# A QUANTITATIVE INVESTIGATION OF THE TECHNOLOGY OBSOLESCENCE MODEL (TOM) FACTORS THAT INFLUENCE THE DECISION TO REPLACE OBSOLETE SYSTEMS

by

Scott P. Marchek

MARY ROBINSON LIND, PhD, Faculty Mentor and Chair

MARILYN E HARRIS, PhD, Committee Member

GEOFFREY LAENDNER, PhD, Committee Member

Sue Talley, EdD, Dean, School of Business and Technology

A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree

Doctor of Philosophy

Capella University

April 2015

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#### Abstract

The Technology Obsolescence Model (TOM) provides a framework of key factors involved in assessing influences to the decision to replace obsolete Information Technology (IT) systems. TOM focuses upon what is important and significant to the replacement decision. Formulated from well-established models in decision making and technology acceptance, TOM presents a structured interface of influence factors crossing technical, business, organizational, and interpersonal effects matched with demographic influence assessment. Survey results of questions exploring TOM are analyzed for insight into decision motivation and their influences and significance to the replacement decision. Primary questions employ both 7-point Likert scale of importance as well as ordered ranking for prioritization assessment. The survey augments quantitative material with qualitative rationale for prioritized responses. Reviewed survey response focuses on a large, multinational conglomerate organization's IT department. Primary assessment tools include ANOVA, regression, factor, and correlation analysis. Validity and reliability are examined in detail. Assessment of responses indicates a business-centric focus of decision makers where systems obsolescence may be influential to, but not a primary causal factor for, a replacement decision. While the business and technical benefits of replacement systems are perceived by respondents as most important, statistical analysis identifies obsolescence as one of the only potential significant influencing factors. Demographic effects also demonstrated influence. Findings and recommendations for instrument improvements and continued research opportunities in additional venues, demographic modification, and longitudinal studies are identified as well

#### **Dedication**

First and foremost, I must thank the Lord for the blessing of freedom and opportunity bestowed upon my country and me at this time and place in history. I can only hope and pray that it will always remain so.

To my mother, Lea, I had sure hoped to complete this work while you were still with us in this world. I carry your love and joy of life with me always.

To my father, Mike, your example of dedication, selflessness, and steadfast resolve have provided me with a lifetime of example upon which to build my own success.

To my loving wife, Cheryl, your consideration, support, and ability to grant me the freedom to pursue this work is one of the fundamental sources of its completion.

Thank you for everything we have and share together. I love you always.

To my sons, Michael and William, thank you for your patience and tolerance with my absence and obligation that consumed time I could have shared with you in your youth. That time dedicated to scholarship is the foundation this work was built upon. I hope that my example may be of benefit to you in your lives.

To my friends and coworkers who have helped me and from which the inspiration for this work originated. I hope that it may be of use and do some good!

To the broader academic community who may review this work and find both criticism and value, thank you. Both are critical in our development and the ongoing struggle to advance our collective knowledge.

Therefore, let us boldly go...to Live Long and Prosper...Quap'la!

#### Acknowledgments

I would like to start this acknowledgement by thanking my mentor Dr. Mary

Lind. Her dedication, patience, directness, and character have been crucial to the success
of completing this work. Challenging my ideas to make me work through issues
thoroughly and ensure sufficient insight has been acquired before moving forward has
been of immense value along with the support and encouragement to complete this work.
In sincere appreciation: Thank you!

To my committee members, Drs. Marilyn Harris and Geoffrey Laender, I would also like to extend my thanks. Your insight, assistance, time, and care have helped me to improve this work to a presentable state! Thank you so much!

The educators in my life have inspired me to pursue this effort. From a young age, Maisie Egger and Rosemary Adalian showed me I could find success with education that would take me much further in life than I could imagine. In high school, I met a wonderful core of teachers whose lessons produced this life-long passion to pursue knowledge and experience life. Peggy Randall, Math and Science, you showed me intellect and the practical applied value of learning. Mr. Jim Gregory, History, you taught me dedication and passion in learning. Dr. Botso Korishelli, you opened your home to us and my eyes and heart to the joy of learning. The two short courses I had with you changed my life and instilled in me a passion for art, literature, and music that inspires me still today. John Iribarren, your patience with the impetuousness of the young provided the opportunity to learn lessons that could not be learned in a classroom.

Finally, though my collegiate studies I received some excellent experiences from Dr. Orville Menard from the University of Nebraska at Omaha, Dr. Nan Poulios with

Walsh College, and the educators at the University of Maryland, Nova Southeastern and Capella University. Goal: Lifelong Learner: Achieved!

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#### **CHAPTER 1. INTRODUCTION**

#### **Introduction to the Problem**

Computers and their software have widely permeated modern business and professional environments; however, they do not last forever. Newer systems with more capabilities regularly expand the market, while parts and support for aging system become scarce. This presents the manager with the decision of when to replace obsolete systems. Numerous factors influence this replacement decision, many of which have not been examined in this context. Investigation into these factors may help practitioners better understand the decision process and thus improve their decision making and improve the body of knowledge on the subject.

## **Background of the Study**

Many studies have been prepared that address technology acceptance (Davis, 1989; Davis, Bagozzi & Warshaw, 1989; Venkatesh, 2000, Venkatesh, Morris, Davis, & Davis, 2003) and factors of decision making (Ajzen & Fishbien, 1980; Bandura, 1982, 1985; Samuelson & Zeckhauser, 1988; Ajzen, 1991), while others address some of the psychological aspects (Samuelson & Zeckhauser, 1988; Kim & Kankanhalli, 2009), personal impacts (Joshi, 1989, 1991, 2005), and effects of moderators such as voluntariness (Venkatesh, 2000; Wu & Lederer, 2009, Gigerenzer & Gaissmaier, 2011). Likewise, obsolescence itself is a key factor of examination (Marchek, 2012, Weerasuriya & Wijayanayake, 2014). However few studies have investigated these factors in organizational business terms (Clemons, 1986; Marchek, 2011), nor have they addressed the specific challenge of obsolete legacy systems (Swanson & Dans, 2000; Furneaux & Wade, 2010). These factors are summarized into the Technology Obsolescence

Model (TOM); see Figure 1 to understand their perceived relationship and interaction of these multiple effects upon the replacement decision.

Active writing and research (Slade, 2006; Singh & Sandborn, 2006; Sandborn, 2007; Devereaux, 2010; Pijnenburg, 2011; Nguyen, Yeung & Castanier, 2011) demonstrate that obsolescence and technology replacement remain an active issue for many organizations. Approaches such as Diminishing Manufacturing Sources and Material Shortages (DMSMS) (Singh & Sandborn, 2006; Sandborn, Jung, Wong & Becker, 2007; Konoza & Sandborn, 2013) focus on parts and equipment management while software end-of-life lifecycle planning (Jansen, Popp & Buxmann, 2011; Mehra, Seidmann, & Mojumder, 2014) presents a limited approach for similar management, especially in the commercial off the shelf (COTS) domain (Bartels, Ermel, Sandborn & Pecht, 2012). These operationally-oriented efforts focus on management awareness and implemented support systems funded for operational execution to support the technology maintenance or upgrades; however, do not directly address the replacement decision itself, which is the focus of this study.

#### Statement of the Problem

While substantial study has been devoted to acquisition of new systems and organizational and personal decision-making, there is a gap in the literature relating to decision factors influencing the replacement decision for obsolete legacy systems. The convergence of multiple disciplines influences the single replacement decision, which presents a unique problem not currently examined. The lack of understanding which variables exert significant influence reduces the effectiveness of decision makers who must then guess about impacting factors. This may result in overlooked effects, which produce sub-optimal decision making or simply succumb to status quo bias (Samuelson & Zeckhauser, 1988).

## **Purpose of the Study**

The purpose of this internet survey research of salient screened technology decision makers is to investigate the TOM, developed for this study. Specifically, the factors of organizational decision making, obsolescence imperative, cost, benefit, and technical perception variables influence upon the behavioral intent for the decision to replace obsolete systems are examined to determine which are perceived by respondents as most important, which exert significant influence, and which present the greatest influence. Investigation into these factors may help practitioners better understand the decision process and thus improve their decision-making and improve the substantive content of the body of knowledge on the subject.

#### Rationale

In today's competitive business environment, systems acquisition and transitions can make or break an organization. Thus, it should be no surprise that some organizations continue to employ legacy systems long beyond the operational dates supported by hardware and software manufacturers, even into obsolescence. Parts manufacturers typically only support a limited lifecycle (Basahel, 2009) of a few years, which Fieldman and Sandborn (2007) indicate has been on a declining slope from 1969 to 2002, dropping from a 17-year average lifetime to about a 2-year average lifetime. Software manufacturers have followed a similar pattern, supporting a limited lifecycle for their products and pushing ever-newer versions, which incorporate newer, faster, and better features. This can leave organizations that have very long lifecycles with systems that are obsolete and possibly without means for updating them. This can be especially true for DoD weapons systems that can have a lifecycle exceeding a decade in just their development cycle (Fieldman & Sandborn, 2007) as well as for other large institutions (e.g., schools and hospitals) whose budgets may be constricted by very long timelines.

However, making the decision to replace systems is complex with multiple influencing factors. Parts and software obsolescence may cripple an individual system, while technical and functional obsolescence can limit business opportunities. Replacement systems have many costs (e.g., acquisition, transition, switch, lifecycle) for consideration. While a replacement system may present benefits (e.g., improvements in efficiency, interoperability with suppliers and customers, and increases in competitive advantage), it retains many technical and organizational considerations (e.g., impacts upon jobs, budgets, political influence, or personal status) that may influence the replacement decision and form the basis of status quo bias (Samuelson & Zeckhauser, 1988).

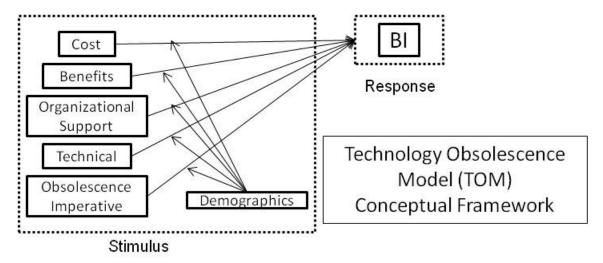


Figure 1. TOM Framework

In seeking to identify factors most influential to the replacement decisions, this work introduces the TOM model (see Figure 1). With this information, business decision makers and IT planners facing a recurrent and ongoing obsolescence issue can ensure that their decision assessments address these key factors adequately in order to improve the quality of their replacement decision making. This is significant to organizations tasked with replacement decisions and management of the systems, people, and processes with which they interoperate.

TOM research seeks to provide IT decision makers with understanding of the factors influencing their decision process. This research highlights factors perceived most important to a replacement decision, such as those exerting the greatest influence upon a decision and the relationships between influencing factors. For the practitioner, this can aid in understanding how to approach a replacement decision and help to identify key concerns that their planning may need to address to increase success likelihood and overcome status quo bias.

For the body of knowledge, the TOM model incorporates elements from several fields based from both seminal works and current research (see Table 1). TOM applies the working theories of technology acceptance and adoption resistance with decision-making and organizational behavior to the issue of systems obsolescence along with active writing and current research to establish a basis for assessment of this subject. Founded in the seminal works of many cross-domain disciplines, the research of this work covers a wide breadth of literature from the last 50 years.

Table 1. Theoretical Models and Research from which TOM is based

Theory/Model	Seminal/Baseline Research used in TOM	Current Studies in these fields
Theory of Reasoned Action (TRA)	Ajzen & Fishbein (1980)	Prayag, Hosany, Nunkoo, & Alders (2012)
Theory of Planned Behavior (TPB)	Ajzen (1991)	Sentosa & Nik Mat (2012)
Technology Acceptance Model (TAM)	Davis (1989); Davis, Bagozzi & Warshaw (1989); Venkatesh (2000); Venkatesh et al. (2003)	Aggorowati, Iriawan, Gautama, & Gautama (2012)
Rational Decision Making	Samuelson & Zeckhauser (1988)	Walter, Kellermans, & Lechner (2012)
Cognitive Misperception	Samuelson & Zeckhauser (1988)	Kim & Gupta (2012)
Psychology: Sunk Cost:	Kim & Kankanhalli (2009)	Macaskilla & Hackenbergb (2012)

Equity Implementation	Joshi (1989, 1991)	Laumer & Eckhardt (2012)
Organizational Decision Making	Katz & Kahn (1966); Clemons (1986); Ward & Peppard (2002); LaPointe & Rivard (2005); Scheepers & Scheepers (2008); Friesner (2011)	Huber (2009); Oral (2012); Spencer, Buhalisa, & Moitala (2012); Sekerka & Stimel (2012)
Self Efficacy (SE)	Bandura (1982)	Schunk & Zimmerman (2012); Nichols (2012); Parschau et al. (2013)
Outcome Expectancy (OE)	Bandura (1985)	Nichols (2012)
Information Economics	Parker, Benson, & Trainor (1988)	Gao, Zhan, Wang, & Ba (2012);
Obsolescence	Swanson & Dans (2000); Slade (2006); Singh & Sandborn (2006); Sandborn (2007); Devereaux (2010); Furneaux & Wade (2010); Pijnenburg (2011); Nguyen, Yeung, & Castanier (2011)	Meng, Thornberg, & Olsson (2012); Zhang, Ryan, Prybutok, & Kappelman (2012); Rojo, Baguley, Shaikh, Roy, & Kelly (2012)

## **Research Questions**

As Table 1 demonstrates, TOM draws from authors across a wide spectrum of disciplines to integrate a robust model that addresses the many factors influencing the decision process.

These are addressed in detail within the literature review. TOM variables are derived from these disciplines with the following key research questions and hypotheses shown in Table 2.

## **Research questions**

Q1 Which factor of the TOM model presents the greatest influence over the replacement intent?

- Sub Q1: Does the Obsolescence Imperative (OI) exert significant influence over replacement intent?
  - Which aspect of OI is evaluated as most important?
  - Which aspect of OI is evaluated as least important?
  - How did respondents explain these values?
- Sub Q2: Does the Cost (C) exert significant influence over replacement intent?
  - Which aspect of C is evaluated as most important?

- Which aspect of C is evaluated as least important?
- o How did respondents explain these values?
- Sub Q3: Does the Benefits (B) exert significant influence over replacement intent?
  - Which aspect of B is evaluated as most important?
  - Which aspect of B is evaluated as least important?
  - o How did respondents explain these values?
- Sub Q4: Does the level of organizational support (OS) exert significant influence over replacement intent?
  - Which aspect of OS is evaluated as most important?
  - Which aspect of OS is evaluated as least important?
  - o How did respondents explain these values?
- Sub Q5: Does the Technical concerns (T) of the replacement system exert significant influence over replacement intent?
  - Which aspect of OS is evaluated as most important?
  - Which aspect of OS is evaluated as least important?
  - o How did respondents explain these values?
- Q2 Does demographic variances exert significant influence over responses?
- Q3 Which factor of the TOM model do respondents identify as most important?
- Sub Q1: Does respondent perception of greatest importance vary from significant influence?

## **Hypotheses**

Table 2. *Dissertation Hypotheses* 

Research	Нур#	Hypotheses Description
Questions		
Q1 and Sub Q1	H01	Obsolescence Imperative (OI) is not the greatest influencing factor over replacement intent
	H1	Obsolescence Imperative (OI) is the greatest influencing factor over replacement intent
	H01a	Obsolescence Imperative(OI) exerts no significant influence over replacement intent
	H1a	Obsolescence Imperative (OI) exerts a significant influence over replacement intent
Q1 and SubQ2	H02	Cost (C) to replace the obsolete system exerts no significant influence over replacement intent
	H2	Cost (C) to replace the obsolete system exerts a significant influence over replacement intent
Q1 and SubQ3	H03	Benefits (B) of replacing the obsolete system exerts no significant influence over replacement intent

 Table 2.
 Dissertation Hypotheses (Continued)

Research	Нур#	Hypotheses Description
Questions		
	Н3	Benefits (B) of replacing the obsolete system exerts a significant influence
		over replacement intent
Q1 and Sub Q4	H04	The level of organizational support exerts no significant influence over replacement intent
	H4	The level of organizational support exerts a significant influence over replacement intent
Q1 and Sub Q5	H05	The Technical (T) concerns of the replacement system exerts no significant influence over replacement intent
	H5	The Technical (T) concerns of the replacement system exerts a significant influence over replacement intent
Q2	H06	Demographic variances exert a significant influence in OI responses
	H6	Demographic variances exert no significant influence over OI responses
Q2	H07	Demographic variances exert a significant influence in (C) responses
	H7	Demographic variances exert no significant influence over (C) responses
Q2	H08	Demographic variances exert a significant influence in (B) responses
	Н8	Demographic variances exert no significant influence over (B) responses
Q2	H09	Demographic variances exert a significant influence in (OS) responses
	H9	Demographic variances exert no significant influence over (OS) responses
Q2	H010	Demographic variances exert a significant influence in (T) responses
	H10	Demographic variances exert no significant influence over (T) responses
Q3	H011	Factor respondents identified as most important varies from the most significant influencing factor
	H11	Factor respondents identified as most important does not vary from the most significant influencing factor

## Significance of the Study

Despite research and active programmatic development in planning and management, organizations continue to employ systems after they become obsolete. TOM focuses upon what is important and significant to the replacement decision. Understanding of the replacement decisions can help managers ensure that decision makers are informed of the specifics relevant to their replacement case. For example, if a manager had not previously addressed Technology Acceptance Model (TAM) or demographic factors within their decision-making, and these are discovered to be significant factors, that manager would be well-advised to examine these before

presenting a replacement decision case. Increased understanding is the first step to a more successful and productive decision-making process.

## **Definition of Terms**

Table 3. *Obsolescence Terms and Definitions* 

Term	Definition	Similar Terms
Planned	When it is planned, a product breaks down or wears out	Quality obsolescence
obsolescence	in a given time, usually not too distant (Packard, 1960)	
	When obsolescence of components is expected and	
	planned as part of a systems lifecycle (Devereaux (2010)	
Psychological	When sound products become "worn out" in the mind of	Desirability,
obsolescence	the owner "because styling or other changes make it	Progressive, Dynamic
	appear less desirable" (Packard, 1960, p. 58-59)	or Style obsolescence
Functional	When competing products or technologies perform the	Technological
obsolescence	function better; where there are significant missed	obsolescence
	opportunities due to systems obsolescence (Pijnenburg, 2011)	
Human	When human workers can be replaced by machines and	
obsolescence	when the skillsets of workers become obsolete (Slade,	
	2006)	
Supply	When there is no need in the current application for a	Manufacturing and
obsolescence	product with increased function; however, the market	Maintenance
	demands do not support a supplier's continued	Obsolescence
	production or support of the legacy component	
	(Devereaux, 2010)	
Technical	Where the system is no longer capable of meeting	
obsolescence	production needs of the market demand (Pijnenburg, 2011)	
Factor	Employed in this work as a reference to one of the	
	primary 5 constructs of the TOM model or similar	
	demographic influencing variable. Factors are comprised	
	of multiple elements	
Elements	Employed in this work, elements are the subset	
	components of the collective factors of the TOM model	
	for which questions on the survey are comprised to	
	assess.	

# **Assumptions and Limitations**

# Assumptions

The following are methodological assumptions employed in this study.

- This dissertation assumes that questionnaire respondents meet the screening criteria, having been pre-selected by the sampling organization's functional managers for personnel meeting the specified criteria.
- A standard assumption for surveys is that respondents are honest in response to the survey questions, having no reason for deception.
- The use of the Survey Monkey automated collection tool and its blind data pass through, having been approved by the Institutional Review Board (IRB), is assumed to meet privacy and confidentiality requirements, as are the author's efforts presented in the methodology section.
- After pretesting, screening, and the use of clarification solicitation questions, the questions, terms, and definitions are assumed to be clearly understood and unambiguous.
- The employment of survey data collection is well established in the literature, and it is assumed that detailed oversight by the IRB and committee throughout the process ensures adherence to accepted performance standards.
- Sampling method is deemed acceptable due to their extended use throughout the body of literature.
- Theoretically, the stimulus/response mechanism people exhibit, exemplified in the relationship between the independent variables of the TOM model to Behavioral Intent (BI), is sufficiently well researched and assumed to be a legitimate framework.
- Topically, the subject areas identified by the literature review are assumed accurate for investigation of the TOM model.

#### Limitations

Theoretical limitations are expected in that not all potential sources of impact can be studied, and some known early theoretical work (e.g., Equity Implementation (Joshi, 1989, 1991), Self Efficacy (Bandura, 1982), and Outcome Expectancy (Bandura, 1985)) are not included within the survey vehicle for this study.

A few methodological limitations present themselves in the research. First, the breadth of generalization of the study's findings is limited, due to its sampling method. With the sample being drawn from a very large conglomerate corporation, its results may degrade in generalizability between industries or size of organizations, with smaller organizations presenting different priorities or interactions. Second, the sample size of 50 is sufficient for an exploratory study but not for establishing full formal scientific significance. While it is possible the study could suffer from the satisficing effect observed by Barge and Gehlbach (2012), this is not expected to be realized due to the lack of any compensation effect from this survey method.

The analytic techniques specified in the methodology (e.g., Means, ANOVA, Correlation Matrices, and Multiple Linear Regression) are investigated, but it is possible that these are inadequate to fully identify all potential interpretation of the gathered data and that additional analysis could reveal different interpretation of the investigation. The survey instrument is drawn as much as possible from existing question forms and is pretested, reviewed by Subject Matter Experts (SMEs), reviewed by the IRB, and assessed and evaluated by the researcher and the dissertation committee before public administration. However, it is acknowledged that the construct of the instrument may lack sufficient precision for evaluation of all sub variables.

#### Theoretical/Conceptual Framework

This study employs the theoretical form established by the seminal works of a) Ajzen and Fishbien (1980) Theory of Reasoned Action, b) Bandura's theories of Self-Efficacy (1982) and Outcome Expectancy (1985), and c) Samuelson and Zeckhauser's (1988) Rational Decision Making and Conceptual Misconception. This form was codified via the TAM by Davis (1989) and Davis, Bagozzi and Warshaw (1989) with modifications as demonstrated by Venkatesh (2000) in TAM 2 and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis & Davis, 2003). This form posits that independent variables and modifying variables influence behavioral intent for an action (or inaction). As applied to the TOM model, factors of Cost, Benefits, Organizational Support, Obsolescence Imperative, and Technical factors, which may be modified by demographic factors, influence the Behavioral Intent to replace an obsolete system, as demonstrated by Figure 1. TOM is a convergence model, which incorporates theory from multiple disciplines through its model form to gain understanding for the factors influencing the replacement decision, focused upon what is most important and significant to the replacement decision.

## Organization of the Remainder of the Study

Chapter 2 of this study presents the findings from a detailed literature review of theories employed in the TOM model and the factors that form the variable structures from which the questions on the survey are drawn.

Chapter 3 of this study presents the methodology that was employed in investigating this gap in the literature. It describes the population to be examined, the survey to be employed, and the statistical tools used to analyze the information acquired.

Chapter 4 presents the findings of the study. This focuses upon the direct results of the survey instrument with analysis of the results and their implications reserved for chapter 5.

Chapter 5 presents analysis of the findings of the study by drawing conclusions from the findings, discusses how the research questions and hypotheses were satisfied or failed, and presents recommendations for modification of the research instrument and use of TOM by practitioners as well as ideas for further research.

#### CHAPTER 2. LITERATURE REVIEW

To ensure adequate address of the many disciplines integrated in the TOM model, the literature review uses the framework model as the structure guide for the review. Founded in the seminal works of many cross-domain disciplines, this research work covers a wide breadth of literature from the last 50 years. Initial discussion addresses the TAM form structure and the TAM variables due to collocation convenience. Then a systematic walk through of individual elements is provided, ordered by their presentation in the model. The approach facilitates adequate address of salient components and the theory and ideology of each in the literature. Finally a short examination of the decision making process as it relates to the TOM model is reviewed.

## **Technology Acceptance Model (TAM)**

TAM provides the theoretical structure base the TOM framework builds upon. Introduced by Fred Davis in 1989, TAM observes a correlation between the impacts of two key variables upon the behavioral intention of users to use a new system: perceived usefulness (PU) and perceived ease of use (PEOU) in their impact upon their attitude toward using the technology and thus their behavioral intent. Davis identified input inspiration from the following: Vroom's (1964) alternate expectance theory model, Bandura's (1982) self-efficacy theory, the cost benefit paradigm of behavioral decision theory as presented by Beach and Mitchell (1978), Johnson and Payne (1985) and Payne (1982) as well as Tomatzky and Klein's (1982) adoption of innovations work, Swanson's (1982, 1987) channel disposition model, and Hauser and Simmie's (1981) marketing survey amongst others.

Davis, Bagozzi, and Warshaw (1989) demonstrate how TAM is derived from the Theory of Reasoned Action (TRA) as presented by Ajzen and Fishbein (Fishbein & Ajzen, 1975; Ajzen

& Fishbein, 1980). From TRA Davis, Bagozzi and Warshaw (1989) observed, "a person's performance of a specified behavior is determined by his or her BI to perform the behavior, and BI is jointly determined by the person's attitude (A) and subjective norm concerning the behavior in question" (p. 983). This provides the equation: BI = A+SN.

TAM, however, forwards the idea that acceptance is determined by BI, but "differs in that BI is viewed as being jointly determined by the person's attitude towards the system (A) and perceived usefulness (U) with relative weights determined by regression" (p. 985). This forms the equations BI = A + U, which supports the model at Figure 2.

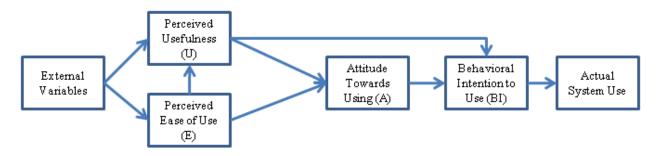


Figure 2. Technology Acceptance Model (TAM). Adapted from "User acceptance of computer technology: a comparison of two theoretical models," by F. Davis, R. Bagozzi and P. Warshaw, 1989, *Management Science*, 35(8), p. 985. Copyright 1989 by The Institute of Management Sciences. Reprinted with permission.

TAM is supported by empirical study to differentiate it from TRA and to demonstrate the functionality of the impact of the two variables, PU & PEOU (variables U and E in the model at figure 2). Primary conclusions were that actual usage can be predicted reasonably well from intentions, PU is a major determinant of BI, and PEOU is a significant secondary determinant of

BI. While ease of use may be an influencing factor, the actual usefulness of the product is shown to be the primary driver influencing attitudes that shape BI.

Davis (1989) cited extensive methodology reviews to ensure validity and reliability, using proven clustering techniques, regression analysis, and examination of covariance and then demonstrating the application of TAM through two independent empirical studies. These studies showed primary, significant influence of PU (.85 and .69) as an indicator with PEOU as a substantial influencing factor with PU, but independently PEOU was not significant (.32 & .25).

Mathieson (1991) compares TAM performance against the Theory of Planned Behavior (TPB). TAM results returned a much higher reliability score (Cronbach's alpha of .932 vs .848) and .73 accountability for predictive variability in attitude compared with .39 for TPB. A study by Taylor and Todd (1995) produced similar results of .73 for accountability TAM and .58 for TPB, demonstrating a good predictability and accountability for variances.

TAM has been widely studied and evaluated. As Chuttur (2009) observed, there have been over 700 citations of Davis original 1989 work. Chau (1996) evaluates TAM for both short term and long-term usefulness of its predictive functions. Straub, Keil, and Brenner (1997) studied TAM's effectiveness across different cultures (Japan, Switzerland, and USA). Dishaw and Strong (1999) study the integration of TAM with the task-technology fit model. Davis and Weidenbeck (2001) provide a software adoption study in which PEOU modified by exposure and directness provides indications related to adoption of the software. Chau and Hu (2002) provide a study that evaluates the performance of TAM against the TPB as relates to the technology acceptance decisions of physicians, in which TAM provided better overall performance. Chan and Teo (2007) "examine the values of BI over the two-dimensional boundary space formed by PU and PEOU" (p. 297) and find substantive variance in their study.

Park, Nam and Cha (2012) provide a TAM study of how student adapt to using mobile learning. Table 4 identifies some of the wide variety of means by which TAM has been applied.

Table 4 Application, Participants, Country and Settings for Applying TAM (Chuttur, 2009).

