Mark Mahaney on your article titled, "This One Chart Shows The Vicious Price War Going On In Cloud Computing" during January 14, 2015 on Business Insider. Can I have a reprint with permission of the RBC Capital Market chart?

Thank you,

Anne Lee

Ph.D. Student

Walden University

On Fri, Aug 19, 2016 at 11:20 AM, ekim <ekim@businessinsider.com> wrote:

Hi Anne -- thanks for the email, but I would suggest reaching out to RBC Capital directly (you should be able to find their press contact online) and ask for permission from them.

Thanks!

Eugene Kim

Enterprise Tech Reporter

Business Insider

ekim@businessinsider.com

On Mon, Aug 22, 2016 at 9:34 AM, Hannah Sloane <hannah.sloane@rbc.com> wrote:

I'm glad to grant you the reprinted with permission from RBC Capital Markets.

Regards,

Hannah

From: Anne Lee <anne.lee@waldenu.edu>

Date: Fri, Apr 18, 2014 at 10:29 AM

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To: mehdi.ebrat@gmail.com;

Mehdi,

I am writing for permission to include in my dissertation on figure titled “Fuzzy risk assessment” of the material from the International Journal of Academic Research, article title: Risk assessment of construction projects using network based adaptive fuzzy system, volume: 3, number: 1, date: 2011, and page number: 414.

Thank you for your help.

Sincerely,

Anne Lee

On Tue, Apr 30, 2014 at 2:41 PM, Mebrat Ebrat <mehdi.ebrat@gmail.com> wrote:

I hereby grant permission agreement to reprint the above reference. The above reference will be updated once my new research complete somewhere between late 2013 and early 2014. The new article “Construction project risk assessment by using adaptive-network-based fuzzy inference system: An empirical study” will be submitted to KSCE Journal of Civil Engineering for publication during June 2014 under volume 18 issue 5.

Mebrat Ebrat

mehdi.ebrat@gmail.com

From: Anne Lee <anne.lee@waldenu.edu>

Date: Wed, Jan 11, 2012 at 2:00 PM

Subject: Reprinted with permission

To: jaypaap60@alum.mit.edu

Dr. Paap,

I graduated from Caltech in 2006. Now, I'm working on my Ph.D. dissertation at Walden University. I would like to extent your Paap's CFTP framework in my upcoming research. I am writing to request permission to reprint your CFTP framework and figures?

Thank you,

Anne Lee

Ph.D. Student

Walden University

On Fri, Jan 12, 2012 at 9:10 AM, Jay Paap < jaypaap60@alum.mit.edu> wrote:

Anne,

I'm glad you are pursuing a higher education. I authorize you to reprint material.

Jay Paap, Ph.D.

President, Paap Associates

jaypaap60@alum.mit.edu

From: Anne Lee <anne.lee@waldenu.edu>

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The Open Group Techical Report

Author: Mark Skilton

Title: Building return on investment from cloud computing

Year of publication: 2010

The figure appears on page 22.

Sincerely,

Anne Lee

Ph.D. Student

Walden University

On Wed, Jun 21, 2012 at 8:12 AM, Mark Skilton < mark.skilton@capgemini.com> wrote:

Hi Anne,

I hereby grant permission to use the above referenced material.

Regards,

Mark Skilton

Director of Portfolio and Solutions

Capgemini

mark.skilton@capgemini.com

+44 7787 692197

From: Anne Lee <anne.lee@waldenu.edu>

Date: Fri, Sep 6, 2013 at 7:32 AM

Subject: Reprinted with permission

To: warren.chan@crowehorwath.com; eugene.leung@crowehorwath.com; Heidi.pili@crowehorwath.com

Warren, Eugene, and Heidi,

I'm working on my Ph.D. dissertation at Walden University. I would like to request permission to reprint the following material from your publication:

The Committee of Sponsoring Organizations of the Treadway Commission (COSO) Conference paper

Author: Warren Chan, Eugene Leung, and Heidi Pili,

Title: Enterprise risk management for cloud computing

Year of publication: 2012

The figure appears on page 13 titled "ERMF along with cloud computing options".

Thanks,

Anne Lee

Ph.D. Student

Walden University

On Fri, Sep 13, 2013 at 11:54 AM, warren chan < warren.chan@crowehorwath.com> wrote:

We received your request to reprint ERMF figure. We grant you the rights to reprint.

Warren

From: Anne Lee <anne.lee@waldenu.edu>

Date: Wed, Aug 8, 2012 at 9:05 AM

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To: seanacollins@kpmg.com

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KPMG International Cooperative Conference Paper

Author: S. Collins, and D. McAllister

Title: Telcos advance in cloud computing

Year of publication: 2011

The figure appears on page 3, titled “Global cloud services market growth, 2010–14”.

Sincerely,

Anne Lee

Ph.D. Student

Walden University

On Wed, Aug 8, 2012 at 9:20 AM, Collins <seanacollins@kpmg.com> wrote:

Good Morning Anne,

I have the authority to grant the permission requested and please send me a copy of your dissertation for review before publication.

Thanks,

Sean Collins

Global Head of Communications & Media

seanacollins@kpmg.com