Variations in TAM Application	Examples
Applications	Email, voicemail, fax, dial-up system, e-commerce application, groupware, word processor, spreadsheet, presentation software,
	database program, case tools, hospital information systems, Decision support system, Expert support system, and telemedicine technology
Country	USA, UK, Taiwan, Hong Kong, Switzerland, Japan, Australia, Turkey,
	Canada, Kuwait, Nigeria, France Singapore, China, and Finland
Type of Study	Lab study, field study, and web survey
Participants	Students (graduate & undergraduate), knowledge workers, physicians,
•	bank managers, programmer analysts, IT vendor specialists, computer
	programmers, internet users, brokers, and sales assistants

Venkatesh, another leading TAM theorist, continued to develop and refine TAM. In 2000, he published a study expanding TAM to what he called TAM2, which introduces the impacts of seven additional extant variables, including voluntariness of participation, from both social influence processes and cognitive instrumental processes as they impact upon PU and BI, which he tested over several longitudinal studies. Venkatesh later (2003) led a study with several others, including TAM's originator Fred Davis, to produce a more complex predictive model in 2003 called Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). Here the authors compared eight contemporary IT acceptance models (TRA, TAM, TAM 2, Motivational Model, TPB, TPB+TAM [C-TPB], Model of PC Utilization [MPCU], Innovation Diffusion Theory [IDT], and Social Cognitive Theory [SCT]), evaluating the strengths and weaknesses of each and conducting a study to demonstrate the performance of each. The study provided statistical performance evaluation of

each model for the same data sets, using longitudinal and cross industry methods similar to those used in the TAM 2 study, along with regression and beta differences for each model and its variable interactions. From these results, the more detailed UTAUT model was developed. This more complex model demonstrated evolution of inclusion of additional variables within the assessment/measurement structure but did not catch on widely in driving more derivatives from this form of assessment, with researchers preferring the previous base structure. Additionally, the UTAUT model removed attitude as an intermediary between the independent variables and behavioral intent. This modification was adopted into the TOM model.

Examination of the components that make up the TAM model is in order. Starting left to right on the Davis, Bagozzi, and Warshaw (1989) model at Figure 2, are the external variables. While these are not the central focus of the TAM model, they are acknowledged from the beginning to exist in recognition that there may be factors that influence PU and PEOU. This is also the source of the modifications most commonly seen in derivative works, such as TOM. While the original TAM model routes the impact of any external variables such as additional features, training, and experience through PU and PEOU exclusively, the expansions provided by TAM 2 and UTAUT demonstrate direct influence, paralleled in TOM.

PEOU in TAM is seen to have influence over PU and A, but not directly over BI. Davis, Bagozzi, and Warshaw (1989) indicate PEOU incorporates two primary mechanisms of influence: Self-efficacy and Instrumentality. They cite Bandura (1982) and Lepper (1985) observations that efficacy "is one of the major factors theorized to underlay intrinsic motivation" (p. 987), which is confirmed by Margolis and McCabe (2004), Parajes (2005), Schunk and Meese (2005), and Schunk and Zimmerman (2012). Likewise, PEOU is observed to save effort that can then be redeployed, thus its influence over PU. However, studies such as Chau (1996)

and Straub, Keil, and Brenner (1997) did not find the corresponding relationship between PEOU and A, likely given the extensive variations and altered focus of study. Dishaw and Strong (1999) found it to be weaker than other factors being studied, and Chan and Teo (2007) found that relationships vary based on the intersection point of the two variables. Within TOM, the ease of using the proposed replacement system is perceived as a subcomponent of organizational support.

PU is really the central variable to the original TAM equation, in which the "prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context" (Davis, Bagozzi, & Warshaw, 1989, p. 985).

PU's relationship with BI is placed in TAM because it is perceived that "people form intentions towards behaviors they believe will increase their job performance, over and above whatever positive or negative feelings may be evoked towards the behavior per say" (Davis, Bagozzi, & Warshaw, 1989, p. 986). There are intrinsic rewards for enhanced performance, which do not need to be activated with each usage; therefore, it is a relationship of the intention based upon the cognitive appraisal of how it will improve performance.

Attitude (A) is affected by PU and PEOU, and its relationship with BI is derived from Triandis (1977) and Bagozzi (1981) studies of TRA that indicate, "all else being equal, people form intentions to perform behaviors towards which they have positive affect" (Davis, Bagozzi, & Warshaw, 1989, p. 986), thus this is an inherited factor of origin. For TOM, however, attitude is removed from the equation. As with the UTAUT model (Venkatesh et al., 2003) it was shown not to have a significant effect on BI.

BI is another inheritance from TRA and is used as an indicator for actual systems use.

"BI is a measure of the strength of one's intention to perform a specified behavior (e.g., Fishbien

and Ajzen, 1975, p. 288)" (Davis, Bagozzi, & Warshaw, 1989, p. 984). BI is expected to account for the variance in findings. In TOM, the Replacement Intention is the primary indicator of the decision prediction.

### **Obsolescence Imperative**

The focus of the TOM model is the application of the presented theories and influencing elements to the decision to replace obsolete systems. TOM focuses upon what is important and significant to the replacement decision. Obsolescence can affect several aspects of operation. These elements are collected as the *Obsolescence Imperative*.

The Defense Acquisition University (DAU, 2012) observes that obsolescence addresses the "process or condition by which a piece of equipment becomes no longer useful, or a form and function no longer current, or available for production or repair" (para 1). Likewise continued development of new products and technology reduces the supportability lifecycle of software and component parts due to diminished availability from suppliers. For example, Cox and Blackstone (1998) define obsolescence as (a) the condition of being out of date: a loss of value occasioned by new developments that place the older property at a competitive disadvantage (a factor in depreciation); (b) a decrease in the value of an asset brought about by the development of new and more economical methods, processes, and machinery; or (c) the loss of usefulness or worth of a product or facility as a result of the appearance of a better or more economical product, methods or facilities.

Pijnenburg (2011) highlights conditions of the obsolete states where the system no longer optimally performs its established function via (a) Capacity, where it is no longer expandable to support additional production; (b) Performance, where its response time is inadequate for the users' needs; (c) Availability, where failure rates increase for parts, software, and production; or

(d) Support, where spare parts availability becomes sparse and the knowledge required to the operate the system starts to become very expensive to acquire. Pijnenburg (2011) indicates that this obsolescent state causes opportunities to be missed due to (a) Limited adaptability, because of the inability to modify system performance for changing market needs; (b) New functionality, because the systems can simply not provides new performance requirements demanded from a changing environment; or (c) Efficiency, because the system cannot provides sufficient efficiency to compete in demanding markets.

Pijnenburg (2011) presents at least three potential obsolescent states: (a) *Technical Obsolescence* where the system is no longer capable of meeting production needs of the market demand, (b) *Functional Obsolescence* where there are significant missed opportunities due to systems obsolescence, and (c) *Supply Obsolescence* where limits to parts or components present risk to system operation. Of these, supply obsolescence is typically the primary (and many times, only) form of obsolescence observed by formal systems. The best example of this is diminishing manufacturing sources and material shortages (DMSMS), which is employed widely in manufacturing and federal procurement processes (Sandborn, Prabhakar & Ahmad, 2011), due to its immediacy of production impact. Devereaux (2010) and Slade (2006) identify additional terms and perceptions, highlighted in the definitions section in Chapter 1.

With obsolescence as the driving factor behind the change decision of the TOM model, these obsolescence elements become an obvious impacting variable. However, as has been demonstrated, obsolescence may take more than one aspect based upon the state of technology, exposure to environment, position of the system within the organizations structure, and its contribution to exploiting opportunities. Therefore, obsolescence is presented within TOM as

the *Obsolescence Imperative (OI)*, a compound variable, similar to cost and organizational support.

# **Supply Obsolescence**

Supply obsolescence is one of the most widely examined forms of systems obsolescence. Broken into two major components of systems, hardware and software, these tangible assets can be directly measured and addressed by an obsolescence planning and decision making process. Other supply issues such as processes and personnel training aspects can be addressed through training and quality management functions.

Sandborn (2007) observes that:

A part becomes obsolete when it is no longer manufactured, either because demand has dropped to low enough levels that manufacturers choose not to continue to make it, or because the materials or technologies necessary to produce it are no longer available (p. 886).

The literature refers to this as DMSMS. This is of particular impact to industries such as the military, industrial manufacturing, and the aircraft industry for example, which employ very long lead times and lifecycles (Singh & Sandborn, 2006). The DMSMS field is widely studied with many methodologies, databases, and tools that address status, forecasting, risk, mitigation, and management of parts obsolescence (Sandborn, Jung, Wong & Becker, 2007; Sandborn, Prabhakar, & Ahmad, 2011).

In general practice, manufacturers will follow a fairly standard availability path giving End of Life (EOL) notice first, which will define the timing of the following steps (FMA, 2010):

- 0. Availability (during the planned manufacturer's production lifecycle)
- 1. Ceasing component manufacture (spares stock only)
- 2. Component Service Exchange (refurbished stock, faulty hardware returned)

## 3. Component Repair only (return of hardware required)

Once a component has been included in EOL literature, the process of planning replacement should begin. This allows time for technical and budgetary planning. The longer this planning is delayed the higher the risk to production as illustrated in Figure 3. Systems whose management engages an active obsolescence planning policy can minimize this risk by planning for replacements and/or risk mitigation within the systems lifecycle. This planning can also address design elements such as mean time between failures (MTBF) and mean time to failure (MTTF) (Puvanasvaran, Teoh, & Tay, 2012). Organizations that lack awareness may find themselves in a high-risk state where components may no longer be available and interruptions of critical functions may occur.

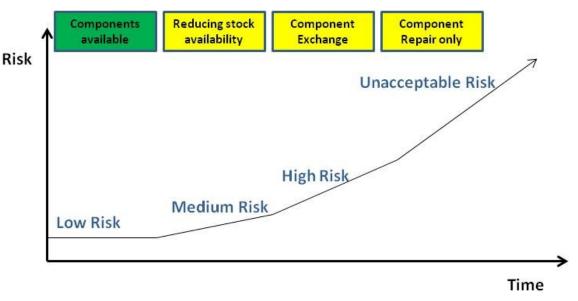


Figure 3. DMSMS Parts Obsolescence Risk. Adapted from "Obsolete Control System...? PLC Obsolescence – What should you consider?" FMA. Copyright 2010 by FMA. Reprinted with permission.

In a similar manner, as new versions of software are released, they move through the vendor manufacturing period, into support, and finally into end-of-life (Microsoft, 2012). The

manufacturing and sales period will typically overlap the vendor support period significantly (see Table 5). Availability of open consumer support and end-of-life to available patching will typically be the leading public end-of-life (Microsoft, 2012; Jansen, Popp & Buxmann, 2011), with true final end of life for extended service contracts being the minimal residual functions of the vendor (Jansen, Popp & Buxmann, 2011) as the product is "retired" by the manufacturer.

Table 5. Microsoft Operating System Software Support Lifecycle (Microsoft, 2012)

Desktop Operating System	Latest Service Pack	Date of general availability	Retail Software end of Sales	End of Sales for PCs with Windows Preinstalled	End of Mainstream Support	End of extended support
Windows XP	SP 3	31-Dec-01	30-Jun-08	22-Oct-10	14-Apr-09	8-Apr-14
Windows Vista	SP 2	30-Jan-07	22 Oct-10	22-Oct-11	10-Apr-09	11-Apr-17
Windows 7	SP 1	22-Oct-09	TBD	TBD	12-Jan-15	14-Jan-20

Different from Parts obsolescence, lack of vendor support does not typically immediately invalidate the software. The organization may use software for an indefinite period, typically until other obsolescence and risk factors overtake its perceived usefulness. Sandborn (2007) observes that all of these may impact software obsolescence: lack of expandability or support, inability to expand or renew licensing agreements, and discontinuance of support from the manufacturer. Likewise, Sandborn (2007) also observes that media obsolescence, formatting, and degradation can terminate access to software; for example, few systems retain 5 ½" floppy drives. However, use of COTS software beyond its EOL introduces an increasing curve of security risk due to patches and repairs no longer being available (Bartels, Ermel, Sandborn, &

Pecht, 2012). This risk may not be acceptable in some regulatory environments (e.g., FAA control systems) or market sectors (e.g., financial systems).

#### **Functional Obsolescence**

The nature of evolving technology and free market enterprise spurs innovation of new capabilities and functions that may obviate the need for or performance of an existing system. The technological aspect of this occurs regularly, as new capabilities are added to subsequent versions of software (e.g., the capability to handle IPv6 addressing) or the advance in throughput speeds and ranges of wireless routers (e.g., 802.11 2 MB/s, 802.11b 11 MB/s, 802.11g 54 MB/s and 802.11n over 100 MB/s; Hiertz et al., 2010). Technologies with greater functionality, scalability, speed, and access replace their predecessor technologies by this natural evolutionary process. For example, the technologically obsolete system may no longer be able to compete with its advance brethren (e.g., IPv4 only switches vs. those enables with IPv6 capability), or it may eventually no longer be able to perform its function at all. For example, all of the original DARPA internet accesses have been upgraded to protocol compliant products, as their legacy systems could no longer properly interface with an advancing internet.

This evolution crosses over in a parallel manner to the business functions of the system, where obsolete systems inhibit the organizations opportunity to pursue new business, expand into different markets, or create or adjust products to changing markets. Competition very typically drives the business aspects of functional obsolescence where improved efficiency, lower price, increased functionality, and/or greater capacity of new systems or technologies overshadow the legacy system (Barreca, 1999; Lobontiu, 2013). The inability of the system to adapt or to accommodate new feature sets, such as adaptability of a plant to switch from internal combustion only to hybrid engine designs, may limit the systems contribution to the

organizations value stream until it becomes unprofitable (Nguyen, Yeung, & Castanier, 2011). This would likewise affect those systems unable to support new software or perform new functions, such as real-time data integration against scheduled reconciliation.

#### **Technical Obsolescence**

The environments in which systems, their input suppliers and output markets exist are constantly changing. These changes may obsolesce a system very quickly. Smith Corona made great typewriters but saw their environment radically change in just a few years with the introduction of the PC (Erwin, 2011). Twinkies were once a kids' lunch main stay; however, changing markets contributed to Hostess going out of business in 2012 (Foodbeast, 2012). Some supply chains were wiped out by the Tohoku earthquake and tsunami that hit Japan in 2011 (Norio, Ye, Kajitani, Shi, & Tatano, 2011). The availability of online streaming movies destroyed the Blockbuster video rental business model (Almeda, 2011) completely. An information systems lack of ability to adapt to new regulations such as HIPAA (Brown & Brown, 2010) may force an obsolescence issue. Systems that lack adaptability to environmental changes may become quickly obsolete in favor of those that can.

Additionally, market changes affect systems in a similar manner. If the system cannot scale up to increase production to meet higher market demand, a competitor can be expected to step in to the market space. Likewise, if capacity cannot adjust, overall market share may be lost to competitors that can vary rates more easily. If the system is not adaptable to add additional features (such as different colors, different materials, or ability to adapt to multiple communication protocols), the system may find itself disadvantaged against a replacement system or technology. These market factors interact with business factors to drive many economic based organizational decisions.

#### OI Summation

Thus, a primary impacting variable to the TOM model is the imperative risk state of the system. Systems early in their lifecycle with continued available support would not expect to have a high likelihood of overcoming the switching costs and acquiring organizational support for a change. Whereas systems with high availability risk and/or systems whose support costs have crossed the profitability threshold to the point that they cost more than they are worth would be expected to be good candidates for replacement success. Any system may be at different risk levels for the subordinate variables of OI; however, the accumulated risk perception is the effect impacting the replacement decision. Figures 1 and 2 demonstrate the TOM theoretical and conceptual frameworks that incorporate these variable effects.

#### **Total Cost**

In addition to TAM and OI factors, an accumulation of elements to form a cost perspective is likewise presented within TOM. This incorporates elements from the financial/business aspect of a replacement decision as well as Information Economics (Parker, Benson, & Trainor, 1988), psychology (Kim & Kankanhalli, 2009), Rational Decision Making (Samuelson & Zeckhauser, 1988), and Organizational Decision Making (Clemons, 1986; Scheepers & Scheepers, 2008). These elements commonly include components of cost both tangible and intangible.

### **Tangible Financial Elements**

As Nasher et al. (2011) observes, there are techniques that assess tangible assets and those that assess intangible assets for financial/business decision-making. For IT systems, Information Economics (Parker, Benson, & Trainor, 1988) is an ideology that provides tighter coupling between IT and business value, whereby value is defined as the true economic impact

of IT. The following paragraphs examine several financial decision techniques commonly employed within the financial/business sector. One or more of these is expected to be employed by the decision maker within the replacement decision activity. Each generates a perspective of tangible cost for the replacement activity, which in turn influences the replacement attitude and intent.

**Net present value (NPV).** Net present value is a relatively simple calculation to determine, comparing the perceived future value of money against the investment to support Cost/Benefit analysis (Palmer, 2000). As Thamhain (2015) demonstrates: Future Value = Present Value X (1+discount rate) is raised to a power of the number of years, while Present Value = Future Value/ (1+discount rate) is raised to a power of the number of years. This becomes a major comparison component to other financial comparison tools.

**Discounted cash flow (DCF).** Palmer (2000) provides a simple example of DCF through which NPV is determined, and then the rate of return is discounted for current value, whereby short term versus long term payback rates and net profitability can be compared. This technique may be of use to a decision maker considering replacement decisions regarding payback period and lifecycle net results.

Payback period. Simply put, the payback period represents the length of time between when an information system (IS) investment is undertaken and the point at which the investment is recouped as a result of incoming cash flows (Campos, Manrique, Kobiski, Casagrande Jr., & Urbanetz Jr., 2014). This calculation is frequently projected to support decision-making based upon estimated cash flows to derive the acceptability of the payback period to the investor. To achieve better accuracy, it must incorporate perceived elements of risk and the discount for the value of money over time.

Return on investment (ROI). Bacon (1992) cites ROI as one of the evaluation elements considered when using criteria to determine IT selection, similar to the TOM replacement decision, as does Somers and Nelson (2001) in their discussion of successful Enterprise Resource Planning Implementation. Thamhain (2015) indicates that there is not a universally accepted definition of ROI as to inclusion of both non-discounted and discounted financial analysis methods or ratio calculations, the simplest of which are based on the following formula:

ROI = (Gross Benefit – Investment Cost) / Investment Cost

**Cost benefit analysis (CBA).** Thamhain (2015) cites King and Schrems's (1978) process of conducting a CBA via five steps:

- 1. Selecting an analyst
- 2. Identifying and selecting the alternatives
- 3. Identifying and measuring the associated costs and benefits
- 4. Comparing the alternatives
- 5. Performing the analysis itself

Thamhain (2015) observes that CBA may use a variety of techniques to identify and measure (*ex post*) or estimate (*ex ante*) the costs and benefits associated with a given project.

CBA uses DCF to place all factors into equal terms, although they can be difficult with intangible benefits. In general terms, most decision makers comparing risks and benefits engage in some element of logical CBA, which lines up with the structure form of the TOM model.

**Others.** Other elements and methods commonly employed were reviewed for their usefulness to TOM, but not selected for inclusion, such as Multi Objective Multi Criteria (Kabir, Sadiq, & Tesfamariam, 2014) and Critical Success factors (Ram & Corkindale, 2014) and Kaplan

and Norton's Balanced Scorecard (1992, 1996). These were found to have different objectives and purposes than TOM and thus were not included within the cost structure.

# **Business Intangibles**

IntangAbility (2013) notes that much of what is valuable or important to organizational success incorporates the intangible elements of operation, which is also what helps to differentiate one organization from another. Tuten (2009) reinforces this message in his overview of the implementation of a Manufacturing Resource Planning (MRPII) system within a small-medium enterprise case study presented by Irani (2002), where "the anticipated benefits of the MRPII system appeared to management as 'important for the growth and survival of the firm' yet were largely intangible or non-financial" (p. 206). The International Accounting Standards Board standard 38 (IASB, 2009) defines an intangible asset as "an identifiable non-monetary asset without physical substance" (para 5).

IntangAbility (2013) and Business Intangibles (n.d.) provide some extensive lists of potential business intangibles, which vary by industry and application:

- Business Relationships
- Business Culture and Values
- Skills and Competencies
- Processes and Systems
- Innovation
- Power and Influence
- Options and Flexibility
- Intellectual Property
- Brand Recognition & Loyalty

As Arkes and Bloomer (1985) observe, "The sunk cost effect is manifested in a greater tendency to continue an endeavor once an investment in money, effort, or time has been made" (p. 124). The Kahneman and Tversky (1979) prospect theory explanation reinforces the basic sunk cost finding that people will throw good money after. Sunk costs have been shown to be irrelevant to rational decision making, but continue to be engaged in (Jaramillo & Spector, 2015) This is one of the elements of the Kim and Kankanhalli (2009) perspective of Status Quo Bias, which replacement decisions must overcome. Existing investment in time, money, and the systems integration into the business process present forms of sunk cost that bias decisions. Interestingly though, in the Furneaux and Wade (2011) study, while perceived usefulness was observed as significant, the level of investment in existing systems (sunk cost) did not appear to significantly undermine the replacement intentions. The survey instrument of this study evaluates sunk cost to see if investigation results corroborate the Furneaux and Wade (2011) findings or are consistent with previous observations in the field.

# **Rational Decision Making (RD)**

In their often-cited paper on status quo bias, Samuelson and Zeckhauser (1988) provide observations regarding the rational approach to making the same decision in identical circumstances. They observe that influences such as transition costs and uncertainty costs of changes from the status quo influence decision-making, presenting a status quo bias. They provided additional observations related to the impacts of personal biases such as a preference for loss avoidance resulting in cognitive misperception, presenting a bias towards the status quo. They also observe the effect sunk cost can have in creating psychological commitments to the status quo that can influence decisions and is reiterated by Kim and Kankanhalli (2009). RD posits that perceived net benefits must overcome these status quo elements.

**Transition Costs.** Transition costs are the costs incurred in adapting to the new situation (Kim & Kankanhalli, 2009). These may be comprised of transient costs that occur during the change and permanent costs that are results of the change (Samuelson & Zeckhauser, 1988). An example, of a transient transition cost is the learning cost for adapting to the new system, while a permanent transition cost may be the loss of work in converting to the new system.

Uncertainty Costs. Uncertainty costs represent the effort necessary to overcome the status quo bias incurred by the psychological uncertainty or perception of risk associated with the decision to replace the obsolete system (Kim & Kankanhalli, 2009). Uncertainty costs tie in with loss aversion bias observed by Samuelson and Zeckhauser (1988). Whitten, Chakrabarty, and Wakefield (2010) likewise observe uncertainty costs in their IT system/service replacement costs study, perceiving that uncertainty is the result of doubt that may come from lack of experience with the potential replacement system and skepticism regarding its ability to provide service at the same or superior level to its predecessor.

## **Equity Implementation (EI)**

Joshi's (1989, 1991) EI model provides focus upon individual concerns when interpreting IT changes in the organization.

Users employ three levels of analysis in evaluating the change introduced by an implementation. At the first level of analysis, a user is viewed as assessing a change in terms of the gain or loss in his or her equity status. At the second level of analysis, the user is viewed as comparing his or her relative outcomes with that of the organization. Finally, at the third level of analysis, the user is viewed as comparing his or her relative outcomes with that of other users in the reference group. Users who evaluate the change

to be unfavorable in terms of inequity or loss of equity are likely to be distressed by the change and resist it. (Joshi, 1991, p. 229)

The findings identified are easily interpreted as an effect upon attitude, which parallels the variables employed by the TRA, TPB and TAM models, and is transferred as an effect on BI in TOM. The EI model is an individually-focused measure compared with other measurement tools.

# **Organizational Decision-Making**

However, beyond all of the personally impacting effects, the organization exerts its own influence based upon its own set of needs. Costs elements such as acquisition costs (Lu & Ye, 2013), switching costs (Blut, Frennea, Mittal & Mothersbaugh, 2015), lifecycle costs (Woodward, 1997; Berghout, Nijland & Powell, 2011), and departmental costs (Pardo del Val & Fuentes, 2003) influence the decision making attitude. The variance between total cost and the departmental budget supporting the cost may also be a significant variable of resistance (Kipp, 1978).

**Acquisition cost.** In the financial world, this is the direct financial cost to acquire the new system after discounts, incentives, and expenditures (Lu & Ye, 2013). However, the cost study of IS management, acquisition is rarely limited to only the direct financial activity (Lu & Ye, 2013). Total cost of ownership (David & Schuff, 2002) approach is advocated, which is included within the TOM cost variable.

**Switching cost.** Switching costs are different than transition costs. The investment in the legacy system created a level of competitive advantage. In the instance of TOM, when the system under replacement consideration is deemed obsolete, the switching costs are generally perceived relatively low as compared to switching from a mainstay system. This set of ideas was put

forward by Clemons (1986) as a means of using IT-based customer switching costs as a source of sustained competitive advantage for firms selling IT applications (Mata, Fuerst, & Barney, 1995) and has come to be known as the "create-capture-keep" paradigm (Clemons & Kimbrough, 1986; Clemons & Row, 1987, 1991; Feeny & Ives, 1990). Switching and changing the level of competitive advantage acquired from the systems is the net of the loss of the old and perceived gain of the new system. In the case of the obsolete system, this may in fact be a benefit rather than a cost.

Lifecycle cost. Lifecycle Cost (LCC) as put forward by Woodward (1997) is a measurement process for Total Cost of Ownership. LCC grew from a new theory form in the 1970's (Anderson, 1978; Rich, 1978; Fullman, 1979) to a widely adopted practice employed by many organizations, including the Department of Defense (DAU, 2012). Originally drafted for use in construction and capital equipment acquisition, LCC quickly found a home in application to many large acquisition projects. Observant that there are costs throughout the entire lifecycle of operation, a project has multiple stages as shown by White and Ostwald (1976) in Figure 4. Executing an extensive view of ownership, as identified by Kaufman (1970) in Figure 5, LCC provides the decision maker with a much broader strategic view of the acquisition decision. This affects attitude differently for different decision makers whose values in long-term versus short-term return perspectives vary.

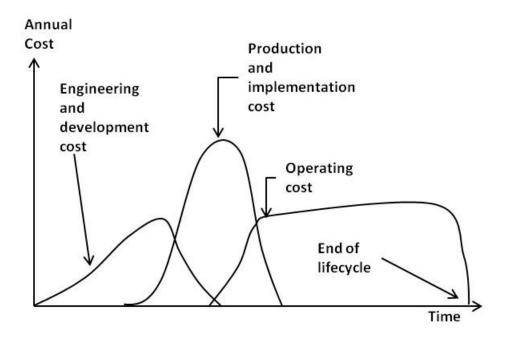


Figure 4. Three stage example of LCC. Adapted from "Life cycle costing—Theory, information acquisition and application," by D. Woodward, 1997, *International Journal of Project Management*, 15(6), p.336. Copyright 1997 Elsevier Science Ltd and IPMA. Reprinted with permission.

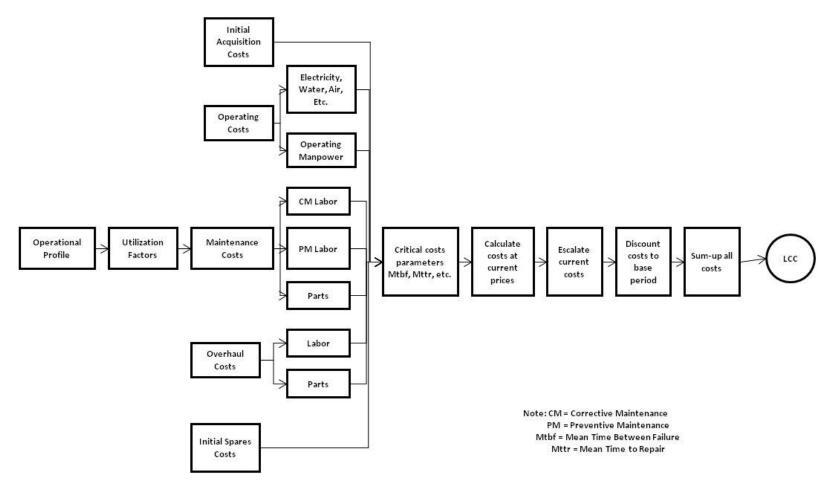


Figure 5. Kaufman's Lifecycle Costing Formulation. Adapted from "Life cycle costing—Theory, information acquisition and application," by D. Woodward, 1997, *International Journal of Project Management*, 15(6), p.337. Copyright 1997 Elsevier Science Ltd and IPMA. Reprinted with permission.

**Departmental cost.** While it may appear obvious, in most cases, acquisition of a replacement system is going to come predominately out of one department's budget. This department and IT managers will exhibit higher change resistance than other departments (Beer, Eisenstat & Spector, 1990; Rumelt, 1995; Beer & Eisenstat, 1996; Pardo del Val & Fuentes, 2003). While this may appear a limited view point amongst the decision makers, it was amongst the top 3 (of 19) sources of change resistance in the Pardo del Val and Fuentes study (2003); therefore, this influence and variance thereof must be acknowledged.

## **Organizational Support**

Similar to cost, Organizational Support (OS) is a compound variable of multiple theories. This includes (a) social contract theory, where personal needs force societal/organizational cooperation (Hobbes, 1651; Locke, 1689; Rousseau, 1762; Kant, 1781), and (b) risk management decision-making, where occurrence frequency, impact, certainty, and trust come together (Witt, 1973; Fischoff, 1978; Hussey, 1978; Douglas & Wildavsky, 1982; Drake, 1991; Gigerenzer, 1991 & 2002; Sjoberg, 2000; Pavlou, 2003; Clausen & Frey, 2005; Bahill & Smith, 2009). The overall OS perception is for the perceived level of support for the decision. Understanding of how the decision impacts the business process, the entrenchment of loss aversion within management, the proximity of the system to the businesses core functions, and the overall political capitol it will cost to make a change decision are perceived to influence the behavioral intent within TOM. Also of note is that component elements of OS may not influence some kinds of systems but may be crucial for others. Variance between case instances may be an element for further study.

### **Business Process Impacts**

Technology replacement nearly always has an impact upon the business processes of an organization (LaPointe & Rivard, 2005). ). In practice, technology replacement may take the form of replacing workers with machines or processes that are more efficient, changes to the power/political structure of the organization, or even changes in the interactions between various groups and departments. As Scheepers and Scheepers (2008) and Furneaux and Wade (2011) indicate, these impacts can influence decision-making. For example, a manufacturing plant with a strong union presence and entrenched processes may have a higher perceived impact than a dynamic software house with more fluid processes.

## **Business Intelligence**

As Marshall and de la Harpe (2009) indicate, organizations make decisions within the context of the information available, as business intelligence. Low business intelligence can lead to risky, uncertain, or impulsive decisions that may not return the outcome expected. Higher business intelligence is a correlated variable for decision outcomes that are closer to the desired effect. Therefore, one may expect that the level of business intelligence available about the replacement product or its decision space as a whole may influence the replacement decision.

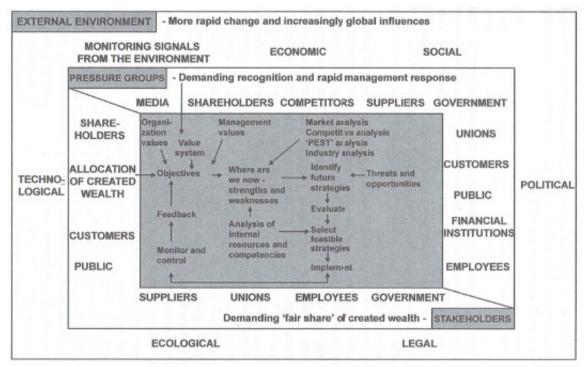
The stability and reputation of replacement product or development team augments this business intelligence (Slotegraaf & Atuahene-Gima, 2011). When selecting a replacement product, knowledge about it is a component of the business intelligence and influences performance expectations. Stability, reputation, and history of success influence the decision in a similar manner when selecting a team to develop a replacement.

# **Cognitive Misperception: Loss aversion**

As a component of status quo bias, Samuelson and Zeckhauser (1988) observe that decision makers value avoiding loss more than acquiring gain (Kahneman & Tversky (1979, 1984). This provides a bias towards the status quo that must be overcome for a replacement decision (Kim & Kankanhalli, 2009). Thaler (1980) first observed this effect within selling price variations and reluctance to trade (Kahneman, Knetsch, & Thaler, , 1990). This loss aversion also affects multi-attribute and inter-temporal decisions (Kahneman & Tversky, 1984; Loewenstein & Prelec, 1992; Quattrone & Tversky, 1987). Thus, it is expected to matter how a decision is framed in terms of gains and losses.

## **Business Strategy and Core Competency**

Ward and Peppard (2002) lay out a strategic framework (p. 71), originated as a PEST matrix (Political, Economic, Social, and Technological) and expanded to include Ecological and Legal concerns. This PESTLE strategic framework, see Figure 6, ensures the broad scope of stakeholders and concerns are perceived when making decisions and engaging in strategic planning. The TOM replacement decision is an example of a PESTLE type decision. The importance of the system to the organization's mission, core competencies, and its position to support the business strategy via strengths, weaknesses opportunities and threats (SWOT) style analysis (Friesner, 2011) are intrinsic elements of the overall IT/IS capability (Katz & Kahn, 1966; Ward & Peppard, 2002). As the systems contribute to the organization's competitive advantage via these variables, OI effects would be expected to follow these influences very closely. Whereby, systems with high relationship to the organization's core competencies and high integration with its business strategy receive significant attention as OI risk increases.



*Figure 6.* A Strategic Framework. Adapted from "Strategic Planning for Information Systems, 3 ed. By J.Ward & J. Peppard, 2002, p. 71. Copyright John Wiley & Sonse Ltd. Reprinted with permission.

## **Political Capital**

Acquisitions and replacements of capital assets entwine within the politics of the organization (Pettigrew, 1975). The assets considered for replacement affect internal processes, job positions, and potentially profit centers. Therefore, internal political contention for control and influence is to be expected (Zahra, 1987). The change champion has to expend significant political capitol to influence the decision makers (Sim, Griffin, Price, & Vojak, 2007), who must trust in this champion's political capital (Pavlou, 2003). This exertion of influence entails a measure of risk to the champion. These risks are countered by potential organizational enhancements.

## **Organizational Enhancements**

While there is risk in replacing an obsolete system, there are many potential benefits as well. The opportunity to generate new business (Ward & Peppard, 2002) being the primary, with its potential enhancement to improvements in communications and increased customer/supplier integration with value networks (Scheel, 2005). The perceived threats to business processes from change are also opportunities for improvement integrating new and potentially transformative technologies as they become available (Sandborn, Herald, Houston, & Singh., 2003). Likewise, risk potential to departmental sizes can be positively offset with organizational modification to enhance effectiveness and obtain benefits from labor adjustments. Perceptions of these benefits influence the behavioral intent of the decision maker.

# **Demographics**

Demographics are classification data characteristics of the population and sample (Sekaran, 2003). These questions are most commonly nominal or ratio data about the respondent. Under analyses variations amongst demographic groups are common (Hinde, 1998), which should therefore be examined as a potential influencing variable. Table 6 demonstrates the demographic collection selected for this study.

Table 6. Demographic Data to be Collected in Survey

Demographic	Measurement Scale	Method of Selection
Age	Ratio	Selection from a scale
Gender	Nominal	Male/Female
Years of experience with IT	Ratio	Explicit collection from participant
Years of experience win acquisition planning	Ratio	Explicit collection from participant
Type of obsolete system replace or being replaced	N/A	Explicit collection from participant based from a list with a supplemental text box

# **Literature Review Summary**

As presented in the TOM model (Figure 1), the literature review examined the seminal works which provided the form structure of the model, as well as the key decision elements perceived to comprise the factors influencing the replacement decision process. The foundations of the Obsolescence Imperative (OI) were laid out, the various Costs (C) and Benefits (B) to be considered were examined, the interactions of support from within the organization (OS) and the effects of technical performance upon the replacement decision were examined in detail. To these the potential influences of demographic effects were identified, as potential influencing factors to the behavioral intent of replacing an obsolete IT system.

#### **CHAPTER 3. METHODOLOGY**

The methodology to research the TOM model was pursued via a survey of prescreened candidates of a purposive sample. The researcher analyzed the survey results via statistical analysis to address the research questions and hypotheses identified in Chapter 1. This chapter explains the research design, who was surveyed and why, and how their responses were gathered and analyzed to ensure valid, reliable, and ethically gathered information.

### Research Design

TOM presents a framework for investigating the independent variables and their interaction to determine if they interact as anticipated and if the perceived relationships exist. A positivist quantitative approach was employed to investigate the TOM framework and its variables to answer the research questions and test the noted hypotheses in a manner to achieve sufficient reliability of the data and analysis, minimizing subjective judgment (Matveev, 2002, p. 61). This research design was opinion research (Straub, 2010) via survey data collection (Vogt, 2007), which provided measurable opinion related to the influencing factors of decision making in the context of the decision to replace obsolete systems. This method was consistent with the extended research discussed in Table 1. By establishing a functional model that accounts for known influencing variables, the specific independent and moderating variables under study were evaluated for their impact upon the decision process and importance to organizational management. Disciplined quantitative execution enhanced reliability and validity of findings analysis.

# **Methodology Overview**

This study took a quantitative approach using a non-experimental design, employing exploratory survey methods (Sekaran, 2003; Flor, 2004; Vogt, 2007). Adhering to the methods employed by previous authors in the field (Ajzen & Fishbien, 1980; Bandura, 1982, 1985; Samuelson & Zeckhauser, 1988; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Ajzen, 1991; Venkatesh, 2000; Venkatesh et al., 2003; Kim & Kankanhalli, 2009), a survey was administered that employed a 7-point Likert scale to collect primary ratio data. The majority of questions were newly created but conform to traditional form and consistency, simply introducing the specific factor under consideration by the respondent. The questions related to TAM variables were drawn from the Davis (1989) TAM instrument, and Behavioral Intent questions were drawn from the Venkatesh (2003) UTAUT Model. The survey instrument also collected limited secondary demographic data, typically nominal.

Creswell (2009) observed survey method to be appropriate when the researcher cannot directly observe or manipulate the phenomena on which data will be collected (i.e., attitude). Likewise, generalizability (a component of external validity) of the findings is a common objective of survey studies and can be accomplished with well-designed surveys with representative samples (Trochim, 2006).

The survey was web administered via SurveyMonkey. This is a form of computerized self-administered questionnaire as described by Groves, Fowler, Couper, Lepkowski, Singer, and Tourangeau (2009). The data source was decision makers in the position to make technology replacement decisions acquired from a case study of a single large, multinational conglomerate company. Independent organizational decision making variables selected for study were drawn from the literature review. The survey instrument was field tested with committee members and

instrumentation subject matter experts for structure and quality. The IRB and the company's parallel Human Services Review Board approved the survey vehicle prior to execution.

The IT Department Executive provided access to the purposive sample who met the screening criteria. Shadish, Cook, and Campbell (2002) indicated that a purposive sample can be used if a probability sample is not possible, as a purposive sample allows researchers to still take conscious actions to ensure the participants of their study are representative of the wider population from a purposive standpoint (p.355). The IT department provided potential participants an e-mail invitation with a link to the survey page. All participants were presented with the informed consent form adhering to Capella format and content, confirming their consent and opportunity to opt-out before proceeding to the survey itself. The survey was completed within 10 days.

# Sample

## **Population**

For this work, a single multinational conglomerate company with over 100,000 employees was established as the overall population. Of this population, the sampling frame focused upon IT acquisition decision makers working in the United States whose duties in their job included making the decision to replace legacy systems via acquisition of new or alternative systems. Applying the percentage estimate of 1%, this provided a sampling frame of 1700 potential candidates population. The case study company provided a prescreened subsample of the potential candidates known to meet the screening criteria of 360 persons, which was 21% of the potential sampling frame.

## **Sampling Frame**

The sample frame for this study consisted of a listing of personnel operating in these functions provided by the organizations corporate IT division. The inclusion criterion was involvement with acquisition/ replacement decision making. No exclusion criteria were included. The list of accessible persons was a subset of the population limited only by the accessibility of the IT department's knowledge of roles and responsibilities.

### **Ideal Sample**

Employing the formula provided by Von Bennekom (2002), sample size was identified as follows:

n = Number of responses needed (Sample size)

Z = Number of standard deviations that describes the precision of desired results

e = accuracy or error of the results

- = Standard error of the estimate

$$e = Z * (\sigma/n)$$

$$Z = 95\% = 1.96$$
 and  $Z^2 = 3.8416$ 

$$-=1.137$$
 and  $-=1.293$ 

$$e = 1.96 * (1.137/ 1700) = .152$$

Drawing a standard deviation from the three instances of the Venkatesh (2003) UTAUT Model (which was formed of the comparison of eight other models in its data structures) as a working expectation provides an  $\sigma = 1.137$ .

Maintaining a 95% confidence level with a confidence interval of 5, n = (3.8416 \* 1.293)/.152 = 186.4. So a minimal sample size of 187 was needed for acquiring a confidence level sufficient to meet scientific verification. With a supplied list of only 360 names, this would have required a response rate of 60% the invited sample.

For this initial study, even numbered participants (from an alphabetical list) were to be invited. If needed, odd numbered persons would also be invited to participate. This would have implemented a systematic strata sample, which protects the integrity of the sample (Groves et al., 2009, p. 121).

The use of the web survey form mitigated introduction of collector bias. The advantage of this sample methodology was its reach and accessibility, providing equal opportunity to all invited persons in the sample. While it was possible the study could suffer from the satisficing effect observed by Barge and Gehlbach (2010), this was not expected to be realized due to the lack of any compensation effect from this survey method.

### Setting

The multinational conglomerate case study was selected due to its breadth of interests and depth of personnel, sufficient to acquire a productive sample, while still ensuring the quality of candidates being accessed. This was augmented by the high-quality interface provided by the SurveyMonkey site, which ensured both anonymity of the respondents and confidentiality of their responses, such that the researcher did not know who completed or did not complete the survey. Recruitment e-mails were prescreened by the IRB.

While the organization received a copy of the published survey, this imparted no intrinsic benefit by supporting the research. This quantitative, non-experimental survey research, examined through the positivist lens, provided a predictive framework by which evaluation of the affected independent variables identified the specific relationships and areas of concern to be addressed by managers seeking to replace obsolete systems. Knowing which effects carry more impact and the relationship of the variables to the decision may help decision makers determine the most successful approach to replacing obsolete systems in any industry. Additionally, having

solicited why these are deemed important can help the manager understand the rationale and needs these elements represent. This contributes to the body of knowledge of both Managerial Science and Information Technology Management.

#### Instrument/Measures

The instrument employed in this study was a survey, a sample of which is provided in Appendix A. The survey starts with collection of demographic data as described in Table 5. The next five sections of the survey follow this format for each of the subject independent variables:

Obsolescence Imperative, Costs, Benefits, Organizational Support, and Technical Factors:

- A series of explicit questions oriented at the elements of the variable identified in the literature review: These were presented in a 7-point Likert scale format as follows: 1 = Strongly Disagree, 2 = Disagree, 3 = Somewhat Disagree, 4 = Neutral, 5 = Somewhat Agree, 6 = Agree, 7 = Strongly Agree.
- A ranking of the importance of the questions subjects to the replacement decision: This
  helped to differentiate from many elements rated of similar importance and helped to
  address some of the research questions.
- Open text boxes were provided for the respondent to explain why they selected the element they ranked most important and least important.
- An open text box was provided for the respondent to identify any additional elements related to the subject variable that they may deem important to their replacement decision that were not included in the questions asked. This provided a continual improvement element to the survey process itself and identifies additional areas for investigation for both the researcher preparing the research and the practitioner employing the tool to gather information about their own application of the discipline.

The next section of the survey instrument also employed a ranking scale for each of the compound variable effects, soliciting a ranking of importance from the respondent. This again was supplemented with questions regarding explanation for the highest and lowest ranking and providing a qualitative element to understanding why the respondents selected such.

The next section employed Behavioral Intent measurements of perception. These questions were drawn in form directly from the UTAUT model (Venkatesh et al., 2003). The final section was a single question presented with an open text box for the respondent to identify any additional elements related to anything presented or not presented in the survey that they may deem important to their replacement decision that may not have been adequately addressed. As before, this provided a continual improvement element to the survey process itself and identified additional areas for investigation for both the researcher preparing the research and the practitioner employing the tool to gather information about their own application of the discipline.

The assembled instrument was reviewed by a panel of experts whose experience in the acquisition decision role prepared them to advise on the appropriateness of the questions.

Additionally support for the instrument was provided by the dissertation mentor, who reviewed questions structure, diction, and assembly before authorizing progress. These functions were conducted under the supervision of the dissertation committee.

The tools fit for purpose was established in Chapter 4. Fit measures could have been categorized by three types—absolute, relative, and/or adjusted (or parsimonious) indexes (Maruyama, 1998). "Absolute fit indexes provide information about how closely the models fit compared to a perfect fit. This can be measured by a  $\chi 2$  test, goodness-of-fit index (GFI)"

(Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007, p. 317). The Chi-Squared GFI was employed in this assessment.

#### **Data Collection**

The survey instrument presented at Appendix A links to the SurveyMonkey website.

Note, that a direct copy of the survey was provided in A as the commercial paid website cannot be guaranteed to maintain the survey indefinitely. SurveyMonkey provided an interactive website where respondents could select to take the survey. Respondents' identities remained both confidential and anonymous to the researcher and from the company, mitigating respondent risk. A password was provided for access to the survey to ensure only the invited candidates complete the survey, which maintained the integrity of the prescreening selection process.

Respondents were first greeted by a general invitation and overview of the survey included within the informed consent. Respondents who concurred with the consent form were passed through to the survey. The survey was available on the SurveyMonkey site for 10 days to acquire the received response.

### **Data Analysis**

Data was analyzed primarily with IBM SPSS Statistics 22.0 Standard statistics software suite. Means were used for direct overall comparison of individual questions and variables for determining what is perceived as most important. ANOVA was employed to determine significance of each variable, verify or fail the null hypothesis, as well as reduce type I errors (Vogt, 2007). The Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions was consulted, as well, for assessment of variable significance. Correlation matrices were employed for identification of excessive similarities of questions, consistency of responses, and significant influences. Multiple regression analysis and correlation

via SPSS was used to measure the strength of the relationship between the models variables and how the independent variables modify behavioral intent (the dependent variable) and unique contributions of each variable to assess the presented hypotheses. Table 7 provides a summary of questions/hypotheses, and the tests that were employed to address them.

Table 7. Data Mapping

Research Question/Hypothesis	SPSS Statistical test			
R1: Greatest Influence				
Inv1/H1: Greatest Influence (OI)	Means of Response			
H1a: Significant Influence (OI)	ANOVA, Regression			
Inv 2/H2: Significant influence (C)	ANOVA, Regression			
Inv 3/H3: Significant influence (B)	ANOVA, Regression			
Inv 4/H4: Significant influence (OS)	ANOVA, Regression			
Inv 5/H5: Significant influence (T)	ANOVA, Regression			
R2: Demographic significance				
H6: Demographic significance (OI)	Regression, Correlation			
H7: Demographic significance (C)	Regression, Correlation			
H8: Demographic significance (B)	Regression, Correlation			
H9: Demographic significance (OS)	Regression, Correlation			
H10: Demographic significance (T)	Regression, Correlation			
R3: Most important Factor				
H11: Most important/Most significant Factor agreement	Means/ANOVA			

Means and distribution were employed to assess the direct responses: (a) what accumulated the greatest response rates and a look at the distributions to assess response distortion, (b) factorial ANOVA (Vogt, 2007, p. 103) was employed for comparing the means of

the questions to minimize type I error. ANOVA (Fisher, 1918) performs the same functions as t-tests but can handle multiple variables better, without incurring type 1 errors for doing so (Elvers, n.d.), Brown and Welch-Forsythe robust test of the equality of means for asymptomatic distributions was also consulted for assessment of variable significance.

Means identified the central tendency (Vogt, 2007, p. 60) of the response to the questions asked in the survey in seeking which variables had the greatest influence. Those with the accumulated lowest means are what the respondents identified as most important to them, with the summed means of the clustered questions creating the greatest and least influence. This was employed to directly answer the research questions.

The Standard Deviation (SD) from the mean identified how widely the responses vary, with high SD identifying a question with low kurtosis and little agreement amongst the respondents as a whole, and thus limits representativeness of the group (Vogt, 2007, p. 20). This was employed to help evaluate the responses for representativeness, ensuring the quality of the research effort.

Correlation matrices were employed to identify the influence of demographic variables upon response results as well as to identify relationships between variables, which may or may not have been linear. Analysis in Chapter 5 specifically employed Spearman correlation in addition to Pearson's.

Multiple Linear Regression (MLR) was employed to determine if a predictive change in BI could be determined from the change in the dependent variables as well as the significance of the relationship between variables. MLR provided for the significance testing of the independent variables as well as the prediction factors of the TOM model related to the prediction of BI for

the model as a whole, each independent variable, and control for the variables within this assessment (Vogt, 2007, p. 146).

## Validity and Reliability

### **Face Validity**

Borden and Abbot (2008) described face validity as "how well a measurement instrument appears to measure what it was designed to measure" (p. 129). The questions forming the survey were drawn from well-tested and verified tools, such as the TAM model with new questions following similar form and employing a similar method. Questions were reviewed by the panel of experts as part of the pretest, and the mentor and committee members provided by Capella, as recommended by Vogt (2007, p. 119).

## **Construct Validity**

Borden and Abbot (2008) indicated that construct validity "applies when a test is designed to measure a 'construct' which is a variable, not directly observable, that has been developed to explain behavior on the basis of some theory" (p. 130). Vogt (2007) described it as "How well the measurement instrument measures the concept (construct) of interest" (p. 119). Factor Analysis was employed to discover the nature of the constructs influencing a set of responses (DeCoster, 1998). The correlation matrices for each variable set was consulted for correlation and identification of multicollinearity issues. Then the same was repeated for the composite vehicle, seeking to verify the number of factors assessed. The pretest identified six factors.

### **Criterion Validity**

Kripanont (2007) observed that Criterion Validity "indicates that items that are indicators of a specific construct should converge or share a high proportion of variance in common (Hair

et al., 2006)" (p. 131). Thus, it assessed the degree to which two measures of the same concept (variable) were correlated, with high correlation indicating that the survey was measuring its intended concept. Robinson, Shaver, and Wrightsman (1991) provided a rule of thumb suggesting that item-to-total correlations exceed 0.50 and the inter-item correlations exceed 0.30. Kripanont (2007) observed Cohen's (1988) suggestion that correlation r = 0.10 to 0.29 (small correlation: both positive and negative correlation), r = 0.30 to 0.49 (medium correlation), and r = 0.50 to 1.00 (large correlation) as criterion evaluation measures. The Pearson's correlation run on the variables produced only 20 out of 7320 intersections with large correlation, which is less than 2 tenths of a percent.

## **Content Validity**

While somewhat similar to face validity, Content Validity is an indication of "... how adequately the content of a test samples the knowledge, skills, or behaviors that the test in intended to measure" (Borden & Abbott, 2008, p. 129). As recommended by Vogt (2007 p. 119), experts reviewed the survey vehicle as part of the pretest and before the survey. These were five IT industry professionals whose roles include replacement decision but will not be a portion of the sample. Also, the dissertation mentor and committee members provided by Capella were consulted as part of the dissertation review.

### **External Validity**

Borden and Abbot (2008, p. 110) observed, "A study has external validity to the degree that its results can be extended (generalized) beyond the limited research setting and sample in which they are obtained." The standardized question structure was designed to have broad applicability to many industries and fields for high generalizability. As the sample for this study was drawn from a large, multinational conglomerate, the application of the TOM survey results

for this study was expected to provide reasonable generalizability to a similar field. Application to different sized organizations in different fields were acknowledged to have a likelihood of variant results, which was why the manager would want to use the TOM tool to gain these insights for their application.

### **Internal Validity**

Internal validity has many potential threats, such as Wortman (1983) observed with the first letter mnemonic THIS MESS, referring to Testing (repeated testing), History, Instrument change, Statistical Regression toward the mean, Maturation, Experimental mortality, Selection, and Selection Interaction. Repeated testing bias was avoided in this case because of a single sampling execution that does not provide participants the opportunity to remember the answers from a previous session and replay them. This was not a longitudinal study; therefore, significant external events are not expected to interfere with respondents' answers and maturation of the subjects will not become an issue. The IRB approved the survey instrument that was administered by a controlled website, mitigating instrument change bias. The short nature of the data acquisition frame mitigated mortality risk, while the professional screening controls employed by the survey service mitigated selection and selection interaction biases. Multiple regression analysis and correlation via SPSS was used to measure the strength of the relationship between the model's variables and how the independent variables modify behavioral intent (the dependent variable) and unique contributions of each variable to assess the presented hypotheses.

### Reliability

Reliability speaks to the consistency of the tool to generate similar results in similar conditions. Four reliability factors are generally recognized. *Inter-rater reliability* speaks to the

consistency or homogeneity of responses between people taking the same test with the same methods. It was assessed via generating a Fleiss' Kappa (Fleiss & Cohen, 1973) score for each variable. *Test-retest reliability* is a measure of the consistency of scores from one administration of the test to the next with the same subjects and conditions. The Pearson product-moment correlation coefficient (or Pearson's *r*) (Vogt, 2007) addressed test application consistency, and Spearman's Rho correlation coefficient identified dependence between variables. *Internal consistency reliability* is typically the greatest concern to testers to ensure what is measured is what is intended to be measured. Cronbach's alpha (Vogt, 2007) for each variable set and compound variable set was provided. *Inter-method reliability* is a concern when methods of gathering data may be different (say different sessions or venues); however, this was not a case for this study.

#### **Ethical Considerations**

## **Participant Privacy and Confidentiality**

The sample was not drawn from persons with any association with the surveyor and, in fact, remained completely anonymous to the surveyor, providing full assurance of confidentiality. The survey questions placed participants at no risk of discrimination or repercussions for participation. All participants were provided an informed consent form before acquiring access to the survey to protect their interests. Additionally, the entire study was reviewed and approved by the corporate Human Subjects Protection Program Administrator. Company policy for human subject protection was in line with the *Belmont Report* (Ryan et al., 1979) principles and with the oversight of the corporate IRB.

### Clear Benefit – Risk Analysis

While no study is completely risk-free, no harm or distress for participants was anticipated. Participants could leave the study at any time they felt uncomfortable. Participants were notified of the small possibility that responses could be viewed by unauthorized parties (e.g., computer hackers, because responses are being entered and stored on a web server). Risk was deemed by the Human Subjects Protection Program Administrator and Capella IRB to be minimal to participants and was in line with the Belmont Report (1979) principles.

### **Vulnerable Population(s) Considerations**

By employing the IT organization as an independent third party, the surveyor benefits from knowing that the selectees were identified by the professional organization that knows their qualification for selection. Survey Monkey did not provide the identities of the Respondents to the surveyor, which provided full assurance of confidentiality through anonymity. The survey questions placed participants at no risk of discrimination or repercussions for participation, and any participation or non-participation was not known to anyone in the company. All participants were provided an informed consent form before acquiring access to the survey to protect their interests.

### **Data Security**

Dissertation data was be stored on a portable hard drive and a backup DVD encrypted with 256-bit Advanced Encryption Standard (AES) symmetric-key algorithm to ensure maximum protection and confidentiality of the collected data. Collected data will be stored for the required period of seven years and then will be wiped with a Department of Defense approved data-wiping tool (for the hard drive) after that period, with the backup DVD being destroyed by incineration.

#### **CHAPTER 4. RESULTS**

# **Chapter 4 Introduction**

This chapter presented findings from the survey. First the population and sample acquired were described, highlighting variations from what was planned in Chapter 3. Each question in the survey, along with its results was reviewed and described, along with the analysis of meaning for the individual questions. Analysis of the methods described in Chapter 3, along with conclusions and analysis of the survey as a whole for its effectiveness in addressing the replacement decision were presented in Chapter 5. Appendix B presented the organized data for analysis (e.g., correlation matrixes, ANOVAs, and factor analyses). For clarity of presentation, questions are presented one or two per page to minimize the effect of table rollover between pages and enhance readability of the printed work.

# **Description of the Population and Sample**

For this work, a single multinational conglomerate company with 170,000 employees was established as the subject of investigation. Of this overall population, the sampling frame focused upon IT department acquisition decision makers working in the United States whose duties in their job included making the decision to replace legacy systems via acquisition of new or alternative systems. Applying the percentage estimate of 1% of the total number of employees, this provided a sampling frame of 1700 potential candidates' population. The case study company provided a prescreened sub-sample of the potential candidates known to meet the screening criteria of 360 persons, which is 21% of the potential sampling frame.

As demonstrated in chapter 3, the ideal sample for a 95% confidence level with a confidence interval of 5 is 187 valid responses. With the supplied list of only 360 names, this required a response rate of 60% the invited sample. As may have been anticipated, a 60%

response rate was not attained. All of the 360 persons provided by the company were invited to participate; 110 of these selected to accept the invitation to the survey. This presents a 30% response rate. Of these 110 persons, 7 selected not to participate in the survey after reading the informed consent. Of the 103 persons who positively selected to participate in the survey, only 50 actually completed all elements of the entire survey.

Respondents identified themselves as 86% as male with 14% as female, with the average age centered at about 50 years old. They averaged about 28 years of IT experience and 15 years of Acquisition Planning experience. All included in the evaluation completed all questions.

# **Summary of Results**

Table 8 summarizes the response findings to the hypotheses and research questions.

 Table 8.
 Results Assessment

Research Question/Hypothesis	Assessment
R1: Greatest Influence	
Inv1/H1: Greatest Influence (OI)	OI not greatest influence; Fail to reject the null
H1a: Significant Influence (OI)	OI shows as significant in 1 measure*, Reject null
Inv 2/H2: Significant influence (C)	C shows as significant in 1 measure*, Reject null
Inv 3/H3: Significant influence (B)	B not shown as significant; Fail to reject the null
Inv 4/H4: Significant influence (OS)	OS not shown as significant; Fail to reject the null
Inv 5/H5: Significant influence (T)	T nearly shown as significant**; Reject the null
R2: Demographic significance	
H6: Demographic significance (OI)	Age (.051) Reject the null
H7: Demographic significance (C)	IT Experience (.053) Reject the null
H8: Demographic significance (B)	IT Experience (.047) Reject the null
H9: Demographic significance (OS)	IT Experience (.039) Reject the null

Table 8. Results Assessment (Continued)

Research Question/Hypothesis	Assessment
H10: Demographic significance (T)	IT Experience (.021) Reject the null
R3: Most important Factor	
H11: Most important/Most significant Factor agreement	Fail to Reject the Null (B was most important, not OI)

*Note.* \*While OI and C failed to identify as significant on the ANOVA assessment they did show such on the Welch and Brown Forsythe tests

#### **Results in Detail**

This section reviewed the results of each question presented on the survey, provided analysis of the results and then addressed analytic assessment of the overall results of the survey effort and related these to TOM. These formed the basis for the assessment of the research questions and hypotheses.

### **Question 1: Participation**

The first question presented to all respondents was in fact the Informed Consent form required by Capella University. SurveyMonkey recorded the selection to proceed positively or negatively. All of the 360 persons provided by the company were invited to participate; 110 of these selected to accept the invitation to the survey. Those who accepted the invitation presented a 30% response rate. Of these 110 persons, 7 selected not to participate in the survey after reading the informed consent. Of the 103 persons who positively selected to participate in the survey, only 50 actually completed all elements of the entire survey.

The first concern related to participation was that of low response rate. While 30% was not dismal, it could likely be improved by acquiring direct support from the CIO executive, or someone on their executive staff, in distributing the invitations, which may have provided

<sup>\*\*</sup>The ANOVA result for T was .55 very near significant

increased visibility to the management endorsement received to pursue the study. Additionally, rehosting of the survey onto a company-provided host site (if available) rather than SurveyMonkey may have increased confidence in participants that the outreach was not social engineering or a phishing, reducing the number of declinations to participate.

In this study, of the 103 persons who positively selected to participate in the survey, only 50 actually completed the survey. The 50 completed surveys is less than half who initially self-selected to participate. Feedback from the expert panel agreed that survey length was the most substantive influence to this decision not to complete the survey. Requiring about 30 minutes to complete in its presented form, the survey instrument should become more efficient.

### **Question 2: Gender**

Question 2, gender, presented a simple choice between two radio buttons. The study respondents identified 86% as male with 14% as female. The IT department population from which it was drawn included 86% male and 14% female, as identified by the company's Human Resources (HR) department. The lopsided ratio presented a distinct skew to the distribution from the national standard distribution, which may have demonstrated a potential demographic impact to broad generalizability. However, the IT industry norm employed only 27% females (WITEF, 2008). The Chi Square Goodness Fit Index of gender alone, as presented in Appendix B, Table B1, did not reconcile this extreme variance sufficiently to reject the null of frequency coincidence in a significant manner.

Review of the correlations matrices identified only two elements of the fifty comprising the five factors showing a significant correlation of influence between Gender and responses.

The correlation rate was low in comparison with the other demographic effects with more impact. While gender showed minimally significant correlation within this study, this may not

replicate itself within replication studies or studies with more normal distributions. The Kim and Kankanhalli (2009) Status quo bias investigation identified no significance to gender bias, nor did the Kim, Chan, and Kankanhalli (2012) study on digital purchase motivation.

## **Question 3: Age**

As demonstrated in Table 9, the identified age responses indicated a more mature sample with no respondents from the 35 and younger demographic, 12% for the 36-45 age cluster, 54% in the 46-55 age cluster, 30% at 56-65, and 4% who were 66 or older. The age clustering at the higher marks would at first appear as a distinct skew to a more mature respondent base that could have a distinct demographic impact upon responses. However, the average age in Aerospace engineering was 45.7 (AIA, 2011), which helped to explain the high kurtosis and skew to distribution, as assessment of the age responses resulted in the rejection of the null based on the Pearson's Chi Square GFI in Appendix B, Table B1.

Table 9. Question 3: Age

Which category Below includes your age?								
Answer Options	Response Percent	Response Count						
18 pr younger	0.0%	0						
18-25	0.0%	0						
26-35	0.0%	0						
26-45	12.0%	6						
46-55	54.0%	27						
6-65	30.0%	15						
66 or older	4.0%	2						

The correlation matrices identified that age had significant impacts upon one element in OI and four elements in OS. This strong showing in OS, with one third of the elements affected significantly, was demonstration of the form of demographic influence investigated by the primary research questions. This was expected to repeat in additional studies, if for no other reason than the focus structure of the model, in difference from findings in status quo bias and TAM research by Kim and Kankanhalli (2009) and Kim, Chan and Kankanhalli (2012).

### **Question 4: Years of IT Experience**

The Years of IT experience question was presented to respondents as an integer box for participants to fill in. As demonstrated in Figure 7, Question 4 presented results with a wide distribution and distinct generational bumps obvious between 15 and 30 years of experience. With an Average of 26.6 years, a Mean of 26.7 years, and a Standard Deviation of 8.76 years, the majority of respondents have at least 18 years of experience in the IT field, indicating deep experience is common within the sample.

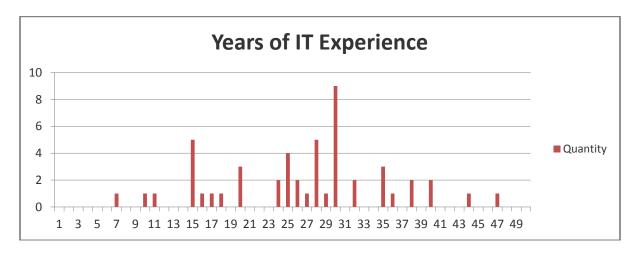


Figure 7. Years of IT Experience

The correlation matrices identified that Years of IT Experience had significant impacts upon 1 or 2 elements of every factor. The broad-spread showing of significance was of interest to the research questions of demographic influence under investigation.

### **Question 5: Years of AP Experience**

Question 5 was also presented to respondents as an integer box they may fill in. The explicit question presented was "For how many years have you been involved with the decisions to acquire or replace IT systems?" With an average and mean response of 16.9 years, the responses presented in Figure 8 demonstrate distinct but declining experience at the 5-year points. From this, one may surmise that respondents were estimating rather than providing exact data. One may also deduce that experience in acquisition decision making did not start until later in the standard careers, but the standard deviation of 9 years presented a wide dispersion. If the two 40 & 42 year respondents were excluded as outliers, the Mean dropped to 15.9 years, and the standard deviation dropped to 7.8 years, presenting a more tightly coupled response focus.

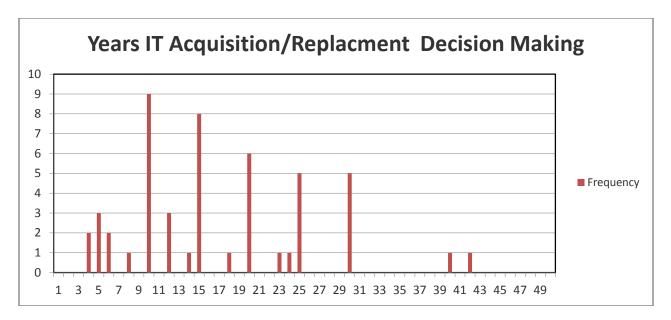


Figure 8. Years of AP Experience

The correlation matrices identified that Years of AP Experience identified only a single element of significant impact in OI, the same one as IT experience, *Concern over Software End of Life Support*. Software End of Life may have greater awareness to the sample, generating its significance. However, depth of penetration of this single element for effect upon the OI factor

as a whole was not significant in aggregation. Years of AP experience should be of interest to additional studies to determine if its correlation repeats effect.

### **Question 6: Example System**

Question 6 acquired from the respondent the type of system they have been involved with acquiring or replacing, which was their frame of reference through the remainder of the questions. The question was presented as a statement with the answer options demonstrated in Table 10 as selectable radio buttons to the right of each options and a text box where respondents could select to enter their own description of the product for which they provide acquisition/replacement services. Execution of this survey observed the needs to ensure that the question form enforces categorical responses for only a single option.

As presented in this application of the survey, respondents were able to select multiple elements, eliminating the precision of and devaluing responses. As seen in Table 10, respondents provided 149 responses. Within these responses however, Servers, Software and Operating Systems accounted for nearly 62%. Of the nine responses identified as "other", one could be characterized as server, 1 as Software, 1 as E-Services, 3 as Network Infrastructure, and three actually unique elements. Robotics and Application Middleware should be considered for adding to the list of further studies.

Table 10. Question 6: Example System

Please think of an obsolete system that you were involved in or may be involved in the decision to replace. Please describe that system:								
Answer Options	Response Count							
Servers (e.g., data storage, e-mail, web, database)	32							
Software program (e.g., Antivirus, engineering tool, desktop utility, database)	39							
Operating Systems (e.g., Windows, Linux, Solaris, AIX, OS X)	21							
E-Services (e.g., Web sites, e-tools, access to software packages and updates, remote	15							
systems administration)								
Entertainment (e.g., Games, Emulators)	1							
Network Infrastructure (e.g., Router, Switch, Hub, Firewall, IDS)	12							
Peripheral Devices (e.g., Printers, copiers, scanners, SAN, )	11							
Specialty Equipment (e.g., Spectrum Analyzer, Programmable Logic Controller,	6							
Cryptographic unit) Embedded Systems (e.g., GPS modules, Flight Control Computers, Instrument Landing System in airplanes)	3							
Other (please specify)	9							

## **Question 7: Elements of Obsolescence**

Question 7 presented eight elements of obsolescence to the respondents by asking, "Is this element of obsolescence (listed below on the left) important to your decision to replace an obsolete system?" The survey presented this question with a seven-part Likert scale response for agreement and disagreement. Table 11 presents the specific wording of each element.

Respondents indicated that all eight elements would influence their decision-making. The numerically strongest element was g) *The inability of the obsolete system to support its business function or mission*. The weakest element was a) *The lack of materials availability (e.g., parts,* 

suppliers, or support). Only one element acquired any substantive disagreement: e) The inability of the obsolete system to adapt to changing regulatory demands.

The correlation matrices identified that OI encountered 3 intersections with high correlation, such as above .65, but 14 intersections identifying as significant correlations between elements. These correlation results were indicative that only a few of the questions were very close in form and should be considered for consolidation or adjustment for clarity, and that the response rate was not likely to occur by chance but to be significant to the research questions.

The ANOVA of OI paired with its effect on BI, as shown in Appendix B, Table B4, identified a .094 significance, with Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions presenting a .052. The ANOVA was not close to a significant effect, but the robust tests were very close. OI should be examined carefully in further studies for the significance of its effect due to this closeness.

Table 11. Question 7: Elements of Obsolescence

Answer Options	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Agreement	Strength
a) The lack of materials availability (e.g. parts, suppliers, or support)	1	3	2	13	9	16	6	31	22
6b) Discontinuance of software support after end of life (EOL)	0	1	2	4	6	22	15	43	37
c) Technological limitations of the obsolete system (e.g. transmission speed variances between copper and fiber communications wires)	0	4	0	11	7	22	6	35	28
d) The inability to pursue business opportunities because of the obsolete systems limitations	1	4	0	5	14	19	7	40	26
e) The inability of the obsolete system to adapt to changing regulatory demands	0	9	3	6	7	14	11	32	25
f) The inability of the obsolete system to adapt to new market demands, causing loss of business	0	4	0	6	8	18	14	40	32
g) The inability of the obsolete system to support its business function or mission	0	3	2	3	3	21	18	42	39
h) The rising cost of maintaining and operating the obsolete system	1	1	2	1	11	27	6	44	33
i) The declining knowledge base of persons who can repair or maintain the obsolete system	0	1	5	7	13	17	7	37	24

## **Question 8: Elements of Obsolescence: Terms or Meaning Clarity**

Question 8 was presented for enhancing the value of this exploratory study. Asking respondents, "Are any of these terms or the meaning of the question unclear? Please explain", this question sought to verify the clarity and familiarity of respondents with the terms used and identify any potential shortcomings to face and content validity. With 45 responses indicating no difficulty understanding the terms and several significant correlations, the elements of this factor were fairly well understood by respondents.

Two comments were received suggesting additional ideas: Addition of an N/A option and maintenance costs. The decision was made during design not to include an N/A option as raters trying to describe an exact instance would over select N/A obviating the value of the survey.

Maintenance costs are included in the costs section of the survey.

Two comments were received requesting terms clarification. One observed that component availability did not impact the instance of business software support of his working example. While this may be the case, this should simply result in a less important rating for this element to the replacement decision and potentially a lower ranking in Question 9. The second inquired whether "inability" included workarounds. Yes, inability to acquire something would be expected to include workarounds. The wording was perceived properly communicated, as no other respondents had this form of comment, and the respondent had no further clarity inquiries through the remainder of the survey.

One comment received simply criticized the study as a whole. The criticism was taken in stride. The responses from this question were not perceived to indicate issue with the survey instrument or the TOM model. No further recommendations were made from this question.

### **Question 9: Elements of Obsolescence: Ranking of Importance**

Question 9 presented the second major evaluation question format, requesting respondents to rank the order of importance of the presented elements of obsolescence. The ranking for question presented a different perspective than Question 7, as rank precedent demonstrated which elements were valued higher than others. The highest number of responses (see Table 12), observed as "the most important element," was assigned to: *Discontinuance of software support after end of life (EOL)*. However, this element was second in response composite score with *The inability of the obsolete system to support its business function or mission* acquiring the highest overall affect upon persons decisions. The least influential element was clearly assigned to *The declining knowledge base of persons who can repair or maintain the obsolete system*.

Interestingly, software end of life identified as significant to influence from Years of IT and AP experience in the demographic assessment, as well as having a significant intersection with the effects of DMSMS. The multiple significant influences and intersections should not be surprising, though, given the proximity of subject between the hardware and software functions.

Variances between the ranking and raw responses from Question 7 were perceived as an effect of the indication of importance versus the forced ordering of preferences. The correlation matrix of the Question 7 importance listing and the Question 9 ranking, the expected significant correlation existed between the individual elements. However, an additional 40% of the intersections identified significant correlation, indicating agreement amongst the respondents to the questions in both importance and ranking, focused upon the perceived lowest importance element of the obsolescence factor: *The declining knowledge base of persons who can repair or maintain the obsolete system*.

Table 12. Question 9: Ranking Elements of Obsolescence

Please rank order each response: Place a 1 for the element most important to the replacement decision. It will then move to the top of the list. Then select 2 for the next most important, which will move to that position. Continue to 9 for the least important.

important.										
Answer Options	1	2	3	4	5	6	7	8	9	Rating
										Average
a) The lack of materials availability (e.g. parts, suppliers, or support)	2	2	7	6	6	8	3	9	7	5.70
6b) Discontinuance of software support after end of life (EOL)	10	9	2	4	6	3	7	3	6	4.50
<ul> <li>c) Technological limitations of the obsolete system</li> <li>(e.g. transmission speed variances between copper and fiber communications wires)</li> </ul>	4	6	7	5	4	8	3	8	5	5.10
d) The inability to pursue business opportunities because of the obsolete systems limitations	8	2	7	6	7	8	7	2	3	4.64
e) The inability of the obsolete system to adapt to changing regulatory demands	7	5	5	4	4	6	7	4	8	5.14
f) The inability of the obsolete system to adapt to new market demands, causing loss of business	5	6	4	6	4	5	9	9	2	5.12
g) The inability of the obsolete system to support its business function or mission	8	11	7	7	5	1	3	5	3	3.96
h) The rising cost of maintaining and operating the obsolete system	4	6	5	8	9	5	4	5	4	4.84
i) The declining knowledge base of persons who can repair or maintain the obsolete system	2	3	6	4	5	6	7	5	12	6.00

# Question 10: Elements of Obsolescence: "Why Did You Select the Element Rated Highest (#1)?"

Question 10 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their top category of Question 9. From this, Table 13 shows the clustering characterization of the types of responses that was completed.

Analyzing these clustered results, key themes of availability, functionality, and profitability occurred throughout all responses. The motivations for the rationale tied into functions of costs and benefits presented later in the survey and indicated basic ideological support for the TOM model assumptions. Additionally they may provide grounds for further research in additional works.

Table 13. Question 10: Elements of Obsolescence: Why did you select the element rated highest (#1)

Element of Obsolescence	Qty	Clusters	Characterization
The lack of materials availability	2	1	System unavailability halts all forms of
(e.g., parts, suppliers, or support)			production
Discontinuance of software support after end of life (EOL)	10	2	<ul> <li>a) Support availability is required to meet standards</li> </ul>
			<ul> <li>b) Lack of support availability increases risk to an unacceptable level: Cost, Schedule, performance, availability, data loss</li> </ul>
Technological limitations of the obsolete system (e.g., transmission speed variances between copper and fiber communications wires)	4	2	<ul> <li>a) Out of date (obsolete) technology can cause loss of business due to inability to meet customer requirements</li> <li>b) Obsolete technology required excessive cost to operate, was more manpower intensive than replacement.</li> </ul>

Table 13. Question 10: Elements of Obsolescence:
Why did you select the element rated highest (#1) Continued

Element of Obsolescence	Qty	Clusters	Characterization
The inability to pursue business	8	2	a) New business is core to profitability which
opportunities because of the			in turn is the end purpose of the system
obsolete systems limitations			b) New business frequently has greater
			demands which must be met in order to
The Cook Street City of the Color of the Color	-	2	succeed, which drives change
The inability of the obsolete system	7	2	a) Some business units regulatory
to adapt to changing regulatory demands			compliance are life and death issues with excessive liability for failure
demands			b) Inability to keep up with security
			requirements may lead to loss of trade
			secrets or exposure of organization to legal
			liability
The inability of the obsolete system	5	1	IT is an enabler to business functions. If it
to adapt to new market demands,			cannot adapt or perform that function, it
causing loss of business			must be replaced.
The inability of the obsolete system	8	1	There is no purpose to maintaining a system
to support its business function or			which cannot do its job
mission		4	
The rising cost of maintaining and	4	1	IT must remain cost effective to enhance
operating the obsolete system			profitability of the purpose it serves,
			otherwise, it should be replaced with something more cost effective
The declining knowledge base of	2	1	Lack of personnel, due to unique in-house
persons who can repair or maintain	_	_	capability (not available on the market), or
the obsolete system			legacy nature of obsolete system, increases
,			likelihood of system unavailability to
			unacceptable level.

# Question 11: Elements of Obsolescence: "Why Did You Select the Element Rated Lowest (#9)?"

Question 11, likewise, presented the respondent with a qualitative element, which was also presented as an open text box so the respondent may explain the rationale for the value decision. The responses for this question were aligned with the raw response for their least category of Question 9. From this, a clustering characterization of the types of responses was completed and presented in Table 14.

Table 14. Question 11: Elements of Obsolescence: Why did you select the element rated lowest (#9)

Element of Obsolescence	Qty	Clusters	Characterization
The lack of materials availability			Software centric respondents perceive
(e.g., parts, suppliers, or support)	7	1	hardware to be easily replaced or software
	,	1	obsolescence normally outpacing hardware
			obsolescence
Discontinuance of software support	6	1	Money and effort can keep software
after end of life (EOL)	O	1	operational for extended periods
Technological limitations of the			These are rarely realized, and are better
obsolete system (e.g., transmission	5	1	presented in terms of direct business impacts,
speed variances between copper	5	1	which are more important
and fiber communications wires)			
The inability to pursue business			New business opportunities are rarely sought
opportunities because of the	3	1	via a legacy system, organization simply uses
obsolete systems limitations			newer systems for that function
The inability of the obsolete system			Regulatory demands rarely affect technology
to adapt to changing regulatory	8	1	decisions as they are slower to change and do
demands			not affect business process quality
The inability of the obsolete system			Lack of external exposure can mitigate this risk
to adapt to new market demands,	2	1	such that business is not lost
causing loss of business			
The inability of the obsolete system			Sufficient size can provide the resources to
to support its business function or	3	1	force continued support and mitigate this risk
mission			
The rising cost of maintaining and			Cost is not as important as functionality, and
operating the obsolete system	4	1	typically is not enough on its own to warrant
			change.
The declining knowledge base of			a) People are trainable
persons who can repair or maintain	12	3	b) Systems rarely last beyond the people who
the obsolete system	12	5	maintain them
			c) Resources can overcome this issue

Responses indicated the most prevalent elements were (a) analyzing the face value of the responses, (b) the theme that resources can solve most issues, and (c) most of the identified obsolescence issues could be overcome before becoming critical. An interesting observation related to the transient state of systems compared to people indicated the perception that systems change much more frequently than personnel do. The sample conglomerate generally has a very low turnover rate. It would be interesting to see if this trend perception held true in more change-prone IT fields, such as a helpdesk.

### **Question 12: Elements of Obsolescence:**

# "Other Elements Not Mentioned That Should be Considered."

Question 12 solicited process improvement for the survey itself, as well as providing an additional insight gauge to the perspectives of the respondents. Responses included 19 that found nothing new to add, 10 that suggested Cost elements that were presented in the next section of the survey, 13 that suggested Technical elements that are presented later in the survey, and 1 that presented an element of Organizational Support found later in the survey. Two respondents cited material that was in the list of presented elements of obsolescence but slightly reworded. Five responses indicated a new element that was considered under Chapter 5 analysis: Significant shifts in technology, market place, or business philosophy that require change or obsolete a previous systems function or usefulness.

### **Question 13: Elements of Cost**

Question 13 followed the same format as Question 8 to obtain presentation equanimity amongst the elements. Question 13 presented twelve elements of cost related to the replacement decision to the respondents, asking, "Is this element of cost (listed below on the left) important to your decision to replace an obsolete system?" The question form was consistent between survey elements with only the elemental macro and its functional elements changing. The survey presented this question with a seven-part Likert scale response for agreement and disagreement. Table 15 presents the specific wording of each element. Respondents indicated that all eight elements would influence their decision-making. The elements of cost found a majority of agreement as important to decision making EXCEPT for the question of *sunk cost* and *the loss of jobs and skills from the transition*. It seemed that these are no longer primary concerns in the business environment, but expectations. Data indicated e) *The cost to switch from the legacy system to the replacement system* as the most strongly responded to, but with k) *The legacy* 

system is no longer sustainable or too expensive to maintain showing the greatest agreement influence. Sunk cost was found to corroborate the Furneaux and Wade (2011) findings that it is no longer an active concern. Also, the lettering indicator labels contained a duplicate letter "c," which would need to be corrected in reuse of the instrument.

In comparison, with OI, the *Cost* factor was of much higher interest to the reviewers. From the correlation matrix, *Cost* identified only 2 intersections with high correlation, such as above .65, but 44 intersections identifying as significant correlations between elements. The low indices of correlations was indicative that only a few of the questions were very close in form and should be considered for consolidation or adjustment for clarity, and that the response rate was not likely to occur by chance, but was significant to the research questions and providing a high level of reliability.

The ANOVA of *Cost* paired with its effect on BI, identified a .071 significance, with Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions presented a .038. The ANOVA was closer to a significant effect than OI, but the robust tests were indeed significant. *Cost* bears the strongest likelihood of maintaining significance of influence in a replication studies.

Table 15. Question 13: Elements of Cost

Is the element of cost (listed below on the left) im	portant to yo	our decision	to replace ar	obsolete	IT system?				
Answer Options	Strongly	Disagree	Somewhat	Neutral	Somewhat	Agree	Strongly	Agreement	Strength
	Disagree		Disagree		Agree		Agree		
a) Financial costs (e.g. Net Present Value (NPV),	0	1	2	3	12	20	12	44	32
Discounted Cash Flow (DCF), or Return on									
Investment (ROI)) of the replacement system									
b) The cost to acquire the replacement system	0	2	2	1	13	21	11	45	32
c) Business Intangibles (e.g. increased	0	4	1	6	13	20	6	39	26
organizational transparency, increased accuracy									
and accessibility to data, and increased									
interoperability with suppliers and vendors									
acquired by the replacement system)									
d) The investment the organization already has in	4	8	9	11	10	6	2	18	8
the legacy system (Sunk Cost)									
e) Transitioning to the replacement system will	5	13	9	11	6	5	1	12	6
cost jobs and may make some of my skills									
obsolete									
f) The cost to switch from the legacy system to	0	2	3	1	17	11	16	44	27
the replacement system									
g) The amount of time it will take to switch from	3	1	4	8	12	16	6	34	22
the legacy system to the replacement system									
h) The concern that the replacement system will	3	1	4	8	12	16	6	34	22
not yield its proposed results									
i) The impact the replacement system will have	2	3	0	10	12	18	5	35	23
on my department and my department's budget									
j) The cost to own and operate the replacement	0	3	2	3	13	22	7	42	29
system over its productive lifecycle (including									
parts, maintenance and software lifecycles)									
k) The availability of qualified people to work on	1	3	3	10	10	19	4	33	23
the replacement system									
I) The legacy system is no longer sustainable or	0	1	2	1	10	23	13	46	36
too expensive to maintain									

## **Question14: Elements of Cost: Terms or Meaning Clarity**

Question 14 was presented for enhancing the value of this initial study. Asking respondents, "Are any of these terms or the meaning of the question unclear? Please explain." Question 14 sought to verify the clarity and familiarity of respondents with the terms used and identify any potential shortcomings to face and content validity. Question 14 elicited 47 responses indicating no difficulty understanding the terms. Two comments about clarification of element c) and the difference between some questions (indicating perhaps too much similarity) and one outlier related to role limitation. Address of the clarifications is included in the recommendations in Chapter 5.

### **Question 15: Elements of Cost: Ranking of Importance**

Question 15 requested respondents to rank the order of importance of the presented *Cost* elements. Within Table 16, *Financial costs* (e.g., *Net Present Value* (NPV), *Discounted Cash Flow* (DCF), or Return on Investment (ROI)) of the replacement system was clearly identified as the greatest influencer by respondents (Number and composite); while *Transitioning to the* replacement system will cost jobs and may make some of my skills obsolete showed least importance. As with elements of OI, this ranking question demonstrated a difference in value perspective from Question 13.

Unlike OI, the correlation matrix of the question 13 importance listing and the question 15 ranking showed little significant correlation, even missing some of the intersections between elements and their ranking. The low correlation significance may have been an effect of the larger number of selections; however, it was also indicative of less agreement between the respondents regarding what was important to their decision making, indicating that the specific elements of *Cost* were more individually unique that those of OI.

Table 16. Question 15: Elements of Cost: Ranking of Importance

Please rank order each response: Place a 1 for the element most Then select 2 for the next most important, which will move to t	-			-					move	to the	e top	of the	list.
Answer Options	1	2	3	4	5	6	7	8	9	10	11	12	Rating Average
a) Financial costs (e.g. Net Present Value (NPV), Discounted													
Cash Flow (DCF), or Return on Investment (ROI)) of the replacement system	16	7	6	9	2	3	1	2	1	1	1	1	3.54
b) The cost to acquire the replacement system c) Business Intangibles (e.g. increased organizational	5	9	14	6	11	1	1	0	3	0	0	0	3.68
transparency, increased accuracy and accessibility to data, and increased interoperability with suppliers and vendors acquired by the replacement system)	6	3	8	5	5	5	4	3	2	2	6	1	5.5.8
d) The investment the organization already has in the legacy system (Sunk Cost)	1	0	0	6	3	2	4	4	6	4	7	13	8.78
e) Transitioning to the replacement system will cost jobs and may make some of my skills obsolete	0	1	0	2	1	1	2	2	4	3	17	17	10.16
f) The cost to switch from the legacy system to the replacement system	7	3	4	2	10	11	3	7	1	0	1	1	5.16
g) The amount of time it will take to switch from the legacy system to the replacement system	0	5	2	3	5	9	9	9	4	3	1	0	6.38
h) The concern that the replacement system will not yield its proposed results	3	3	1	2	4	4	7	4	8	8	6	0	7.26
i) The impact the replacement system will have on my department and my department's budget	0	0	4	2	5	0	8	4	8	12	2	5	8.14
j) The cost to own and operate the replacement system over its productive lifecycle (including parts, maintenance and software lifecycles)	0	8	6	5	0	4	6	7	4	5	4	1	6.36
k) The availability of qualified people to work on the replacement system	1	3	1	2	3	5	3	7	5	9	2	9	8.10
I) The legacy system is no longer sustainable or too expensive to maintain	11	8	4	6	1	5	2	1	4	3	3	2	4.86

**Question 16: Elements of Cost:**"Why Did You Select the Element Rated Highest (#1)?"

Question 16 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their top category of Question 15. From this, a clustering characterization of the types of responses was completed as shown in Table 17.

Key themes of ROI, cost value, cost effective decision making, availability, and performance occurred frequently within the responses. These rationales of motivation supported similarities with the elements of obsolescence seen previously and the desire for benefits presented later in the survey, indicating basic ideological agreement with the literature base from which TOM was constructed.

Table 17. Question 16: Elements of Cost: Why did you select the element rated highest (#1)

Element of Cost	Qty	Clusters	Characterization
a) Financial Costs	16	1	Replacement is a financial decision, with ROI and total cost of ownership being significant in evaluation
b) The cost to acquire the replacement system	5	1	Acquisition cost is the starting point of the replacement decision
c) Business Intangibles	6	2	a) Aids in compliance such as SOX
			b) Important to the acquisition of new business
d) Sunk Cost	1	1	If the business has spent a lot based on IT's recommendation to start with asking them to replace the existing one with another one - will result in lack of trust
e) Transitioning will cost jobs and make my skills obsolete	0	0	
f) Switching Cost	7	1	Switching costs must include systems downtime and unavailability within the transition process, which is likely high
g) Switching Time	0	0	
h) Replacement system will not yield its proposed results	3	1	With performance as a critical functions, disappointing results can lead to failed conversion efforts
i) Department Budget impact	0	0	
j) Lifecycle cost	0	0	
k) Availability of qualified people for the replacement system	1	1	People and people's time are important
I) The legacy system is no longer sustainable or too expensive to maintain	11	2	a) Must be pursued when software replacement or repair are no longer viable, as unavailability costs are not acceptable
			<ul> <li>b) Replacement consideration must be exercised when it becomes cost effective to do so.</li> </ul>

# Question 17: Elements of Cost: "Why Did You Select the Element Rated Lowest (#12)?"

Question 17, likewise, presented the respondent with a qualitative element, which was also presented as an open text box so the respondent may explain the rationale for the value decision. The responses for this question were aligned with the raw response for their least category of Question 15. From this, a clustering characterization of the types of responses was completed and presented in Table 18.

Three clusters clearly made themselves visible, related to sunk cost, jobs/skills obsolescence, and availability of personnel, which accounted for 39 of the 50 selections as the lowest importance items. The lack of significant impact of sunk cost perception corroborates the Furneaux and Wade (2011) findings. The response for job loss or skills obsolescence demonstrated how the business orientation of *Cost* perception overrode the personalized effects of Joshi's Equity Implementation (1989, 1991). Also, the low impact perception of personnel availability was consistent with the responses of Question 11 related to impacts on personnel availability.

Table 18. Question 17: Elements of Cost: Why did you select the element rated lowest (#12)

Element of Cost	Qty	Clusters	Characterization
a) Financial Costs	1	1	Decisions rarely made based on data of NPV or DCF. ROI is more often considered and evaluated.
b) The cost to acquire the replacement system	0	0	
c) Business Intangibles	1	1	I do not buy the term "business intangibles". If something cannot be described in terms of its business value, it is irrelevant to the discussion.
d) Sunk Cost	13	1	Sunk Costs are either paid off or are not part of the business case
e) Transitioning will cost jobs and make my skills obsolete	17	4	a) It is the individuals responsibility to keep their skills current
			b) It is an expected part of business
			c) Frees resources for other pursuits
			d) Not realized or relevant to the specific change
f) Switching Cost	1	1	It is history. Only current benefits and costs are relevant.
g) Switching Time	0	0	
h) Replacement system will not yield its proposed results	0	0	
i) Department Budget impact	5	1	Disruption would already be realized, and budget does not get impacted in that manner.
j) Lifecycle cost	1	1	It just ended up there based upon the ranking - I still think it is very important.
k) Availability of qualified people for the replacement system	9	2	a) Qualified people are always available internally or externally
			b) Training and documentation can overcome deficiencies
I) The legacy system is no longer sustainable or too expensive to maintain	2	1	Decision always made before this became an issue

# **Question 18: Elements of Cost:**"Other Elements Not Mentioned That Should be Considered."

Question 18 solicited process improvement for the survey itself, as well as providing an additional insight gauge to the perspectives of the respondents. Of the 50 responses, 32 identified no additional input suggestions. The remaining 18 identified either elements covered elsewhere in the survey or the following for consideration: (a) The cost of failure to improve, (b) Alternative solution, or (c) Facilities costs. These are taken into consideration in the recommendations presented in Chapter 5.

### **Question 19: Benefits**

Question 19 followed the same format as Question 8 to obtain presentation equanimity amongst the elements. Question 19 presented nine potential benefits related to the replacement decision to the respondents, asking, "Is this benefit (listed below on the left) important to your decision to replace an obsolete system?" The question form was consistent between survey elements with only the elemental macro and its functional elements changing. The survey presented this question with a seven-part Likert scale response for agreement and disagreement. Table 19 presents the specific wording of each element.

Table 19. Question 19: Benefits elements

Answer Options	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Agreement	Strength
a) Improvements in interoperability with vendors, suppliers and customers offered by the replacement system	0	5	1	2	12	25	5	42	30
b) The ability to pursue new business by replacing the obsolete system	0	5	3	7	7	14	14	35	28
c) Improvements in competitiveness by replacing the obsolete system	0	3	1	9	4	17	16	37	33
d) Decreasing maintenance costs by replacing the obsolete system	0	1	1	3	18	20	7	45	27
e) The increased availability of skilled workers for the replacement system	0	3	4	12	15	15	1	31	16
f) Increased competitive advantage from replacing the obsolete system	0	4	0	8	6	15	17	38	32
g) Increased market share from replacing the obsolete system	0	5	3	9	5	16	11	32	27
h) Increased customer satisfaction from replacing the obsolete system	0	2	0	4	9	26	9	44	35
) Increased effectiveness of other systems and business processes from replacing the obsolete system	0	0	0	4	7	25	14	46	39

Question 19 found *Benefit* f) *Increased competitive advantage from replacing the obsolete system* had the highest instance of strong agreement. However, the *Benefit* with the highest overall level of agreement and strength of response with no disagreement was i) *Increased effectiveness of other systems and business processes from replacing the obsolete system.* While *Benefits* b) and g) elicited a slightly greater number of disagreements, *Benefit* e) *The increased availability of skilled workers for the replacement system* produced the weakest response, which appeared consistent with responses from the obsolescence and cost elements already examined.

Benefits was also of high interest to the reviewers. From the correlation matrix, Benefits identified 6 intersections with high correlation, such as above .65, but 20 intersections identified as significant correlations between elements. The high indices of correlation was indicative that some of the questions were very close in form and should be considered for consolidation or adjustment for clarity, and that the response rate was not likely to occur by chance but to be significant to the research questions and providing a high level of reliability. Also, these 6 similar benefit intersections with high correlation were all focused upon direct aspects of business pursuit, which may explain their close relationship.

The ANOVA of *Benefits* paired with its effect on BI, identified a .67 significance with Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions presenting a .473. Benefits, while important to the respondents, did not present a significant influence on the replacement decision.

# **Question 20: Benefits: Terms or Meaning Clarity**

Question 20 was presented to assess the clarity and familiarity of respondents with the terms used elicited 45 no issue responses, four comments identified too much similarity between

elements f) and c), and one outlier related to role limitation. The language employed for elements f) and c) were addressed in the recommendations section of Chapter 5.

# **Question 21: Benefits: Ranking of Importance**

Question 21 requested respondents to rank the order of importance of the presented *Benefits*. As depicted in Table 20, *Decreasing maintenance costs by replacing the obsolete system* acquired the highest rate of Number 1 ratings, but the *Benefit* with the most overall influence identified by the respondents composite was *Improvements in competitiveness by replacing the obsolete system*. *The increased availability of skilled workers for the replacement system* showed least importance. The ranking question demonstrated a difference in value perspective from Question 19 for the elements of high importance but concurrence with what was least important. Also of note was the broad spread of Number 1 important elements across nearly all benefits.

Similar to OI and unlike cost, the correlation matrix of the Question 19 importance listing and the Question 21 ranking showed over 50% of intersections produced significant correlation, even despite missing 2 of the intersections between elements and their ranking. While these presented different forms of assessment, direct versus ranked, this high level of consistency between responses to both question forms indicated strong agreement amongst the respondents to the questions.

Table 20. Question 21: Benefits: Ranking of Importance

Please rank order each response: Place a 1 for the element most important to the replacement decision. It will then move to the top of the list. Then select 2 for the next most important, which will move to that position. Continue to 9 for the least important.

important.										
Answer Options	1	2	3	4	5	6	7	8	9	Rating
										Average
a) Improvements in interoperability with vendors, suppliers and customers offered by the replacement system	5	4	7	6	6	7	5	6	4	4.98
b) The ability to pursue new business by replacing the obsolete system	6	4	3	13	8	4	3	6	3	4.70
c) Improvements in competitiveness by replacing the obsolete system	6	12	8	3	5	6	6	2	2	4.06
d) Decreasing maintenance costs by replacing the obsolete system	9	2	4	4	11	5	3	9	3	4.92
e) The increased availability of skilled workers for the replacement system	0	4	2	4	1	8	4	6	21	6.96
f) Increased competitive advantage from replacing the obsolete system	5	14	4	5	1	5	9	7	0	4.38
g) Increased market share from replacing the obsolete system	5	1	5	6	4	6	8	5	10	5.76
h) Increased customer satisfaction from replacing the obsolete system	6	4	9	5	14	3	2	5	2	4.42
i) Increased effectiveness of other systems and business processes from replacing the obsolete system	8	5	8	4	0	6	10	4	5	4.82

# Question 22: Benefits: "Why Did You Select the Element Rated Highest (#1)?"

Question 22 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondents rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their top category of Question 21. From this, Table 21 presents a clustering characterization of the types of responses.

Responses were spread broadly across nearly all elements. Business and technical functions driving decision making emerged as common themes among responses in Table 21. These were consistent with response themes emerging from OI and Cost explanations of respondent rationales.

Table 21. Question 22: Benefits: Why did you select the element rated highest (#1)

Benefits	Qty	Response Clusters	Characterization
a) Improvements in interoperability with vendors, suppliers and customers offered by the replacement system	5	1	Current solutions did not support interoperability, which is perceived to support overall ease of use, efficiency and quality
b) The ability to pursue new business by replacing the obsolete system	6	1	New business is the cornerstone of growth and sustainment of the business
c) Improvements in competitiveness by replacing the obsolete system	6	2	a) Improvements to effectiveness and efficiency improved competitiveness
			b) Improved competitiveness improves revenue
d) Decreasing maintenance costs by replacing the	9	2	a) Cost is king
osolete system		b) Sustainment costs increase on legacy systems, and start lower on newer systems: identifying the sweet spot is the optimization focus	
e) The increased availability of skilled workers for the replacement system	0	0	
f) Increased competitive advantage from replacing the obsolete system	5	1	The need to remain efficient, competitive and relevant compared to competitors is paramount
g) Increased market share from replacing the obsolete system	5	1	Market share increases provide increases in revenue, job stability and are a significant point of business leverage
h) Increased customer satisfaction from replacing the obsolete system	6	1	Customer satisfaction is a key performance metric of IT, identifying likelihood of business sustainment
i) Increased effectiveness of other systems and business processes from replacing the obsolete system	8	1	Overall synergies act as a force multiplier to effectiveness/efficiency to achieve greater overall business benefit

### Question 23: Benefits: "Why Did You Select the Element Rated Lowest (#9)?"

Question 23 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their least category of Question 21. From this, Table 22 presented a clustering characterization of the types of responses.

Unlike the highest ranked questions, which were broadly spread over many elements, the lowest ranked elements, highly centralized on 2 elements accounting for 31 of the responses: e) *The increased availability of skilled workers for the replacement system* and g) *Increased market share from replacing the obsolete system*. However, review of the responses demonstrated a much more complex landscape of rationales from respondents, covering technical, business, and organizational aspects of benefits. These supported the other factors of the TOM model but demonstrated that, even in agreement about what was least important, why that was true could remain disparate. Reasons for this variation in rationales could be based upon the function of the system being replaced, the data capture of which erred in this collection effort.

Table 22. Question 23: Benefits: Why did you select the element rated lowest (#9)

Benefits	Qty	Clusters	Characterization
a) Improvements in interoperability with vendors, suppliers and customers offered by the replacement system	4	1	It is difficult to quantify the revenue benefit of increased interoperability
b) The ability to pursue new business by replacing the obsolete system	3	1	Changes did not affect new business pursuits
c) Improvements in competitiveness by replacing the obsolete system	2	1	Competitiveness is not an end in itself, but is a result of working the key areas.
d) Decreasing maintenance costs by replacing the obsolete system	3	1	Maintenance cost is important but it is a result of a properly designed architecture that leverages new technologies and improved interoperability
e) The increased availability of skilled workers for the replacement system	21	5	<ul> <li>a) Skilled labor can be acquired or trained</li> <li>b) Simply does not impact decision</li> <li>c) short lifecycles render this irrelevant</li> <li>d) Least among many choices</li> <li>e) Mandated use of COTS reduced impact</li> </ul>
f) Increased competitive advantage from replacing the obsolete system	0	0	
g) Increased market share from replacing the obsolete system	10	2	<ul><li>a) Change was internal, non customer facing or did not affect market share</li><li>b) Market share change may only be an incidental by product without causal relationship</li></ul>
h) Increased customer satisfaction from replacing the obsolete system	2	1	While customer satisfaction is important, it is not a key decision factor in systems replacement, due to its generic nature
i) Increased effectiveness of other systems and business processes from replacing the obsolete system	5	1	This can happen as a result of a portfolio review that finds a single system that is holding back growth in other important systems. But a given system is rarely updated solely because of its impact to other systems. Those types of issues tend to result from architecture assessments rather than from business driven improvements

## Question 24: Benefits: "Other Elements Not Mentioned That Should be Considered."

Question 24 solicited process improvement for the survey itself, as well as providing an additional insight gauge to the perspectives of the respondents. Of the 50 responses, 37 identified no additional input suggestions. The remaining 13 identified either elements covered elsewhere in the survey or the following for consideration: a) Retiring obsolescence risk or b) Breadth of change was so significant as to impact many systems and processes. Employing Risk as a business *Benefit* rather than *Cost* was a managerial technique a bit outside the scope of the study focus; however, breadth of impact was a *Benefit* that should be seriously considered, as it was the potential counterpart to ROI in *Costs*. Accurate data collection of the type of system the respondents are referencing in their responses, the data capture of which erred in this collection effort (question 6), may provide significant insight into this breadth of impact recommendation.

# **Question 25: Elements of Organizational Support**

The next factor under examination with Questions 25 through 30 was one of the most varied for respondents. Question 25 followed the same format as Question 8 to obtain presentation equanimity amongst the elements. Question 25 presented 12 elements of Organizational Support (OS) related to the replacement decision to the respondents, asking, "Is the element of organizational support (listed below on the left) important to your decision to replace an obsolete system?" The question form was consistent between survey elements with only the elemental macro and its functional elements changing. The survey presented this question with a seven-part Likert scale response for agreement and disagreement. Table 23 presents the specific wording of each element.

Table 23. Question 25: Elements of Organizational Support

		ow on the left) important to your decision to replace an obsolete IT system?									
Answer Options	Strongly	Disagree	Somewhat	Neutral		Agree	Strongly	Agreement	Strength		
a) My concern that the replacement system will	Disagree 5	14	Disagree 9	16	Agree 4	2	Agree 0	6	2		
replace some people's jobs	3	14	9	10	4	2	U	U	2		
b) My concern that the replacement system will	9	13	10	11	3	3	1	7	4		
change our department's political orientation in	5	15	10		3	3	_	,	•		
the organization											
c) My anticipation that the replacement system	0	1	3	2	10	27	7	44	34		
will improve the manner in which we interact	J	-	3	_	10	_,	,	77	34		
with suppliers and customers											
d) My concern about the reputation of the	4	8	5	9	9	13	2	24	25		
replacement system	·	· ·	J	•	J		_				
e) My concern about the implementation success	3	4	1	12	11	14	5	30	19		
record of the replacement systems											
implementation team/vendor											
f) My concern that I will regret the replacement	5	20	6	12	5	1	1	7	2		
decision											
g) My concern that, if the replacement	4	12	4	14	8	7	1	16	8		
implementation does not go well, I will be											
blamed											
h) My concern that, if the replacement	2	11	9	15	9	4	0	13	4		
implementation does not go well, my											
department's future budgets will be cut											
i) The ability of the replacement system to	0	1	0	2	9	21	17	47	38		
support our business strategy											
j) The ability of the replacement system to	0	0	1	3	8	29	9	46	38		
support and help the organization expand core											
competencies											
k) My concern that acquiring the replacement	6	12	8	16	6	2	0	8	2		
system will cost me or my department political											
capital											
I) My concern that replacing the legacy system	6	15	8	13	3	4	1	8	5		
will cost me or my department political capital											

The Question 25 responses presented in Table 23 identified the element with the highest agreement and strongest agreement as i) *The ability of the replacement system to support our business strategy.* The least important element was between: a) *My concern that the replacement system will replace some people's jobs* and f) *My concern that I will regret the replacement decision.* Of interest in the responses to OS elements was the polarizing response. With only responses d) and g) acquiring broadly dispersed responses, the other were fairly heavily weighted to either strong agreement or strong disagreement as to influence over a replacement decision.

OS presented a very peculiar set of responses. From the correlation matrix, OS identifies 10 intersections with high correlation, such as above .65, but 40 intersections identifying as significant correlations between elements. The high indices of correlation was indicative that several of the questions were very close in form and should be considered for consolidation or adjustment for clarity, and that the response rate was not likely to occur by chance but to be significant to the research questions and provided a high level of reliability. Respondents and reviewers identified elements of OS as the most challenging to apply consistently to their individual situations.

The ANOVA of OS paired with its effect on BI identified a .121 significance, with Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions presenting a .175. OS was of moderate interest to the respondents, but did not present a significant influence on the replacement decision.

### Question 26: Elements of Organizational Support: Terms or Meaning Clarity

Question 26, related to clarity and familiarity with the terms used, elicited 45 no issue responses. There was a single comment that indicated too much similarity between *Benefits* and

Organizational Support. There were two comments identifying unfamiliarity with the term political capital and two comments indicating the questions were too vague, repetitive, or unclear. Modifications to the survey instrument to address these comments was addressed in the recommendation section of Chapter 5.

#### **Question 27: Elements of Organizational Support: Ranking of Importance**

Question 27 requested respondents to rank the order of importance of the presented elements of OS. As depicted in Table 24, *The ability of the replacement system to support our business strategy* acquired the highest rate of number 1 ratings and the most overall influence identified by the respondents composite. Whereas, *My concern that replacing the legacy system will cost me or my department political capital* showed least importance. The ranking question demonstrated agreement with Question 25 related to what was of greatest importance but varied in what was least important, nearly opposite results from Question 21.

Checking the correlation matrix of the Question 25 responses against the ranked responses in Question 27 identified little agreement. Of the 12 intersections, 5 were not even correlated enough for significance. Of the remaining 132 intersections, only 11 identified as significant, but none of these rose above .4 strength of Pearson's correlation. The low indices of correlation indicated little agreement between respondents answering of the two sets of questions and the questions immediate salience to the study.

Table 24. Question 27: Elements of Organizational Support: Ranking of Importance

Please rank order each response: Place a 1 for the element most Then select 2 for the next most important, which will move to the				•					move	to the	e top (	of the	list.
Answer Options	1	2	3	4	5	6	7	8	9	10	11	12	Rating Average
a) My concern that the replacement system will replace some people's jobs	1	0	2	5	4	8	4	4	4	4	5	9	7.88
b) My concern that the replacement system will change our department's political orientation in the organization	0	3	3	4	8	5	5	6	6	5	2	3	6.92
c) My anticipation that the replacement system will improve the manner in which we interact with suppliers and customers	11	11	12	6	6	0	1	1	0	0	0	2	3.24
d) My concern about the reputation of the replacement system	0	3	6	11	7	9	8	2	2	2	0	0	5.34
e) My concern about the implementation success record of the replacement systems implementation team/vendor	1	5	4	15	7	7	7	2	1	0	0	1	4.92
f) My concern that I will regret the replacement decision	0	0	0	2	6	7	6	11	2	3	5	8	8.18
g) My concern that, if the replacement implementation does not go well, I will be blamed	2	0	0	1	3	3	7	8	10	1	7	8	8.5
h) My concern that, if the replacement implementation does not go well, my department's future budgets will be cut	0	0	1	1	3	8	5	10	11	10	1	0	7.90
i) The ability of the replacement system to support our business strategy	27	9	8	2	0	0	0	0	1	3	0	0	2.32
j) The ability of the replacement system to support and help the organization expand core competencies	6	16	13	2	4	1	2	0	2	3	1	0	3.68
k) My concern that acquiring the replacement system will cost me or my department political capital	1	1	0	1	1	1	4	5	8	12	15	1	9.10
I) My concern that replacing the legacy system will cost me or my department political capital	1	2	1	0	1	1	1	1	3	7	14	18	10.02

# **Question 28: Elements of Organizational Support:**"Why Did You Select the Element Rated Highest (#1)?"

Question 28 presented the respondent with a qualitative element. Presented as an open text box, the respondent may explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their top category of Question 27. From this, Table 24 presented a clustering characterization of the types of responses.

Here one saw radical clustering on 2 elements within Table 25: *My anticipation that the replacement system will improve the manner in which we interact with suppliers and customers* and *The ability of the replacement system to support our business strategy*, which accounted for 38 of the 50 responses. Rationale responses again identified strong business-centric purposes of technology as the core themes that influenced their ranking of important elements that would influence their decision-making.

Table 25. Question 28: Elements of Organizational Support: Why did you select the element rated highest (#1)

Element of Organizational Support	Qty	Clusters	Characterization
Replaces some people's jobs	1	1	No Comment
Change department's political orientation	0	0	
Improve the manner in which we interact with suppliers and customers	11	4	<ul> <li>a) Must strive for continuous improvement.</li> <li>b) Relationships with both suppliers and customers impacts our survivability. This is an overall assessment of quality, cost and schedule achievements.</li> <li>c) Improvement and customer satisfaction are top goals</li> <li>d) Improved efficiency is essential</li> </ul>
Reputation of the replacement system	0	0	
Success record of the replacement systems implementation team/vendor	1	1	Ensure avoidance of "vapor ware". Ensure the work is completed by experienced, competent employees or a vendor with a proven track record
I will regret the replacement decision	0	0	
Failure = I will be blamed	2	1	Subject Matter Experts are often held accountable for any failure, regardless of extenuating circumstance
Failure = my department's budgets cut	0	0	
The ability of the replacement system to support our business strategy	27	4	<ul> <li>a) This element supports the long-term viability of the organization's strategy;</li> <li>Replacement system must be in lock step with this strategy. It is our top priority in our current discussions. Not a cost well spent if it does not support our business strategy.</li> <li>b) Technology must support the Business needswithout business needs you have no need for technology</li> <li>c) This element is most likely to affect the bottom line</li> <li>d) Must have modern functionality to move forward</li> </ul>
The ability of the replacement system to support and help the organization expand core competencies	6	2	<ul><li>a) Core competencies must be a central focus for any success</li><li>b) 60% of my teams skill base primarily consists of technologies dating back to the 90's, which must be updated</li></ul>
Acquisition =cost me or department political capital	1	1	In my experience, mid-level organizational decision-makers tend to favor political drivers over facts and data. Perception that this is learned behavior - facts and data have failed them in the past, or they were inadequately presented.
Replacing =cost me or department political capital	1	1	Concern that the replacement decision will have political consequences

# Question 29: Elements of Organizational Support: "Why Did You Select the Element Rated Lowest (#9)?"

Question 29 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their least category of Question 21. From this, Table 26 presents a clustering characterization of the types of responses.

Lowest rating did not have as focused agreement; however, *My concern that replacing the legacy system will cost me or my department political capital* did stand out, with 18 of the 50 responses. Response themes indicated that personal impact and localized effects were not influential to the decision and are part of the business landscape, which matched with the business-centric focus of the rationales for the highest-ranking elements and indicates that, within this form of organization, these functions lost importance or were obviated by the decision process or methods. This may not hold true for smaller, more individually interactive organizations.

Table 26. Question 29: Elements of Organizational Support: Why did you select the element rated lowest (#9)

Element of Organizational Support	Qty	Clusters	Characterization
Replaces some people's jobs	9	4	a) There is always some sort of collateral damage when systems get replaced. The benefits outweigh the emotional factor b) Interpersonal human concerns of this nature do not drive business decisions c) Job replacement is typically part of the reduced cost benefit of the decision d) The new jobs will be available and employee's technical skills can be extended and enhanced. It is a good thing for the organization in long run.
Change department's political orientation	3	1	This should never be part of a replacement decision
Improve the manner in which we interact with suppliers and customers	2	1	These decisions are typically made independent of suppliers
Reputation of the replacement system	0		
Success record of the replacement systems implementation team/vendor	1	1	The vendor has, to date, always has provided good upgrade support as well as day-to-day support. I have never had a reason to worry about their success record
I will regret the replacement decision	8	1	So long as due diligence was exercised, there is nothing to regret.
Failure = I will be blamed	8	2	<ul><li>a) This is a personal concern not related to business decisions</li><li>b) Decision of this nature are typically involve a group of decision makers, where no personal blame is applicable</li></ul>
Failure = my department's budgets cut	0		
The ability of the replacement system to support our business strategy	0		
The ability of the replacement system to support and help the organization expand core competencies	0		
Acquisition =cost me or department political capital	1	1	The political capital was with the business process reengineering, not the legacy system
Replacing =cost me or department political capital	18	2	<ul><li>a) This does not affect the business decision to replace</li><li>b) This simply is not a concern</li></ul>

# **Question 30: Elements of Organizational Support:**"Other Elements Not Mentioned That Should be Considered."

Question 30 solicited process improvement for the survey itself and provided an additional insight gauge to the perspectives of the respondents. Of the 50 responses, 41 identified no additional input suggestions. The remaining 9 identified either elements covered elsewhere in the survey or the following for consideration: a) Commonality with other organizations/divisions in the company, b) The make or buy decision, c) The use of product roadmaps, or d) The importance of executive support.

One comment observed, "This is a hard section because the selections are based on people and personal issues they are having or have had with management and others. Each system evaluated would prioritize results differently based on the players." While this may be an accurate observation at the individual response perspective of simply comparing individual responses, assessment of the TOM model was not harmed by these variations but, in fact, was facilitated by the diversity of responses.

#### **Ouestion 31: Technical Elements**

The final factor under examination with questions 31 through 36 was focused upon *Technical* elements of a replacement decision. Question 31 followed the same format as Question 8 to obtain presentation equanimity amongst the elements. Question 31 presented 8 *Technical* elements related to the replacement decision to the respondents. The question form was consistent between survey elements, with only the elemental macro and its functional elements changing. The survey presented this question with a seven-part Likert scale response for agreement and disagreement. Table 27 presents the specific wording of each element.

Table 27. Question 31: Technical Elements

Is the technical element (listed below on the left)	important to	your decis	ion to replace	an obsole	te IT system?				
Answer Options	Strongly	Disagree	Somewhat	Neutral	Somewhat	Agree	Strongly	Agreement	Strength
	Disagree		Disagree		Agree		Agree		
a) Increases in usefulness from the replacement system	0	0	3	3	5	22	17	44	39
b) Ease of using the replacement system	0	0	0	1	8	32	9	49	41
c) The interoperability of the replacement system with my other IT systems and networks	0	2	1	3	7	22	15	44	37
d) The interoperability of the replacement system with my suppliers and customers systems and networks	0	2	2	2	6	27	11	44	38
e) The scalability of the replacement system	0	1	0	3	7	25	14	46	39
f) The projected product lifetime and manufacturer support projection	0	1	2	4	6	26	11	43	37
g) The Mean Time Between Failure of the significant components	0	4	2	6	12	14	12	38	26
h) The adaptability of the system to new market or regulatory demands	0	1	2	10	9	16	12	37	28

The Question 31 responses identified the greatest numerical response as a) *Increases in usefulness from the replacement system*. However, b) *Ease of using the replacement system* produced the strongest level of agreement. Of least interest to respondents was g) *The Mean Time Between Failure of the significant components*; however, this was still overall a positive response.

*Technical* responses found some of the highest resonance with respondents. From the correlation matrix, *Technical* identified no intersections with high correlation, such as above .65 but 18 intersections (nearly half) identifying as significant correlations between elements. The high indices of correlation was indicative that questions are well understood and unique, and that response was consistent, reliable, and not likely to occur by chance.

The ANOVA of *Technical* paired with its effect on BI identifies a .055 significance with Welch and Brown-Forsythe robust test of the equality of means for asymptomatic distributions presenting a .071. The ANOVA result presented *Technical* as one of the most likely candidates for potential significant influence on the replacement decision in further studies.

### **Question 32: Technical Elements: Terms or Meaning Clarity**

Question 32, related to clarity and familiarity with the terms used, elicited 48 no issue responses. One comment questioned the section description of technical elements influence over replacement decisions, and one requested a definition of usefulness, which was viewed as anomalous, given the deep track record performance of the TAM model from which it was drawn over the last 30 years.

#### **Question 33: Technical Elements: Ranking of Importance**

Question 33 requested respondents to rank the order of importance of the presented technical elements. As depicted in Table 28, a) *Increases in usefulness from the replacement* 

system acquired the highest rate of number 1 ratings and the overall influence identified by the respondents composite. Whereas, g) *The Mean Time Between Failure of the significant components* showed least importance. The question 33 responses remained consistent with the responses of Question 31. It was of little surprise that the TAM feature of usefulness emerged as the highest observed influence given the deep study of this element in IT acceptance and change resistance literature.

Examination of the correlation matrix of the Question 31 responses against the ranked responses in Question 33 identified little agreement. 7 of the 8 intersections were significantly correlated. Of the remaining 56 intersections, only 3 identified as significant, but none of these rose above .32 strength of Pearson's correlation. The correlation result demonstrated that the questions have high independent salience that was easily distinguishable by the respondents.

# Question 34: Technical Elements: "Why Did You Select the Element Rated Highest (#1)?"

Question 34 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker.

The responses for this question were aligned with the raw response for their top category of Question 33. From this, Table 29 presents a clustering characterization of the types of responses.

There was a high clustering of TAM results (elements A & B) consistent with the TAM literature, but also showing a more pronounced link with business function than was anticipated. In fact, the explanations of most respondents in the technical arena tied back to business function and the need of technical elements to support those needs. The strong link between business need and technical function perceptions the respondent's identified should be investigated further in replication and longitudinal study.

Table 28. Question 33: Technical Elements: Ranking of Importance

Please rank order each response: Place a 1 for the element most important to the replacement decision. It will then move to the top of the list. Then select 2 for the next most important, which will move to that position. Continue to 8 for the least important. **Answer Options** Rating Average a) Increases in usefulness from the replacement system 2.94 b) Ease of using the replacement system 3.66 c) The interoperability of the replacement system with my other IT 3.94 systems and networks d) The interoperability of the replacement system with my suppliers and 4.64 customers systems and networks e) The scalability of the replacement system 4.34 f) The projected product lifetime and manufacturer support projection 5.58 g) The Mean Time Between Failure of the significant components 5.82 h) The adaptability of the system to new market or regulatory demands 5.08

Table 29. Question 34: Technical Elements: Why did you select the element rated highest (#1)

Technical Elements	Qty	Clusters	Characterization
Increases in usefulness from the replacement system	16	3	<ul><li>a) Usefulness is why we have systems; increasing usefulness is how we achieve business objectives.</li><li>b) Increased usefulness provides the business case for the upgrade. It empowers the ability to pursue greater endeavors</li><li>c) Visibility of usefulness improvements reduces resistance</li></ul>
Ease of using the replacement system	5	2	<ul><li>a) Ease of use is critical to customers and business partners</li><li>b) Ease of use increases acceptance and reduces resistance to adopt the replacement</li></ul>
The interoperability of the replacement system with my other IT systems and networks	5	1	Systems do not live in isolation but are part of a meta-system of data, processes, and information
The interoperability of the replacement system with my suppliers and customers systems and networks	1	1	Interoperability is a key function, as our 3rd party data follows e-business standards and our data is consumed by multiple interfacing systems.
The scalability of the replacement system	4	1	Rapidly increasing business demands require scalability for the replacement to be of value
The projected product lifetime and manufacturer support projection	5	1	Long lifetime supports larger investments to acquire return
The Mean Time Between Failure of the significant components	5	1	Higher reliability/longer MTBF yields longer uptime, productivity and lower maintenance costs to support the replacement decision
The adaptability of the system to new market or regulatory demands	9	2	<ul><li>a) Regulatory mandates are critical or the business goes under.</li><li>b) Acquiring new and future business is why the system is being replaced</li></ul>

#### Question 35: Technical Elements: "Why Did You Select the Element Rated Lowest (#9)?"

Question 35 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their least category of Question 33. From this, Table 30 presents a clustering characterization of the types of responses.

In contrast to the rationales of what was most important, the rationales of what was least important, showed a lack of the subject matter's applicability to the respondents' perceived situation or to the technical environment at all. The observation was perceived as an interaction of the Question 6 system type variable. It would be very useful to have insight into this variable's effect, and it was highly recommended that this be accurately gathered in replication and longitudinal studies.

#### **Question 36: Technical Elements:**

# "Other Elements Not Mentioned That Should be Considered."

Question 36 solicited process improvement for the survey itself and provided an additional insight gauge to the perspectives of the respondents. Of the 50 responses, 38 identified no additional input suggestions. The remaining 12 identified either elements covered elsewhere in the survey or the following for consideration: a) Architectural Simplicity, b) currency of the replacement technology, c) stability of the vendor or country of origin, d) ease of migration, and e) Depth of supplier's availability. These are addressed in the recommendations section of Chapter 5.

Table 30. Question 35: Technical Elements: Why did you select the element rated lowest (#9)

Technical Element	Qty	Clusters	Characterization
Increases in usefulness from the replacement system	3	2	<ul><li>a) Not important to the individual case</li><li>b) Assumed or there would not be a replacement</li></ul>
Ease of using the replacement system	1	1	No Response
The interoperability of the replacement system with my other IT systems and networks	3	1	Some systems are self-contained
The interoperability of the replacement system with my suppliers and customers systems and networks	3	2	a) Some systems are internal and not externally facing b) I perceive these lower-ranked elements to be closely tied to implementation, and not relevant in the early planning and budgeting phases of a system replacement. Nobody ever asks for a system which does not scale, or which will not allow for interoperability. These technical requirements should be baked into the proposal.
The scalability of the replacement system	1	1	Solution should have capacity planned as part of its basic approach
The projected product lifetime and manufacturer support projection	8	4	<ul> <li>a) Product standards and lifecycles often change within the life-span of an application with little or no long-range guidance</li> <li>b) Not within context of COTS</li> <li>c) Internal product does not have supplier dependency</li> <li>d) support projection is a point in time. There are no guarantees that the vendor supports the product forever and/or vendor stays afloat</li> </ul>
The Mean Time Between Failure of the significant components	16	3	<ul><li>a) Not that much of an issue w/ modern enterprise hardware</li><li>b) N/A to software: we just fix it</li><li>c) Not much of a consideration to replacement decision</li></ul>
The adaptability of the system to new market or regulatory demands	15	3	<ul><li>a) Regulatory issues do not impact infrastructure</li><li>b) Some projects are not aimed at new markets</li><li>c) Not applicable to the case</li></ul>

## **Question 37: Summary: Ranking of Importance**

In culmination of all of the questions introduced so far, Question 37 requested respondents rank the order of importance of the presented TOM factors. As depicted in Table 31, *Benefits* were identified as the most influential element of the replacement decision, while *Organizational Support* was evaluated as the least important.

Table 31. Question 37: Summary: Ranking of Importance

Please rank order each response: Place a 1 for the element most important to the replacement decision. It will then move to the top of the list. Then select 2 for the next most important, which will move to that position. Continue to 8 for the least important.

Answer Options	1	2	3	4	5	Rating Average
a) Obsolescence Elements	8	9	6	10	17	3.38
b) Business Costs	12	14	15	5	4	2.50
c) Benefits	26	12	5	7	0	1.86
d) Organizational Support	3	4	4	16	23	4.04
e) Technical	1	11	20	12	6	3.22

Question 37 provided distinct insight that is different from previous questions. The ANOVAs of the individual element responses for their significance of influence over BI were independent measurements. However, the Question 37 rankings set the factors directly against one another for perceived significance and value by the respondent. The ANOVA of the respondent's ranking did not show a significant impact as a whole to BI; however, assessment of the coefficients, as shown in the regression assessments in Appendix B, Table B5, showed only OI as significant despite its next to last assessment of importance. The showing of significance demonstrated that, while respondents may not perceive it as critical, OI played a substantive role in the replacement decision.

#### Question 38: Summary: Why Did You Select the Element Rated Highest (#1)?

Question 38 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their top category of Question 37. From this, Table 32 presents a clustering characterization of the types of responses.

Table 32. *Question 38: Summary: Why did you select the element rated highest (#1)* 

Summary elements	Qty	Clusters	Characterization
Obsolescence elements	8	2	<ul><li>a) Obsolescence frequently forces the change to enable business to continue</li><li>b) The costs of failing to replace become unsustainable, harming the business</li></ul>
Business Costs	12	2	<ul><li>a) Cost must be justified to make a successful business case for the decision</li><li>b) Cost is king to a business</li></ul>
Benefits	26	3	<ul><li>a) Benefits represent the purpose of the replacement decision</li><li>b) The business case must show benefit and must be aligned to a strategic direction (revenue, compliance, etc.)</li><li>c) Benefits which outweigh costs result in replacement decision</li></ul>
Organizational Support	3	2	a) Organizational support is critical to acquire the replacement b) Business functions and organizational needs are integral, and the business needs must be addressed
Technical aspects	1	1	There was a true need for an improved solution

Once again, there was a very strong tie between respondent's rationale for a specific subject and business, which was consistent amongst all of the rationales and presented a theme that could be pursued independently or as an augmentation to ongoing research on the TOM model. Whether this logic plays through to the non-business environment of a hospital, a school, or other non-business organization, tying the decision to the core organizational purpose was another avenue of investigative interest.

# Question 39: Summary: Why Did You Select the Element Rated Lowest (#5)?

Question 39 presented the respondent with a qualitative element. Presented as an open text box, the respondent could explain the rationale for the value decision. The respondent's rationale spoke to the motivation behind decision making to the values of the decision maker. The responses for this question were aligned with the raw response for their least category of Question 37. From this, Table 33 presents a clustering characterization of the types of responses.

Table 33. *Question 39: Summary: Why did you select the element rated lowest (#5)* 

Summary elements	Qty	Clusters	Characterization
Obsolescence elements	17	6	a) Replacement is an inevitability, overcoming cost/benefit comes first b) Obsolescence lessons have been learned, so this is no longer an issue c) It is a common factor that many obsolete systems will be operated until funding can catch up d) Obsolescence is a driver, but not the core decision factor to a replacement decision e) Some decisions are directed from above f) Technology replacement lifecycles are sufficiently short now that this has been overcome as an issue
Business Costs	4	3	<ul><li>a) Performance mandates and the cost of failure outweigh cost concerns in certain domains</li><li>b) Benefits outweighed cost</li><li>c) Costs were not available to the decision making</li></ul>
Benefits	0	0	
Organizational Support	23	6	<ul> <li>a) All 5 are needed, Org support is just last</li> <li>b) Organizational support can be managed or acquired</li> <li>c) Some systems replacement occurs regardless of Organizational Support</li> <li>d) Sound business decision will acquire organizational support</li> <li>e) Organizational Support was dictated from "the top"</li> <li>f) Acquiring organizational support is within the control of the decision maker(s)</li> </ul>
Technical elements	6	2	<ul><li>a) There are often many technical alternatives that support the business case.</li><li>b) Technical solution differences are usually small, reducing their impact upon decision making</li></ul>

The rationales presented in Table 33 showed a strong picture for why OS and OI were not perceived as important to the respondents. OI was perceived as: (a) inevitable, (b) its problem

solved already, (c) it could be easily addressed, (d) it was an influencing symptom but not a causal factor of replacement decision, and (e) a decision being driven "from above." OS also identified from the top decision direction, but also note the perceptions that IS was controllable by the decision maker and was addressed by sound business practice. These elements selected as weakest were not perceived by the respondents as important as the other elements, as broadly consistent observation among 40 of 50 respondents.

#### **Question 40: Behavioral Intent Indicators**

The evaluations presented in Question 40 were oriented around the predictive effect of behavioral intent established within Ajzen and Fishbien's (1980) Theory of Reasoned Action and codified via the Technology Acceptance Model (TAM) by Davis (1989), Davis, Bagozzi, and Warshaw (1989) with modifications as demonstrated by Venkatesh (2000) in TAM 2 and Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). The question forms were drawn directly from the Venkatesh, Morris, Davis, and Davis (2003) UTAUT survey model. Presented as a seven point Likert scale, the questions employed both positive and negative question forms to clarify respondent behavioral intent perspective. Response was overwhelmingly positive, via both positive and negative question forms, to replace the obsolete system, as depicted in Table 34.

As demonstrated in Table 34, the responses were overwhelmingly in line with a replacement decision effect for both positive and negatively answered questions. Analysis of each factor's assessment effect upon the BI has been discussed and can be seen in the ANOVA and regression tables in Appendix B. Under regression analysis, OI was the only ANOVA to show significance for the assessment of OI ranking against BI, while Technical showed the

closest significance to BI. Thus there were indeed relationships within the TOM model with significant effect upon decisions that an acquisitions manager could find very helpful.

Table 34. Question 40: Behavioral Intent Indicators

Please describe your perception regarding the dec	ision to repl	ace the obs	olete system						
Answer Options	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree	Agreement	Strength
a) Increases in usefulness from the replacement system	12	19	7	6	2	4	0	6	4
b) Ease of using the replacement system	0	1	0	4	6	18	21	45	39
c) The interoperability of the replacement system with my other IT systems and networks	1	1	0	3	7	23	16	45	38
d) The interoperability of the replacement system with my suppliers and customers systems and networks	0	2	1	5	4	22	16	42	38

## Question 41: Summary: "Other Elements Not Mentioned That Should be Considered."

Question 41 solicited process improvement for the survey itself and provided an additional insight gauge to the perspectives of the respondents. While 31 of the 50 respondents identified no additional information to consider, 19 respondents provided additional insight into factors they perceived to influence their replacement decisions. Presented in Table 35, 3 of the responses were about the survey itself, suggesting a way to save responses locally and shortening the survey. Other responses were similar to material already in the survey or identify either leadership, decision-making practices (such as timeliness) or additional technical functions of systems as influence factors on the replacement decision. These were addressed in the recommendations in Chapter 5.

Table 35. *Question 41: Summary: Other elements not mentioned that should be considered.* 

Ref	Qty	Suggestion
Α	2	Find a way to combine elements to shorten the survey
В	1	More attention to long-term costs, savings and cost recovery (payback)
С	1	Delay replacement decision in favor of clearly identifying affected business processes via Value Stream Mapping and Accelerated Improvement Workshops to ensure overall business process improvement
D	1	Ensure timeliness of decisions, procrastination only diminished credibility and creates additional inertia which must be overcome
E	1	Systems obsolescence may impact many aspects of the business driving extensive replacement and updating across the boardthese secondary impacts may be additional material to examine
F	1	Difficulties with capital purchasing and entrenched corporate bureaucracy which inhibits action
G	2	Executive support!!! Without it the Program is dead in the waterand it has to be seen through to completion even if the next management team does not want to do itwasted time, effort and \$\$not to mention employee morale. Also, If I do not believe that management will support even the possibility of the replacement, it is very frustrating to push for a change and to be told to just go away and do not bug us.
Н	1	It would be nice to be able to save the survey as I go along, instead of having to fill it out all in one sitting, but I know that is hard to do while maintaining anonymity.
1	1	There are two other factors that inhibit onboarding new technologies or inhibit the decision to replace - the ability to access/acquire new technology in a timely manner (extremely long lead times for procurement approvals) and lack of opportunities to test new technologies with real life scenarios (lab environment on in the field).
J	1	Security, historic vendor relations, CM, QA
K	1	Changes in business environment

### **Survey Fit for Purpose Assessment**

The survey tools fit for purpose, as established in Chapter 3 of the dissertation body, was established by use of the absolute fit index measured by a Chi-Square  $\chi 2$  GFI (Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007). Comparing against the Chi-Square tables for the presented degrees of freedom provided by the sample, greater than 60% of the presented questions presented good fit. The questions not passing the Chi-Square assessment were considered for modification under the recommendations section in Chapter 5.

#### **Primary Statistical Analysis**

TOM focused upon what was important and significant to the replacement decision.

Analysis was provided primarily with IBM SPSS Statistics Grad Pack 22.0 Premium statistics software suite. Table 36 provides a summary of questions/hypotheses and the tests that were employed for their assessment.

Table 36. Data Mapping

Research Question/Hypothesis	SPSS Statistical test
R1: Greatest Influence	
Inv1/H1: Greatest Influence (OI)	Means of Response
H1a: Significant Influence (OI)	ANOVA, Regression
Inv 2/H2: Significant influence (C)	ANOVA, Regression
Inv 3/H3: Significant influence (B)	ANOVA, Regression
Inv 4/H4: Significant influence (OS)	ANOVA, Regression
Inv 5/H5: Significant influence (T)	ANOVA, Regression
R2: Demographic significance	

H6: Demographic significance (OI) Regression, Correlation
H7: Demographic significance (C) Regression, Correlation

Table 36. Data Mapping (Continued)

Research Question/Hypothesis	SPSS Statistical test
H8: Demographic significance (B)	Regression, Correlation
H9: Demographic significance (OS)	Regression, Correlation
H10: Demographic significance (T)	Regression, Correlation
R3: Most important Factor	
H11: Most important/Most significant Factor agreement	Means/ANOVA

Face value respondent assessment. In direct assessment by the respondents (Question 27), *Benefits* were ranked as most influential. *Benefits* presented the lowest assessed mean at 1.84 with an equally low 1.08 standard deviation presenting a low kurtosis. This efficacy effect became a central factor in motivation (Margolis & McCabe, 2004; Parajes, 2005; Schunk & Meese, 2005; Schunk & Zimmerman, 2012) for overcoming status quo bias (Kim & Kankanhalli, 2009). However, the summed averages of responses to the individual factors, as shown in Table 37, identify *Technical* was assessed overall higher than *Benefits*. The difference presented a peculiar variation as to which effect truly did exert the greatest influence in the minds of the respondents. The variation could be the effect of surveying from within an IT department, and it is possible this behavior would not show through in replication or longitudinal studies of TOM.

Table 37. Ranked Evaluation Summary

Variable	Mean	Standard	Summed Means of
		Deviation	Cluster Questions
Rank Obsolescence Imperative	3.37	1.5	5.35
Rank Cost	2.49	1.19	5.095
Rank Benefits	1.84	1.08	5.429
Rank Organizational Support	4.01	1.18	4.089
Rank Technical	3.25	1.02	5.746

Means = Lower is better; Summed Means, Higher is better

ANOVA. Employing ANOVA assessment of each effect against the clustered perceptions of Behavioral Intent, as shown in Appendix B, Table B4, and Figure 9, *Technical* emerged as the closest to significant at .055, with the *Obsolescence Imperative* and *Cost* elements achieving .094 and .071 in the ANOVA. Interestingly, the Welch and Brown-Forsythe robustness of equality tests present variant significance. These observations indicated that while there may be substantive agreement amongst respondents to what they perceive as important to their replacement decisions (e.g., *Benefits*), there was substantial enough variability that the result was not significantly more common that a random effect. Thus, these findings leave the decision maker with the simple common sense result: when making an IT replacement decision, a solid understanding of *Technical* elements is necessary to move beyond the status quo.

	ANOVA					Robust Tests of Equality of Means					
Variable		Sum of Squares	df	Mean Square	F	Sig.		Statistic <sup>a</sup>	df1	df2	Sig.
	Between Groups	6.277	1	6.277	2.911	.094	Welch	5.190	1	8.180	.052
OI	Within Groups	105.644	49	2.156			Brown-Forsythe	5.190	1	8.180	.052
	Total	111.922	50				a. Asymptotically F distributed.				
	Between Groups	4.612	1	4.612	3.417	.071	Welch	6.099	1	8.186	.038
С	Within Groups	66.133	49	1.350			Brown-Forsythe	6.099	1	8.186	.038
	Total	70.745	50				a. Asymptotically F	distributed.			
	Between Groups	.212	1	.212	.177	.676	Welch	.545	1	12.989	.473
В	Within Groups	58.533	49	1.195			Brown-Forsythe	.545	1	12.989	.473
	Total	58.745	50				a. Asymptotically F	distributed.			
	Between Groups	3.388	1	3.388	2.495	.121	Welch	2.333	1	6.287	.175
OS	Within Groups	66.533	49	1.358			Brown-Forsythe	2.333	1	6.287	.175
	Total	69.922	50				a. Asymptotically F	distributed.			
	Between Groups	3.775	1	3.775	3.861	.055	Welch	4.585	1	6.780	.071
Т	Within Groups	47.911	49	.978			Brown-Forsythe	4.585	1	6.780	.071
	Total	51.686	50				a. Asymptotically F	distributed.			

Figure 9. ANOVA of Variables to BI

**Correlation matrices.** Not shown due to size constraints of APA formatting, this study, employed Pearson and Spearman correlation matrices to identify the influence of demographic

variables upon response results. Gender was identified to have a correlation with only two of the factors: under OI: The inability of the obsolete system to support its business function or mission, and under Technical: The Mean Time Between Failure of the significant components. The sparseness of additional correlation within each element and accumulation mitigated this as a primary concern, reinforcing the perspective that Gender did not have a significant impact upon responses.

However, this is not the case for the remaining demographic factors. While Age had only a single factor identified under OI, Age identified four significant correlations within OS (over a full third of the factors). Years of IT experience showed correlations on elements in each of the factors under examination (OI, *Cost, Benefits*, OS, and *Technical*) indicating that as a dependent variable, it had the greatest influence of the demographic variables. Examining the nature of this influence (positive or negative towards the replacement decision) is another venue for independent study.

The assessment also examined correlation matrices for evaluation of similarity of the question forms within each element under examination to identify relationships between variables, which may or may not be linear, specifically employing Spearman correlation in addition to Pearson's. Each factor showed several correlations amongst the individual questions, indicating the subject sets resemble each other too closely. The recommendation for this issue was to consolidate ideas into a single more inclusive form.

**Multiple linear regression.** MLR was employed to determine if a predictive change in BI could be determined from the change in the dependent variables. MLR provided for the significance testing of the independent variables as well as the prediction factors of the TOM

model related to the prediction of BI for the model as a whole, each independent variable, and control for the variables within this assessment (Vogt, 2007, p. 146).

The rank respondents applied to each factor was compared against BI, as was the cumulative average of responses to all elements of a factor, along with a combination of these factors to identify predictive effects upon BI. As can be seen in Appendix B, Table B4, OI did in fact present a significant predictive effect upon BI, with an ANOVA significance of 0.42. OS presented a very near effect, ANOVA significance of .065, that may also present true under further examination in additional studies.

Factor Analysis. Factor Analysis was employed to identify the number of significant factors within the responses of each of the primary five elements (OI, B, C, OS, T), as well as the cumulative means and the same assessed with the demographic variables. The factor analysis helped identify factors with substantive commonality, which was verified with the correlation matrices. Appendix B, Figures B12-B19, contains the listing of all factor analyses for each element, but Table 38 provides a summary of these results. Each of the primary five elements were segregated into similar patterns accounting for the significant portion of response explanation. Interestingly, the cumulative averages each identified as a unique factor when run with Egan values higher than 1; however, when run again with an Egan value set to .5, only three factors emerged, with OI and B clustered and C and T clustered, accounting for 89.1% of response. When the demographic effects were added, the five primary elements formed a single factor while Gender formed a second and Age, IT Exp, and AP Exp cluster together in a third. The investigated factor analysis demonstrated a high degree of expectation that the survey accounts for the majority of rationale for respondent answers.

Table 38. Summary of Factor Analysis

Element	# Factors Identified	Cumulative % Explained by these factors			
Ol	3	70.8%			
С	3	60.4%			
В	3	73%			
OS	3	67.2%			
Т	2	55.7			
Cumulative	5 and 3	100% and 89.1%			
Cumulative w/ Demographics	3	69.2			

#### Validity and Reliability

Face validity. Borden and Abbot (2008) described face validity as "how well a measurement instrument appears to measure what is was designed to measure" (p. 129). The questions forming the survey were drawn from well-tested and verified tools, such as the TAM model, with new questions following a similar form and employing a similar method. Questions were reviewed by the panel of experts as part of the pretest, the doctoral review panel, and Doctoral committee, as recommended by Vogt (2007, p. 119).

Construct validity. Borden and Abbot (2008) indicated that construct validity "applies when a test is designed to measure a 'construct,' which is a variable not directly observable, that has been developed to explain behavior on the basis of some theory" (p. 130). Vogt (2007) described it as "How well the measurement instrument measures the concept (construct) of interest" (p. 119). Factor Analysis was employed to discover the nature of the constructs influencing a set of responses (DeCoster, 1998). Correlation matrices for each variable set and its ranking were also developed and consulted. Figure 9 identifies the number of factors and percentage of explanation for each variable, as well as the composite assessment.

Multicollinearity is the state in multiple regression analysis where one or more predictor variables are closely correlated to the point that one can be predicted from the other (Vogt, 2007). Appendix B, Figures 24-29 provide the detailed multicollinearity assessment of each question along with the assessment of the composite question. Table 39 summarizes these observations. The majority of questions had few or no multicollinearity issues; however, some did have issues. *Benefits* and OS had the largest instances. These were taken into consideration for modifications to be made in the recommendations segment of Chapter 5.

Table 39. Summary of Multicollinearity Analysis

Variable	Total Questions	No MC	Few MC	Many MC	All MC
Obsolescence Imperative	9	4	5	0	0
Costs	12	5	3	2	1
Benefits	9	0	1	7	1
Organizational Support	12	0	7	4	1
Technical	8	4	4	0	0
TOM Composite	5	5	0	0	0

Criterion validity. Kripanont (2007) observed Cohen's (1988) suggestion of correlation r = 0.10 to 0.29 (small correlation: both positive and negative correlation), r = 0.30 to 0.49 (medium correlation), and r = 0.50 to 1.00 (large correlation) as criterion evaluation measures. The correlation matrices showed that each factor identified several of its elements with large correlation so much so that consolidation was warranted.

**External validity.** Borden and Abbot (2008, p. 110) observed that "A study has external validity to the degree that its results can be extended (generalized) beyond the limited research setting and sample in which they are obtained." The sample was drawn from the core IT decision making functionaries within a large conglomerate multinational corporation. The sample of 50 participants was sufficient for model exploration assessment, with adequate

external validity and generalizability to the large corporation business segment. Deeper sampling pools for confirmatory and longitudinal study were recommended.

**Internal validity.** Data distribution and MLR were assessed for each variable presentation, assessing the significance of the relationship between the model's independent variables and the independent and behavioral intent (the dependent variable), as well as the influence of demographic variables upon the model variables and BI. The explicit material for the regression assessments were provided in Appendix B, Tables 45-50.

Reliability. Reliability speaks to the consistency of the tool to generate similar results in similar conditions. To assess *Inter-rater reliability*, a Fleiss' Kappa (Fleiss & Cohen, 1973) score for each factor identified at least slight to fair agreement amongst respondents across the board, using the Landis and Koch scale (1977), see Appendix B, Table B3. The Pearson product-moment correlation coefficient (or Pearson's *r*) (Vogt, 2007) speaks to consistency of test application, while Spearman's Rho correlation coefficient identifies dependence between variables. Both Pearson's and Spearman's were generated within the correlation matrices. There are few elements for each factor (other than *Technical*) that returned rhos' approaching 1, indicating strong relationships or dependencies. The results identified that the instrument questions warranted some consolidation but also demonstrated expected levels of reliability. Internal consistency reliability was typically the greatest concern to testers to ensure what was measured is what was intended to be measured. Cronbach's alpha (Vogt, 2007) for each factor was provided at Appendix B, Table B11, with results that showed at least .75 or greater for each factor under assessment, demonstrating adequate reliability.

# **Summary of Findings**

The overwhelming message coming through from this survey was that while obsolescence was an influencing factor, perhaps a significant factor, upon the replacement decision, this decision action remains a business function in which the benefits gained must outweigh the costs. Findings identify the Technical factor as the closest to significant (.055) with OI and Cost presenting as significant employing alternate methods. Demographics identified as significant influences to the decision intent, and the factors respondents identified as most important did not align with the factors which exerted the greatest influence in responses.

# CHAPTER 5. DISCUSSION, IMPLICATIONS, RECOMMENDATIONS Chapter 5 Introduction

In this chapter, the results of the survey in consideration of the hypotheses and research questions are discussed. Implications of the study and its findings for how the TOM model may aid decision makers are addressed along with the limitations encountered in this effort. The identification of future research needed along with ongoing research with TOM are discussed. Finally, provided are recommendations for modifications to the survey instrument and methods in pursuing further TOM research.

#### **Summary of Results**

The research work focused upon addressing a gap in the literature relating to decision factors influencing the replacement decision for obsolete legacy systems. The convergence of multiple disciplines influences the single replacement decision, which presented a unique problem not previously examined. Since initiation of this piece, additional work in the field have been identified which are of particular interest to practitioners: Gangadharan, Kuiper, Janssen, and Luttighuis, (2013) deciding to continue or decommission legacy systems; Alkazemi, Nour, and Meelud, (2013) provided a framework to assess legacy systems; and Wagner (2014) presented a methodology for reengineering, recovery, and modernization of legacy systems. Founded in the seminal works of many cross-domain disciplines, this research work covers a wide breadth of research and practice from the last 50 years.

The researcher used Internet survey research to investigate the TOM, developed for this study. Specifically, the factors of organizational decision making, obsolescence imperative, cost,

benefit, and the technical perception variables influence upon the behavioral intent for the decision makers to replace obsolete systems were examined to determine which factors were perceived by respondents as the most important and which exerted significant influence. The desired effect of this research was to help practitioners better understand the decision process and thus improve their decision-making and improve the substantive content of the body of knowledge on the subject.

Focusing upon the results of the survey assessment, the results were that the Obsolescence Imperative (OI) did not present as the greatest influencing factor over the replacement decision. The TOM factor identified as the closest to significant (.055) via ANOVA assessment was *Technical*, with OI and *Cost* presenting as significant when employing alternate methods of what. Demographics of Age and IT experience were identified as significant influences to the decision intent, where Gender and AP experience did not. The factors respondents identified as most important (lowest means of responses) did not align with the factors which exerted the greatest influence (highest summed means of clustered questions) in responses. Since this research was conducted in one large corporation, these results are of limited generalizability, which will be discussed in detail within the following sections.

#### Discussion

The first research question focused upon which factor would identify as the greatest influence. Given the focus upon obsolescence within this study, the hypothesis H1 posited that OI would provide the greatest influence, however, this was not the result. As shown in Table B2, the lowest mean scores identified the factors the respondents found most important to their decision, with Benefits presenting as the most important, and OI coming in 4<sup>th</sup> out of 5 factors. As was documented in qualitative question responses, often all questions were deemed

important, but some simply held greater weight than others. These variations were also why the survey employs more than one measure, to help determine not just importance, but strength of importance. The application of TOM to this work environment emphasized the importance of business benefits and technical execution within the professional decision environment.

Another reason OI may not have-been rated as having the greatest influence, may be the realistic expectation that obsolescence should be expected to have been solved in most IT implementations. Product obsolescence is not new. The rapid expansion of technology within the last 40 years is well documented, and product retirement has been an active part of the System Development Lifecycle (SDLC) for that entire period (US Department of Justice, 2003). Product Lifecycle Management (PLM), is an example process by which IT can and should address the issue of obsolescence. PLM conceptualization is credited (Booz, 2011) all the way back to the 50's in the seminal work by Johnson and Jones (1957), however major PLM maturation did not begin to manifest into a recognized, repeatable process until the late 1980's or a real trend until the late 90's and early 00's (Booz, 2011).

The point of this is that while there may be an expectation that obsolescence should be solved by basic technology management discipline, this does not always manifest, and the problem of obsolete IT systems being employed beyond their software end of life, beyond their service contracts, beyond the availability threshold for acquisition of replacement parts persists. The continued use of systems beyond end of life is one of the key drivers behind TOM, to aid the decision maker in identifying and addressing the key concerns within their organization for making a replacement decision.

The first subordinate hypothesis, H1A, sought to identify whether OI identified as having a significant influence upon the replacement decision. The direct ANOVA results did not

identify OI as having a significant influence (.094), however, the Welch and Brown-Forsythe robustness of equality test present variant results, showing OI with a .052 significance (See Figure 9). A larger sample set and confirmatory replication study are recommended to determine how these effects repeat and reinforce the observations of this study or defy them.

Beyond OI, the additional hypotheses, H2-H5, sought out whether the additional TOM factors (Costs, Benefits, Organizational Support and Technical) held significance to the replacement decision. As identified in Figure 9, *Technical* comes very close to significance from the direct ANOVA (.055), and *Cost* and OI showing significance to the Welch and Brown-Forsythe robustness of equality tests (.052 and .031 respectively). Statistical significance to stand out beyond coincidence is important to learn for the integrity of TOM, as well as identifying key factors to the decision maker that are not subjectively conjectured. Within the qualitative responses for cost (Table 20), the criticality of business and "cost is king" comes through as a core message. These results may realistically expect to lead to a significant influence. Likewise, with the focus of the study upon replacing obsolescent IT systems, which may no longer serve their purpose or meet the business needs, one might expect this would become significant to this form of decision making.

The significance of *Technical* factors such as interoperability, scalability and reliability become very salient to the replacement decision of IT systems because of the dependent nature of IT systems themselves for these functions to succeed or result in overall decision failure. Because failure to address Technical concerns can very easily result in non-functional systems and disrupted business processes, regardless of their support of competitive advantage or obsolescence status, IT decision makers are very attuned to the-importance of these factors, which appears evident in this survey with its sample drawn from the IT department.

A reason OI did show as significant to this form of replacement decision on the Brown and Welch-Forsythe measure may be the need of business to evolve with the times and modify its business practices drives replacement decisions. As Kanter (2001, 2001a) observed about the IT industry, much of it, such as jobs, technologies, cultures, did not exist even 10 years ago. With Moore's law (Moore, 1965) driving technology advancement through the last 50 years, companies are driven to evolve and adapt to survive. Within this context is the need to be able to decide to when to replace obsolete systems.

The second research question sought to identify whether demographic elements influenced the replacement decision for each of the factors. Supported by hypotheses H6-H10, only Age and Years of IT experience identified significant influence. With the large skew in *Gender* within the population and sample, one might have expected this to present a significant effect, but as can be seen in Appendix B, Tables 44 and 47, gender elicits only 2 correlations of significance across the entire survey. Whereas *Age* and *Years of IT experience* present 5 and 6 each. However, a more likely explanation might be that the differences in responses between the low end of the spectrum and the high end of the spectrum where "wisdom and experience", steeped in the business processes of the organization, and further within the career projection tracks, present responses which vary significantly from their younger counterparts.

The third research question focused the variance between what was found to be most important, and what was found to be most significant. What the respondents believe to be important compared to what shows up as significant are both important factors of which a decision maker should be cognizant. Failure to adequately address elements that are statistically significant to a decision process risks making a poor or ineffectual decision. Equally so, failure to address factors the peer decision makers within a voting board or decision group consider

important may also lead to ineffectual, delayed or irrational decisions. As Seaman and Allen (2011) observe from the Matrixx Initiatives, Inc. v. Siracusano (2011), Supreme Court decision, an effect may not be statistically significant, yet remain very important. In this court case, the side effects of losing one's sense of smell were not statistically significant, but were very important to the consumers. In the case of this TOM investigation, Figure 9 did not reveal many statistically significant factors, however, as Table B2 indicates, these were very important to the respondents. These values related to these factors demonstrate that the respondent's perceptions remain an important element of decision making beyond the solely statistical message.

The importance of OI remains valid, even if the decision maker does not perceive it as such when compared with other factors. As Shotter (2012) observes:

In 1996, the US Navy began work on a new sonar system to boost its ships' undersea warfare capabilities. By the time the targeting and detection technology was installed in 2003, more than 70 percent of its electronic components were no longer being made. Keeping systems going even as some of their constituent parts become obsolete is not a new problem. It is, however, an increasingly acute one. In 2000, just more than a thousand end of life notices - warnings by manufacturers that they are about to stop making certain components - were issued. In 2010, the figure was almost 5,000. (p. 1).

# **Implications**

While not all of the research questions and hypotheses concluded as originally proposed, this does not mean there is nothing to learn from this research. While OI did not prove to be the greatest influencing factor, it did show in certain measures to be significant. As identified in the discussion, there is a reasonable expectation that this obsolescence problem *should* be fixed by now, since many potential solutions exist. However, the problem of replacing obsolete legacy

systems persists broadly in many industry sectors and particularly in government sectors, providing support for the focus of this research, to better empower decision makers with tools to use in making decisions regarding obsolescence in large scale complex computer based systems (Swanson & Dans, 2000; Furneaux & Wade, 2010; Shotter, 2012).

Industry Week (2014) cites a 2010 study from the ARC advisory group, in which "Over 90 percent of process manufacturers acknowledged the use of automation beyond the manufacturer's obsolescence date" (para 2) and "In the same ARC study, 58% of users acknowledge having no formal plan for managing the lifecycle of their equipment" (para 3). Continued use of aging equipment without a plan for addressing and managing end-of-life technology present a "variety of risks that threaten to drastically increase downtime and decrease profitability should legacy systems fail" (IndustryWeek, 2014, para 3). Tools such as TOM help decision makers with the replacement decision, a step in the lifecycle management of their systems.

A real-world example from by Hoover's (2011) examination of the U.S. Social Security Administration (SSA) shows that, "The SSA's primary data center is nearing the end of its usefulness -- its electrical system is an accident waiting to happen, and decades-old software hampers the agency's ability to extend its services to the Web" (para 1). Replacement is a multi-year endeavor that has fallen years behind schedule.

The strategy of extending the life of its legacy COBOL software is further complicated by the fact that some of the IT staffers required to manage and maintain its code are reaching retirement age, even if the software is not. About 42% of the agency's IT specialists are expected to retire between 2010 and 2016 (p. 3)

The element questions provided in the survey instrument for TOM address many of the issues identified as problems in the Hoover (2011) article. Understanding the important and significant elements and factors of the replacement decision, may better prepare the SSA for their execution needs and presented a better replacement decision.

With the rampant advance of technology of the last 30 years, it has become the expectation of organizations that IT systems will advance along with the times to support their business processes (Michaelson, 2007). Such expectation shows through in the responses to the survey questions and the explanations provided by the respondents. When this does not occur, it can represent a disconnect of the decision makers from the business needs of the organization, the organization from its supporting infrastructure tools or a broader problem

As observed in the literature review, elements of obsolescence are well researched such as DMSMS (Singh & Sandborn, 2006; Sandborn et. al, 2007), software lifecycle planning (Jansen, Popp & Buxmann, 2011), technological obsolescence (Sandborn, 2007; Hiertz et al., 2010), security obsolescence (Bartels, Ermel, Sandborn, & Pecht, 2012), and business obsolescence (Nguyen, Yeung, & Castanier, 2011). Likewise, solutions for managing obsolescence planning are well published (Cooper, Lambert & Pagh, 1997; Evans, 1998; Umble, Haft & Umble, 2003; Verhoef, 2003; Grieves, 2006; Michaelson, 2007; Schneiderman, 2010). However, the decision processes for the management of obsolescence and execution of these solutions may be mired in legacy decision or business processes, which are not conducive to the dynamic field of IT.

As Scharmer and Kaufer (2013a) observe, consciousness of the decision maker to the needs of a broader set of stakeholders and business mandates in a broader sense than the localized needs of the immediate team and system are crucial for evolution of the decision

economy. In terms of TOM and the research of this work, respondents indicated widely that concerns of the local business team, local workers and even the obsolescence state were secondary to the broader needs of the organization as a whole and the technical effects of ensuring a replacement system functioned to meet the broader business goals of the company. Such a perspective would integrate OI as a component of the broader needs, as evidenced by OI showing significant in some of the measures, but not as the leading driver, as evidenced by both Figures 9 and 25 findings.

Scharmer and Kaufer (2013b) establish a 1.0 through 4.0 model of limited but expanding economy perception/engagement.

- 1.0 Organizing around centralized coordination: This involves organizing around hierarchy and central planning, giving rise to centralized economies (socialism, mercantilism), and embodying the traditional forms of values and awareness.
- 2.0 Organizing around decentralized coordination: This involves organizing around markets and competition, giving rise to the second (private) sector, the free market economy. This embodies the state of ego-system awareness, that is, a concern for the well-being of oneself.
- 3.0 Organizing around special interest group driven coordination: This involves organizing around stakeholder negotiations and dialogue, giving rise to the third (social) sector and the social market economy (stakeholder capitalism). This embodies the state of stakeholder awareness, that is, a concern for the well-being of oneself and one's immediate stakeholders.
- 4.0 *Organizing around commons:* This involves organizing around awareness based collective action (ABC) as a mechanism to transform stakeholder relationships from

habitual to co-creative. This way of operating embodies eco-system awareness, that is, a concern for the well-being of other stakeholders and the whole. (p.2)

TOM fits within the 3.0 economy (caring about the well-being of my ego and some of my direct stakeholders) working towards migration into a 4.0 world (caring about the well-being of my ego, all stakeholders, and of the whole eco-system). Current systems are required to maintain harmony with their environment; systems obsolescence presents a challenge to overcoming the change barriers for aligning systems into harmony with their eco-system. However, the practical applications of TOM are more centric to large scale IT systems, infrastructure and software, than smaller mobile apps and dynamic software, whose ease of replacement may very well render them practically immune to obsolescence.

The implications of *Cost* presenting as significant in some of the measures should not be surprising. Cost drives business. The respondents provided repeated business centric observations in their qualitative responses throughout all 5 factors. These business centric effects tie closely to the constraint of costs and the need to ensure a solution technically succeeds. The salience of the system to the business goals and increasing competitiveness stood out as the respondents indicated that investment in a new system should align with these purposes (obviously), but that this was a very important consideration, showing up as the second most important OI rationale, dominant OS rationale, and a major consideration in the overall identification of *Benefits* as the most important ranking assessment. Lowered costs was identified by many respondents as another important influence on their replacement decision. As a part of the highest ranked OI element, highest and second highest *Cost* elements, and highest *Benefits* element, lowered costs would be expected to exert influence in a "cost is king" business world.

Matching this business centric influence of Cost to the decision process, improved productivity and increased customer satisfaction was also identified as key to their replacement decisions. The purpose of IT systems in most cases is some form of productivity improvement over the manual process of human labor, ensuring that this goal was maximized is only rational when seeking a replacement product. Likewise, in IT services many customer interfaces in the modern interconnected era; ensuring the replacement solution has the satisfaction of customer needs and expectations as a part of its decision considerations is also only rational. As a few respondents put it, the replacement decision is still a business decision, thus the significance of *Cost* to the replacement decision.

The significance of *Technical* factors such as interoperability, scalability and reliability become very salient to the replacement decision of IT systems because of the dependent nature of IT systems themselves for these functions to succeed or result in overall decision failure.

Internally and externally, interoperability of systems has become a critical performance factor for IT in business over the last 40 years. Many businesses have interlinked their supply and delivery chains to just in time manufacturing (Monden, 2012; Rainie & Fox, 2012) providing critical information flows (Li, Liu & Liu, 2013), and improved service interfaces with customers (Ghatikar, 2012). Many organizations have likewise extended their interface with the public (Rainie & Fox, 2012) and their customers to IT systems whose interoperability is now critical for business success. Failure of interoperability results in down time and lost business, and potentially, lost customers or suppliers. Scalability (Yeganeh, Tootoonchian & Ganjali, 2013) likewise becomes crucial to the replacement decision, as the replacement system must be able to handle increasing workload demand and be expandable to suit the projected demand of its expected performance lifecycle. Reliability also influences the replacement decision, as down-

time, and availability can significantly influence productivity, customer relations and contractual obligations (Narayan, 2012). Because failure to address *Technical* concerns such as interoperability, scalability and reliability can very easily result in non-functional systems and disrupted business processes, regardless of their support of competitive advantage or obsolescence status, IT decision makers will be very attuned to their importance.

The precedent of *Cost* and *Technical* over obsolescence is exacerbated in most IT systems, as they are designed with planned obsolescence; they are designed to last only so long and then require replacing or updating. Bulow (1986) in his seminal work on the theory of planned obsolescence, observed the economic condition benefits to the manufacturer to produce products with shortened lifecycles, which force consumers to acquire upgrade or replacement technologies. Planned obsolescence has a very high precedent in the IT sector, with the following as just some examples: a) critical infrastructure must keep pace with evolutions in communications protocols, b) software end-of-life is purposefully imposed (Jansen, Popp & Buxmann, 2011), c) format obsolescence (Rosenthal, 2010) can invalidate continued data accessibility, and d) where systemic obsolescence is enforced, such as the change in Apple's iPhone 5 accessory adaptors to force incompatibility and repurchase. These are very real OI effects in the IT sector, which drive Technical solutions and Cost conscious decision making to the forefront, and may reasonably explain the significance of *Cost* and *Technical* within the TOM evaluation.

The implication of demographic influence, specifically *Age* and *IT experience* find significant common ground in the Sproten, Diener, Fiebach, and Schwieren (2010) study on aging and decision making whose results also indicated significant influence of these demographic effects. On explanation could be positivity effect, in which older adults are more

optimistic than young adults (Sproten et al., 2010), as they "focus more on regulating emotion than young adults do, and this improves their overall emotional experience" (p. 13).

Another explanation Sproten et al. (2010) offer for these effects is in the differences in decision strategies employed by young and older adults:

Older adults look up less information and take more time to process it, but overall decision making of older and young adults seems to be equivalent. If this was applied to the fact that ambiguity is a condition with less information available than risk, one could think that ambiguous decisions are more suitable to older adults, (p. 14)

They also suggest that another factor that can have effect is simple experience. "Older adults had a lifetime to decide and develop strategies for decisions under ambiguity. They can retrieve information from a memory that young adults are just beginning to develop" (p. 14).

Dietrich (2010), on the other hand observes that older workers may draw more deeply on their past experiences, which may negatively influence decision making due to undue association with past sunk outcomes. She observes a number of potential cognitive biases which may be exacerbated by age, such as:

a) belief bias, the over dependence on prior knowledge in arriving at decisions; b) hindsight bias, people tend to readily explain an event as inevitable, once it has happened; c) omission bias, generally, people have a propensity to omit information perceived as risky; and d) confirmation bias, in which people observe what they expect in observations.(p.2)

She also observes a) that cognitive functions may decline with age, impacting decision making; b) older people may be more overconfident regarding their ability to make decisions,

which inhibits their ability to apply strategies; and c) that older adults prefer fewer choices than younger adults.

While IT changes at rapid pace, IT is not all a young people's domain. The survey respondents posted a media age around 50, the Aerospace engineering subset market of the IT domain maintains an average age of 45.7 years (AIA, 2011) and the average age of the modern IT professional is 44 (Global Knowledge, 2012). Thus, it is reasonable to expect that this median effect for the industry increasing into the subset market and sample would present a subjective norm predicated upon the need for experience and depth of perspective to aid decision making, rather than being hampered by it. The results of this study, and status of the industry would present a TOM model more aligned with the Sproten study than the Dietrich article.

The implication of the modest response rate is that the survey was too long. Feedback from the expert panel felt that this was the cause of over half of the respondents cancelling completion once they got a look at the survey's length. Only three instances occurred of individual questions not completed; these results were not included in this reporting. A shorter survey would mitigate the time consideration and likely improve responsiveness. Likewise, an improvement in response rate would greatly increase the response sample, providing better precision for fully validated results assessment.

The implications of this study to the IT decision maker is that the TOM tool may provide useful insight into the specific decision factors both important and significant to the organization to which it is applied. TOM is a means of increasing available information for the decision maker (Spoten et al., 2010). Additional research into TOM may enhance the confidence in its ability to successfully predict factors, which may also reduce decision ambiguity (Hey & Pace, 2014).

### Limitations

The most relevant limitation of this report is in its generalizability. Drawn from a single large multi-national conglomerate, its findings are most generalizable to similar type organizations. It is expected that different organizations in different industries, of different size, purpose, hierarchy, and engaging in different decision methods would acquire some different results through the application of the TOM. These are perceived to most specifically vary in the ranked importance results, which would be more influenced by these factors and the culture of the organization in establishing norms. The concentration from a single company did ensure the respondents operated from the same homogeneous culture norm and with similar methods, mitigating these as potential variable effects.

Another limitation of generalizability is that TOM has not yet had the opportunity for longitudinal research. TOM may be evaluated at a single hospital and its results may be mildly generalizable to similar hospitals. However when TOM is evaluated at 10 hospitals and its results longitudinally compiled and compared, its generalizability to hospitals as a whole becomes much stronger. As this is the very first publication study of TOM, it suffers from this lack of replication exposure in its generalizability.

The small sample size acquired limited the reliability of the results. While typical confirmatory study will seek 95% confidence level with a confidence interval of 5, the sample size of 50 is closer to a 90% confidence level with a confidence interval of 10 (Calculator.net, 2015). An increase in sample size is highly recommended for confirmatory investigation of TOM.

As noted in the implications section above, the modest response rate of 14% is attributed primarily to the length of the survey. Feedback from the expert panel felt that this was the most

likely cause of over half of the respondents cancelling completion once they got a look at the survey's length. A shorter survey would mitigate the time obligation to improve responsiveness, which would present a larger sample volume to improve precision and reliability of responses that can fully validate results assessment.

The distribution of Age and Gender acquired in this survey study present distributions significantly skewed from a national level normal distribution. These could be considered limitations, but these have been shown to actually sit closer to the industry norms for these factors than the standard distribution. The failure to adequately acquire the specific type of technology the respondents were considering within the scope of their responses is another limitation, which was perceived to also likely have a significant interaction response with the dependent variables.

Reaching back into the theoretical base, Ajzen's (1980) Theory of Reasoned Action (TRA) includes the subjective norm as an influence upon behavioral intent, in this case the replacement decision. The subjective norm examines the influence of people within the social environment on the subjects' behavioral intentions. While homogeneity of the subjective norm of the business culture within an organizational department may mitigate variability from unknown alternative bias sources, it can also potentially stifle variety perspectives, such as groupthink (Janis, 1972; Esser, 1998) and multiple stakeholder considerations.

As Scharmer and Kaufer (2013) observe, consciousness of the decision maker to the needs of a broader set of stakeholders and business mandates in a broader sense than the localized needs of the immediate team and system are crucial for evolution of decision economy. TOM is a part of the Scharmer and Kaufer (2013) model of the 3.0 economy (caring about the well-being of my ego and some of my direct stakeholders). However, its execution and question

forms expand the respondents and decision makers' consciousness to needs of a broader eco system. It is not intrinsically transformational in and of itself, but can contribute as a small step on the pathway towards migration into a 4.0 world (caring about the well-being of my ego, all stakeholders, and of the whole eco-system). TOM is also a very small step in innovation for vanguard companies (Kanter, 2010) and smaller entities to integrate values and principles into a guidance system for decision-making.

### **Recommendations for Further Research**

As may be anticipated from an emerging model, many opportunities persist for additional research in this field. A first step would be replication studies using a similar set up at a large conglomerate corporation but employing the recommended changes in the survey instrument. A confirmatory study with a larger sample is recommended. The next step may rationally be modification of the testing subjects and venue, such as a school, hospital, or small business. These would reasonably be expected to elicit different insights of the level of influence of the primary as well as the demographic influencing variables.

In addition to the change of venue and size of the organization, one might consider adding an industry variable to empower potential influence. One might also consider a longitudinal study of pre decision, post decision application, which may empower assessment of BI affect. As well, longitudinal assessment amongst many studies may present trend findings and additional insight into the effects of demographics across a wider spectrum.

Additional research may also be conducted using a confirmatory study employing SEM as the methodological tool for deeper assessment of the model structure. Likewise, the predictive effect on BI could be investigated more thoroughly with pretest/post-test approach.

Longitudinal study may also lend itself to broader confirmatory study with its application to multiple data sets.

A further investigative channel is migration away from only evaluating one organization and instead assessing broader industry structures by, perhaps, conducting surveys at specific conventions or industry events to gather a broader base assessment of the model variables and effect of demographic influences. TOM could also be applied to assessment of the model beyond IT systems to equipment replacement decisions in manufacturing or agriculture fields. Also, the positive or negative relationship of years of experience upon decision making BI is likely worth investigating.

Adding status quo as a bias factor for evaluation of BI, say as a moderating variable, would also present a strong research opportunity. Addressing status quo bias may in fact be the next natural evolution of the TOM model as status quo versus change decision are the fundamental cores of discussion. Status quo bias assessment would involve efficacy, motivation, and change resistance theoretical bases more deeply as a research base for such examination.

Further research into the implications of the demographic effect of Age and Experience upon the model variable factors could be examined. As could an examination of the variance between significant findings compared with what the respondents identify as important (Seaman & Allen, 2011). Operated as a two-part longitudinal study, the quantitative study could be followed up with a qualitative study to examine the perception differences discovered between significant versus important response assessment, which might augment TOM into a multi-part tool.

# Recommendations for improvements to the Survey Instrument

From the mass of accumulated analysis and assessment of the results returned, the recommendations presented in Table 40 are suggested as adjustments to the survey instrument. These recommendations are presented in the order of their execution in the survey vehicle, as presented throughout this paper.

These modifications reduce the instrument from 41 questions currently to only 20. Simplification should improve response rate and provide the respondent with a more concise set of selections that focus in their importance to the replacement decision and still supported in the literature as valid issues of concern. Likewise, these modifications may mitigate the Chi-squared deficiencies observed in Appendix B, Table B1.

Based upon the population of 1700, the Von Bennekom (2002) model presented in Chapter 3 identifies a recommended sample size of 187 to acquire results that can accurately sustain a 95% confidence level with a confidence interval of 5. Assuming a similarly sized replication, acquisition of the corporate lead to send out invitations may result in better response rate. However, anticipating no more than 25% response rate, securing a sample frame of 750 would present much better likelihood of achieving the target goal.

As indicated in item 2 of Table 40, accurately constructing the survey instrument to properly acquire the specific type of technology the respondents were considering within the scope of their responses would be very beneficial. As previously noted, question 6 of this survey effort inaccurately set the response mechanism resulting on multiple response which invalidated the question for this effort. However, the type of technology under consideration by the respondents is perceived to potentially have a significant interaction response with the dependent variables.

Table 40. Recommendations for the Survey Instrument

#	Recommendation	Rationale
Der	nographics	
1	Cluster <i>IT experience</i> and <i>AP experience</i> into 5-year clusters similar to how <i>Age</i> is presented for easier evaluation	This change increases consistency of variable structure for easier and more consistent assessment results
2	Specify unique selection for the <i>Type of IT product</i> employed as a reference for the questions. (Question 6)	This was an error in data collection during this effort. It is expected that this may indeed be an additional significant variable.
3	Add Robotics and Application Middleware to the list of question 6 systems	This was observed from the responses acquired by respondents
Prin	nary Variables	
4	Consolidate OI factor into the following five unified elements a) Parts or replacements not available to keep machinery running and/or software is beyond EOL support b) Loss of Business Opportunity c) Not adaptable to regulatory and/or market change d) No longer supports business mission statement e) Excessive rise in O&M cost	Recommendation based upon the following:  1) The Factor Analysis results for OI (Table B12) identified three factors  2) The response means of each question  3) The excessive correlations in correlation matrices  4) The rationales provided by the respondents to questions 10, 11, and 12  5) The similarities in question wording or core topic
5	Consolidate Costs into the following five unified elements a) Financial costs b) Switching time and cost c) Acquisition and Lifecycle cost d) Business Intangibles e) Cost of Legacy Maintenance	Recommendation based upon the following:  1) The Factor Analysis results for C (Table B13) identified three factors  2) The response means  3) The rationales provided by the respondents to questions 16, 17, and 18  4) The similarities in question wording or core topic
6	Consolidate Benefits into the following five unified elements a) New Business b) Improved interoperability/customer satisfaction c) Improve Competitive advantage/market share d) Decrease Maintenance cost e) Increase Business Process effectiveness	Recommendation based upon the following:  1) The Factor Analysis results for B (Table B14) identified three factors  2) The response means  3) The excessive correlations in correlation matrices  4) The very high Multicollinearity in Appendix B, Figure B3  5) The rationales provided by the respondents to questions 22, 23 and 24  6) The similarities in question wording or core topic

 Table 40.
 Recommendations for the Survey Instrument (Continued)

#	Recommendation	Rationale
7	Consolidate OS into the following five unified elements a) New Supports Core competency/business strategy b) New: Improve Supplier/Customer interactions c) Reputation of replacement system and vendor d) Failure: Personal blame/regret e) Failure: Department suffers	Recommendation based upon the following:  1) The Factor Analysis results for OS (Table B15) identified three factors  2) The response means  3) The moderately high Multicollinearity in Appendix B, Figure B4  4) The rationales provided by the respondents to questions 28, 29, and 30  5) The similarities in question wording or core topic
8	Consolidate Technical into the following five unified elements a) New: Perceived Usefulness b) New: Perceived Ease of Use c) New: Increase Systems interoperability d) New: Increased Scalability e) New: Improve reliability (MTBF)	Recommendation based upon the following: 1) The Factor Analysis results for Technical (Table B16) identified three factors 2) The response means 3) The rationales provided by the respondents to questions 34, 35, and 36 4) The similarities in question wording or core topic
Clai	rifying qualitative questions	
9	Eliminate the qualitative "Why questions"	While interesting, they do not address the hypothesis or core research questions, but substantially impact time required to complete the survey, which was identified as a core reason for low return rate.
10	Eliminate the terms clarification questions	The overwhelming majority of responses, 231/250, expressing no need for clarification 92.4%
11	Eliminate the solicitation of additional information for each factor and overall instrument	These questions do not address the hypothesis or core research questions, but substantially impact time required to complete the survey, which was identified as a core reason for low return rate.

# **Summary**

Having identified a gap in the literature relating to decision factors influencing the replacement decision for obsolete legacy systems, this work presented the TOM as a potential solution. TOM presents a convergence of multiple disciplines influences on the single replacement decision, which presents a unique problem not previously examined. TOM provides a relationship framework for the variables perceived as important and possibly significant to the decision to replace obsolete IT systems, specifically, *OI*, *Costs*, *Benefits*, *OS* and *Technical*.

This work presented a detailed review of literature from which the elements and factors of TOM were drawn, as well as the theoretical basis by which its structure is formed. TOM was investigated via an internet survey research of salient screened technology decision makers is to via a survey instrument developed for this study. Specifically, the factors of organizational decision making, obsolescence imperative, cost, benefit, and technical perception variables influence upon the behavioral intent for the decision to replace obsolete systems were examined to determine which are perceived by respondents as most important, which exert significant influence, and which present the greatest influence.

A survey was administered to 50 personnel at a large international conglomerate corporation, with the results collected and analyzed for presentation. Only the technical Factor came close to statistical significance at .055 in direct ANOVA assessment, however, OI (.052) and *Cost* (.038) identified as significant in the Welch and Brown-Forsythe assessments. *Benefits* was identified as the most important factor to respondents, with the lowest mean responses, while *Technical* provide to have the greatest influence (see Table 37) of composite assembled scores.

While the OI did not return as the most important, or greatest influence on the decision to replace, it remained important to the respondents, with potentially significant influence over the replacement decision. Additional confirmatory study is warranted to mature and improve the TOM model. TOM and this investigation of TOM present the decision maker with a tool for better understanding the decision process to ensure important and significant factors are adequately addressed for making successful decisions.

### REFERENCES

- Aggorowati, M.A., Iriawan, N. Gautama, S., & Gautama, H. (2012). Restructuring and expanding technology acceptance model structural equation model and bayesian approach. *American Journal of Applied Sciences*, *9*(4), 496-504.
- Aerospace Industry Association (AIA). (2011). Our nation is not producing enough qualified workers to fill important jobs at aerospace companies and the shortfall will increase as retirements grow. Retrieved from the Aerospace Industry Association website: http://www.aia-aerospace.org/assets/ip\_workforce\_2011.pdf
- Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J.

  Beckmann (Eds.), *Action control: From cognition to behavior* (pp. 11-39). New York,

  NY: Springer-Verlag.
- Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Process.* 50, 179–211.
- Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.
- Albright, J. J. (2008). Confirmatory factor analysis using Amos, LISREL, and Mplus. Retrieved from http://www.iub.edu/~statmath/stat/all/cfa/cfa2008.pdf
- Alkazemi, B. Y., Nour, M. K. & Meelud, A. Q. (2013, Oct). Towards a framework to assess legacy systems. *IEEE International Conference on Systems, Man, and Cybernetics*, 924-928. doi: 10.1109/SMC.2013.162
- Almeda, J. (2011). *Blockbuster the fall of a giant*. (Masters Thesis, Catholic University of Portugal). URI: http://hdl.handle.net/10400.14/8236
- Age. (n.d.). In American Heritage Dictionary. Retrieved from http://www.answers.com/topic/age

- Anderson, M. K. (1978). Life cycle costing in manufacturing industries. *American Association of Cost Engineers Transactions*, 22, 348-353.
- Arkes, H. & Bloomers, C. (1985). The psychology of sunk cost. *Organizational Behavior and Human Decision Processes*, *35*(1), 124-140.
- Bacon, C. J. (1992). The use of decision criteria in selecting information systems/technology investments. *MIS Quarterly*, *16(*3), 335-353.
- Bagozzi, R.P. (1981). Attitudes, intentions and behavior: A test of some key hypotheses. *Journal of Personality and Social Psychology*, 41(4), 607-627.
- Bahill, A., & Smith, E. (2009). An industry standard risk analysis technique. *Engineering Management Journal*, 21(4), 16-29.
- Bandura, A. (1982). Self-Efficacy mechanism in human agency. *American Psychologist*, *37*(2), 122-147.
- Bandura, A. (1985). Model of causality in social learning theory. In S. Sukemune (Ed.), *Advances in social learning theory* (81-99). Tokyo, Japan: Kaneko-Shoho.
- Barge, S., & Gehlbach, H. (2012). Using the theory of satisficing to evaluate the quality of survey sata. *Research in Higher Education*, 53(2), 182-200.
- Barreca, S. L. (1999). Assessing functional obsolescence in a rapidly changing marketplace.

  Retrieved from http://www.bcri.com/Downloads/Technology%20Obsolescence.pdf
- Bartels, B., Ermel, U., Sandborn, P., & Pecht, M. (2012). Strategies to the prediction, mitigation and management of product obsolescence. Hoboken, NJ: Wiley.
- Basahel, A. (2009, March). A framework for evaluation of strategic information system planning (SISP) techniques. *Brunel Business School Doctoral Symposium*, Retrieved from

- http://134.83.117.117/329/BBS documents/PHD Doctoral Symposium 09/AbdullahBasahel0531438.pdf
- Beach, L. R., & Mitchell, T. R. (1978). A contingency model for the selection of decision strategies. *Academy of Management Review*, *3*(3), 439-449.
- Beer, M., & Eisenstat, R. A. (1996). Developing an organization capable of implementing strategy and learning. *Human Relations*, 49(5), 597-617.
- Beer, M., Eisenstat, R. A., & Spector, B. (1990). Why change programs don't produce change. *Harvard Business Review*, 68(6), 158-166.
- Berghout, E., Nijland, M., & Powell, P. (2011). Management of lifecycle costs and benefits: Lessons from information systems practice. *Computers in Industry*, 62(7), 755-764.
- Bergy, J. K., Northrop, L. M., & Smith, D. B. (1997). *Enterprise framework for the disciplined evolution of legacy systems*. (Technical Report CMU/SEI-97-TR-007, Software Engineering Institute), Pittsburgh, PA: Carnegie Mellon University.
- Blut, M., Frennea, C., Mittal, V., & Mothersbaugh, D. L. (2015). How procedural, financial and relational switching costs affect customer satisfaction, repurchase intentions, and repurchase behavior: A meta-analysis. *International Journal of Research in Marketing, Forthcoming*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm? abstract\_id=2553402
- Booz. (2011). Product & service innovation. Retrieved from http://www.booz.com/global/home/what\_we\_do/services/innovation
- Bordens, K.S., & Abbott, B. B. (2008) *Research design and methods: a process approach*.

  Boston, MA: McGraw-Hill.

- Borg, I., Groenen, P. J., Jehn, K.A., Bilsky, W., & Schwartz, S. H. (2009). *Embedding the organizational culture profile into Schwartz's universal value theory using multidimensional scaling with regional restrictions*. (Erasmus Research Institute of Management (ERIM) Report Series Research in Management, ERS-2009-017-MKT), 1-37. Retrieved from http://repub.eur.nl/res/pub/15404/ERS-2009-017-MKT.pdf
- Briney, A. (2001). Security survey 2001. *Information Security*, 3(10), 34-46.
- Brown, D. (2006). Online customer surveys for small business. Retrieved from http://technology.inc.com/2006/12/01/online-customer-surveys-for-small-business/
- Brown, S.A., & Brown, M. (2010). Ethical issues and security monitoring trends in global healthcare: technological advancements. Hershey, PA: IGI Global.
- Bulow, J. (1986). An economic theory of planned obsolescence. *The Quarterly Journal of Economics*, 101(4): 729–749. doi:10.2307/1884176
- Calculator.net. (2015). Sample size calculator. Retrieved from http://www.calculator.net/sample-size-calculator.html?type=1&cl=90&ci=10&ps=360&x=52&y=12
- Campos, H. M., Manrique, A. K., Kobiski, B. V., Casagrande Jr., E.L., & Urbanetz Jr., J. (2104). Study of technical feasibility and the payback period of the invested capital for the installation of a grid-connected photovoltaic system at the library of the Technological Federal University of Paraná. *IEEE International Journal of Energy and Environment*, 5(6), 643-654.
- Chan, H. C., & Teo, H. (2007). Evaluating the boundary conditions of the technology acceptance model. *ACM Transactions on Computer-Human Interaction*, *14*(2), 9-es. doi:10.1145/1275511.1275515
- Chandler, A.D. (1962). Strategy and structure. Cambridge, MA: MIT Press.

- Chau, P. Y. K. (1996). An empirical assessment of a modified technology acceptance model. *Journal of Management Information Systems*. 13(2), 185–204.
- Chau, P. Y. K. & Hu, P. J. H. (2002). Investigating healthcare professionals' decisions to accept telemedicine technology: An empirical test of competing theories. *Information & Management*, 39(4), 297–311.
- Chuttur M.Y. (2009). Overview of the technology acceptance model: Origins, developments and future directions. Indiana University, USA. *Sprouts: Working Papers on Information Systems*, *9*(37). Retrieved form http://sprouts.aisnet.org/9-37
- Clausen, D, & Frey, D. D. (2005). Improving system reliability by failure-mode avoidance Including four concept design strategies. *Systems Engineering*, 8(3), 245-261.
- Clemons, E.K. (1986). Information systems for sustainable competitive advantage. *Information & Management*, 11(3), 131-136.
- Clemons, E.K., & Kimbrough, S.O. (1986). Information systems, telecommunications, and their effects on industrial organization. *Proceedings of the Seventh International Conference on Information Systems*, 99-108.
- Clemons, E.K., & Row, M. (1987). Structural differences among firms: A potential source of competitive advantage in the application of information technology. *Proceedings of the Eighth International Conference on Information Systems*, 1-9.
- Clemons, E.K., & Row, M.K. (1991). Information technology at Rosenbluth Travel: Competitive advantage in a rapidly growing service company. *Journal of Management Information*Systems, 8(2), 53-79.
- Cohen, J.W. (1988). Statistical power analysis for the behavioural sciences, (2nd ed). Lawrence Erlbaum Associates, Hillsdale, NJ.

- Cooper, M.C., Lambert, D.M., & Pagh, J. (1997). Supply chain management: More than a new name for logistics. *International Journal of Logistics Management*, 8(1), 1–14.
- Cox, J. F., III, & Blackstone, J. H. Jr. (1998). *American production and inventory control society*(APICS) dictionary, 9th ed. Falls Church, VA: American Production and Inventory

  Control Society Inc.
- Creswell, J. W. (2009). Research design: Qualitative, quantitative, and mixed methods approaches (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc
- Dake, K. (1991). Orienting disposition in the perceptions of risk. *Journal of Cross-Cultural Psychology*, 22 (1), 61-82. doi: 10.1177/0022022191221006.
- DAU. (2012). Obsolescence. Retrieved from https://acc.dau.mil/obsolescence
- David, J. S., & Schuff, D. (2002). Managing your IT total cost of ownership. *Communications of the ACM*, 45(1), 101-106.
- Davis, F. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340.
- Davis, F., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science*, *35*(8), 982-1003.
- Davis, S., & Wiedenbeck, S. (2001). The mediating effects of intrinsic motivation, ease of use and usefulness perceptions on performance in first-time and subsequent computer users.

  \*Interacting with Computers, 13(5), 549–580.
- DeCoster, J. (1998). Overview of factor analysis. Retrieved from http://www.stathelp.com/notes.html
- Demographics. (n.d.). American Heritage Dictionary. Retrieved from http://www.answers.com/topic/demographics

- Devereaux, J. E. (2010). Obsolescence: A systems engineering and management approach for complex systems (Masters Thesis, Massachusetts Institute of Technology). Retrieved from http://dspace.mit.edu/bitstream/handle/1721.1/59233/666483538.pdf%

  3Fsequence%3D1&sa=U&ei=JgWpUMDjHpL0qQGlxoDYDg&ved=0CCAQFjAF&usg
  =AFQjCNH6K7UOUcspC2okCkYFR1ugorjNzw
- Dietrich, C. (2010). Decision making: factors that influence decision making, heuristics used, and decision outcomes. *Student Pulse*, 2(2), 1-3.
- Dishaw, M. T., & Strong, D. M. (1999). Extending the technology acceptance model with task technology fit constructs. *Information & Management*. *36*(1), 9–21.
- Department of Defense (DOD). (2003, May). DoD supply chain material management Regulation, 4140.1-R, C3.6.1.1.. Retrieved February 6, 2013, from <a href="http://www.dtic.mil/whs/directives/corres/pdf/414001r.pdf">http://www.dtic.mil/whs/directives/corres/pdf/414001r.pdf</a>
- Douglas, M., & Wildavsky, A. (1982). *Risk and culture*. Berkley, CA: University of California Press.
- El-Diraby, T., & Rasic, I. (2004). Framework for managing life-cycle cost of smart infrastructure systems. *Journal of Computing in Civil Engineering*, 18(2), 115-119.
- Erwin, D. (2011). Trying to become a different type of company: dynamic capability at Smith Corona. *Strategic Management Journal*, 32(1), 1-31.
- Esser, J. K. (1998). Alive and well after 25 years: A review of groupthink research.

  Organizational Behavior and Human Decision Processes, 73(2-3), 116-141.
- Evans, M. (1998). The potential of computer aided industrial design to act as a catalyst for greater professional collaboration. *American Society for Information Science*. Retrieved from <a href="http://www.asis.org/Conferences/MY98/Evans.htm">http://www.asis.org/Conferences/MY98/Evans.htm</a>

- Experience. (n.d.) American Heritage Dictionary. Retrieved from http://www.answers.com/topic/experience
- Feeny, D.F., & Ives, B. (1990). In search of sustainability: Reaping long-term advantage from investments in information technology. *Journal of Management Information Systems*, 7(1), 27-46.
- Fieldman, K., & Sandborn, P. (2007). Integrating technology obsolescence considerations into product design planning. *Proceedings of the ASME 2007 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference*, 1-8.
- Fischoff, B., Slovic, P. Lichtenstein, S., Read, S., & Combs, B. (1978). How safe is safe enough?

  A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences*, 9(2), 127-152.
- Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison Wesley.
- Fleiss, J. L., and Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educational and Psychological Measurement*, 33, 613–619.
- Flor, R. (2004). The importance of methodology. Minneapolis, MN: Capella University.
- FMA. (2010). Obsolete Control System...? PLC Obsolescence What should you consider?

  Retrieved from http://www.fma.uk.com/fma\_downloads/

  plc\_obsolescence\_case\_study.pdf
- Foodbeast. (2012). Hostess closing: Twinkies are gone, and it's all our fault. Retrieved from http://www.huffingtonpost.com/foodbeast/hostess-closing-twinkies-\_b\_2146413.html

- Fullman, C. (1979). Accuracy is the best policy for life cycle cost analysis. *Specifying Engineering*, 41, 127-129.
- Friesner, T. (2011). The history of SWOT analysis. Retrieved from http://marketingteacher.com/swot/history-of-swot.html
- Furneaux, B., & Wade, M. (2010). The end of the information system life: a model of is discontinuance. *ACM SIGMIS Database*, *41*(2), 45–69.
- Gangadharan, G. R., Kuiper, E.J., Janssen, M., & Luttighuis, P. O. (2013). IT innovation squeeze: Propositions and a methodology for deciding to continue or decommission legacy systems. *IFIP Advances in Information and Communication Technology*, 402(1), 481-494.
- Gao, J., Zhan, C. Wang, K., & Ba, S. (2012). Understanding online purchase decision making:

  The effects of unconscious thought, information quality, and information quantity.

  Decision Support Systems, 53(4), 772–781.
- Gender. (n.d.) American Heritage Dictionary. Retrieved from http://www.answers.com/topic/gender
- George, D., & Mallery, P. (2003). SPSS for Windows step by step: A simple guide and reference.

  11.0 update (4th ed.). Boston, MA: Allyn & Bacon.
- Ghatikar, G. (2012). Deploying systems interoperability and customer choice within smart grid.

  Retrieved from http://escholarship.org/uc/item/3c7893j3#page-1
- Gigerenzer, G. (1991). How to make cognitive illusions disappear: Beyond 'heuristics and biases', *European Review of Social Psychology*, *2*(4), 83-115.
- Gigerenzer, G. (2002). Reckoning with risk, London, England: Penguin Books.

- Gigerenzer, G., & Gaissmaier, W. (2011). Heuristic decision making. *Annual Review of Psychology*, 62(1), 451-482. DOI: 10.1146/annurev-psych-120709-145346
- Global Knowledge. (2012). 2012 IT skills and salary report. Retrieved from http://www.cisco.com/web/learning/employer\_resources/pdfs/2012\_salary\_rpt.pdf
- Grieves, M. W. (2006). *PLM: Driving the next generation of lean thinking*. Boston: McGraw-Hill.
- Groves, R. M., Fowler, F.J., Couper, M. P., Lepkowski, J.M., Singer, E., & Tourangeau, R. (2009). *Survey Methodology* (2nd ed.). Hoboken, NJ: Wiley.
- Hair, J., Black, W., Babin, B., Anderson, R., & Tatham, R. (2006), *Multivariate data analysis*, (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.
- Hauser, J. R., & Simmie, P. (1981). Profit maximizing perceptual positions: An integrated theory for the selection of product features and price. *Management Science*, 27(1), 33-56. doi: 10.1287/mnsc.27.1.33
- Hey, J. D., & Pace, N. (2014). The explanatory and predictive power of non two-stage-probability theories of decision making under ambiguity. *Journal of Risk and Uncertainty*, 49(1), 1-29.
- Hiertz, G., Denteneer, D., Stibor, L., Zang, Y., Costa, X. P., & Walker, B. (2010). The IEEE 802.11 universe. *IEEE Communications*, 48(1), 62-70.
- Hinde, A. (1998). Demographic methods. New York, NY: Arnold.
- Hobbes, T. (1996). *Leviathan*. New York, NY: Oxford University Press. (Original work published 1651).
- Hoover, J. N. (2011). Social security confronts IT obsolescence. *Information Week*, 1294, 18-20.

- Huber, G. P. (1981). The nature of organizational decision making and the design of decision support systems. *MIS Quarterly*, *5*(2), 1-10.
- Huber, G. P. (2009). Information technology and organizational decision making. In *Strategic Information Management* 3rd ed. (Eds. Galliers, R. D. & Leidner, D. E. ). London, England: Routledge.
- Hussey, D. E. (1978). Portfolio analysis: Practical experience with directional policy matrix. *Journal for Long Range Planning*, 11(4), 2-8.
- International Accounting Standards Board (IASB). (2009). International accounting standard 38

   intangible assets. Retrieved from http://www.iasplus.com/en/standards/standard37
- Industry Week. (May 14, 2014). Mastering mitigation: how to reduce automation obsolescence risks without losing your mind. *Industry Week*. Retrieved from http://search.proquest.com.library.capella.edu/docview/1530410421?accountid=27965
- IntangibleBusiness (N.D.). List of intangible assets. Retrieved from http://www.intangiblebusiness.com/store/data/files/149-List of Intangible Assets.pdf
- IntangAbility. (2013). Intangibles: critical success factors (CSF). Retrieved from http://www.intangability.com/intangibles/
- Irani, Z. (2002). Information systems evaluation: navigating through the problem domain.

  \*Information & Management, 40(1), 11-24.
- Jansen, S., Popp, K. M., & Buxmann, P. (2011). The sun also sets: Ending the life of a software product. *Proceedings of the Second International Conference of Software Business*, *ICSOB 2011*, 154-167.

- Jackson, K. M., & Trochim, W. K. (2002). Concept mapping as an alternative approach for the analysis of open-ended survey responses. *Organizational Research Methods*, **5**(4), 307-336.
- Janis, I. L. (1972). Victims of groupthink: A psychological study of foreign-policy decisions and fiascoes. Oxford, England: Houghton Mifflin. Pp 277.
- Jaramillo, F., & Spector, P. E. (2015). Sunk cost effect, escalation of commitment and the principle of fungibility: Consumers' reactions to membership cards. *Developments in Marketing Science: Proceedings of the Academy of Marketing Science 2015*, 148-154.
- Johnson, S. C., & Jones, C. (1957). How to organize for new products. *Harvard Business Review*, 35(3), p49-62.
- Johnson. E.J., & Payne, J.W. (1985). Effort and accuracy in choice. *Management Science*, 31(4), 395-414.
- Joshi, K. (1989). Role conflict and role ambiguity in information systems design. *Omega*, 17(4), 369-380.
- Joshi, K. (1991). A model of users' perspective on change: The case of information systems technology implementation. *MIS Quarterly*, *15*(2), 229-242.
- Joshi, K. (2005). Understanding user resistance and acceptance during the implementation of an order management system: A case study using the equity implementation model. *Journal of Information Technology Case and Application Research*, 7(1), 6-20.
- Kabir, G., Sadiq, R., & Tesfamariam, S. (2014). A review of multi-criteria decision-making methods for infrastructure management. *Structure and Infrastructure Engineering:*Maintenance, Management, Life-Cycle Design and Performance, 10(9), 1176-1210.

- Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 47, 263-281.
- Kahneman, D., & Tversky, A. (1984). Choices, values and frames. *American Psychologist*, *39*, 341-350.
- Kahneman, D., Knetsch, J., and Thaler, R. (1990), Experimental tests of the endowment effect and the Coase theorem, *Journal of Political Economy*, *98*(6), 1325-1348.
- Kant, I. (1781). Critique of pure reason. London: Macmillan. Translated 1929 by Smith, N.K.
- Kanter, R. M. (2001). Evolve!. Boston, MA: Harvard Business School Press.
- Kanter, R. M. (2001a). Evolving for success [part one]. Retrieved from http://hbswk.hbs.edu/item/2026.html
- Kanter, R. M. (2010). Supercorp: How vanguard companies create innovation, profits, growth, and social good. New York, NY: Random House.
- Kaplan, R., & Norton, D. (1992). The balanced scorecard: Measures that drive performance.

  \*Harvard Business Review, 70(1), 71-79.
- Kaplan, R., & Norton, D. (1996). *The balanced scorecard: Translating strategy into action*.

  Boston, MA: Harvard Business School Press.
- Katz, D., & Kahn, R. L. (1966). The social psychology of organizations. New York, NY: Wiley.
- Kaufman, R. J. (1970). Life cycle costing: a decision-making tool for capital equipment acquisition. *Cost and Management*, March/April, 21-28.
- Kim, H. W., & Kankanhalli, A. (2009). Investigating user resistance to information systems implementation: A status quo bias perspective. *MIS Quarterly*, *33*(3), 567–582.
- Kim, H.W., Chan, H. C., & Kankanhalli, A. (2012). What motivates people to purchase digital items on virtual community websites? The desire for online self-presentation. *Information Systems Research*, 23(4), 1232-1245.

- Kim, H-W., & Gupta, S. (2012). Investigating customer resistance to change in transaction relationship with an internet vendor. *Psychology & Marketing*, *29*(4), 257–269.
- King, J. L., & Schrems, E. L. (1978). Cost-benefit analysis in information systems development and operation. *Computing Surveys*, *10*(1), 19-34.
- Konoza, A., & Sandborn, P. (2013). Evaluating the End of Maintenance Dates for Electronic Assemblies Composed of Obsolete Parts. *Journal of Mechanical Design*, *136*(3), 1-14.
- Kripanont, N. (2007). Examining a technology acceptance model of internet usage by academics within thai business schools. (Doctoral Thesis). School of Information Systems Faculty of Business and Law, Victoria University: Melbourne, Australia.
- Landis, J. R., and Koch, G. G. (1977) The measurement of observer agreement for categorical data. *Biometrics*, *33*, pp. 159–174
- LaPointe, L., & Rivard, S. (2005). A multilevel model of resistance to information technology implementation. *MIS Quarterly*, 29(3), 461-491.
- Laumer, S., & Eckhardt, A. (2012). Why do people reject technologies: A review of user resistance theories. *Information Systems Theory*, 28(1), 63-86.
- Lepper, M. R. (1985). Microcomputers in education: Motivational and social issues. *American Psychologist*, 40(1), 1-18.
- Li, V., Liu, K., and Liu, S. (2013) Semiotic interoperability- A critical step towards systems integration. In: *International Conference on Knowledge Discovery and Information Retrieval and the International Conference on Knowledge, Management and Information Sharing*, 508-513.
- Lobontiu, G. (2013). Planned obsolescence and the product lifecycle. *Applied Mechanics and Materials*, *371*(1), 857-861.

- Locke, J. (1689). *Locke's second treatise on government*. London, England: Printed for R. Butler, etc., 1821.
- Loewenstein, G., & Prelec, D. (1992). Anomalies in intertemporal choice: Evidence and an interpretation. *Quarterly Journal of Economics*, 107(2), 573-597.
- Lu, J., & Ye, L. (2013). Efficient and optimal mechanisms with private information acquisition costs. *Journal of Economic Theory*, *148*(1). 393-408.
- Mabert, V.A., Soni, A., & Venkataramanan, M.A. (2003). The impact of organization size on enterprise resource planning (ERP) implementations in the US manufacturing sector. *The International Journal of Management Science*, 31(1), 235-256.
- Macaskilla, A. C., & Hackenbergb, T. D. (2012). Providing a reinforcement history that reduces the sunk cost effect. *Behavioural Processes*, 89(3), 212–218.
- Marchek, S. (2011). Research Prospectus: A quantitative investigation of the resistance to replacing obsolete legacy systems. [Capella OM8022 Course Project, Unpublished].
- Marchek, S. (2012). Obsolescence variables for the TOM model. [Capella BMGT9920 working Paper, Unpublished].
- Margolis, H., & McCabe, P. P. (2004). Self-Efficacy: A key to improving the motivation of struggling learners. *The Clearing House*. 77(6), 241-249.
- Marshall, L., & de la Harpe, R. (2009). Decision making in the context of business intelligence and data quality. *South African Journal of Information Management*, 11(2). 1-15.

  Retrieved from http://sajim.co.za/index.php/SAJIM/article/view/404
- Maruyama, G.M. (1998). Basics of structural equation modeling. Thousand Oaks, CA: Sage.
- Mata, F. J., Fuesrt, W. L., & Barney, J. B. (1995). Information technology and sustained competitive advantage: A resource-based analysis. *MIS Quarterly*, 19(4), 487-505.

- Mathieson, K. (1991). Predicting user intention: comparing the technology acceptance model with theory of planned behavior. *Information Systems Research*, 2(3), 173-191.
- Matrixx Initiatives, Inc. v. Siracusano. (2011). United States Court Of Appeals for the Ninth Circuit. No. 09–1156. Retrieved from http://www.supremecourt.gov/opinions/10pdf/09-1156.pdf
- Matveev, A. V. (2002). The advantages of employing quantitative and qualitative methods in intercultural research: practical implications from the study of the perceptions of intercultural communication competence by American and Russian managers. *Bulletin of Russian Communication Association, Theory of Communication and Applied Communication*, 1, 59-67.
- Meng, X., Thornberg, B., & Olsson, L. (2012). Component obsolescence management model for long life cycle embedded system. *IEEE AUTOTESTCON*, 19-24. DOI: 10.1109/AUTEST.2012.6334547
- Mehra, A., Seidmann, A., & Mojumder, P. (2014), Product life-cycle management of packaged software. *Production and Operations Management*, 23(3), 366–378.DOI:10.1111/poms.12069
- Michaelson, B. (2007). Closed Loop lifecycle planning: A complete guide to managing your PC fleet. Upper Saddle River, NJ: Addison Wessley.
- Microsoft. (2012). Products lifecycle. Retrieved from http://windows.microsoft.com/en-US/windows/products/lifecycle
- Misa, T. J. (2010). Gender codes: Why women are leaving computing. New York: Wiley.
- Monden, T. (2012). *TOYOTA production system: An integrated approach to just in time* (4<sup>th</sup> ed). Boca Raton, FL: Taylor & Francis Group.

- Moore, G. E. (1965). Cramming more components onto integrated circuits. *Electronics*, 38(8).
- Narayan, V. (2012). Business performance and maintenance: How are safety, quality, reliability, productivity and maintenance related?, *Journal of Quality in Maintenance Engineering*, 18(2), 183 195.
- Nasher, S., Kalantarian, M., Akbari, A., Suzangar, A., Kajbaf, M., & Madani, N. (2011).

  Evaluation of IT investment methods and proposing a decision making model.

  Proceedings of the 2<sup>nd</sup> International Conference on Information Management and Evaluation, 324-332.
- Neuman, W.L. (2006). *Social research methods: Qualitative and quantitative approaches* (6th ed.). Boston, MA: Pearson Education.
- Nguyen, T.P.K., Yeung, T. G., & Castanier, B. (2011). Impact of maintenance on the replacement investment under technological improvement. *ESREL 2011 Advances in Safety, Reliability and Risk Management*, Nantes France.
- Nichols, M. (2012). Self-Efficacy, outcome expectancy, and fear of failure as predictors of physical activity (Doctoral Dissertation, Southern Illinois University Carbondale).

  Retrieved from http://opensiuc.lib.siu.edu/dissertations/638/
- Norio, O., Ye, T., Kajitani, Y., Shi, P., & Tatano, H. (2011). The 2011 eastern Japan great earthquake disaster: Overview and comments. *International Journal Of Disaster Risk Science*, 2(1), 34-42, DOI: 10.1007/s13753-011-0004-9
- Nunnaly, J. (1978). *Psychometric theory*. New York: McGraw-Hill.
- Oral, M. (2012). Action research contextualizes DEA in a multi-organizational decision-making process. *Expert Systems with Applications*. *39*(7), 6503–6513.
- Packard, V. (1960). The Waste Makers. New York: David McKay.

- Palmer, D. (2000). Financial management development: No. 332 discounted cashflow analysis.

  Retrieved from http://www.FinanicalManagmentDevelopment.com
- Parajes, F. (2005). Self-efficacy during childhood and adolescence: Implications for teachers and parents. In Parajes, F., *Self-Efficacy Beliefs of Adolescents* (pp. 339-367). Charlotte, NC.: Information Age Publishing.
- Pardo del Val, M., & Fuentes, C. M. (2003). Resistance to change: A literature review and empirical study. *Management Decision*, 41(2), 148-155.
- Park, S. Y., Nam, M. W., & Cha, S. B. (2012). University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. *British Journal of Educational Technology*, 43(4), 452-605. DOI: 10.1111/j.1467-8535.2011.01229.x
- Parker, M., Benson, R., & Trainor, H. (1988). *Information economics: linking business* performance to information technology. London: Prentice Hall.
- Parschau, L., Fleig, L., Koring, M., Lange, D., Knoll, N., Schwarzer, R., & Lippke, S. (2013).

  Positive experience, self-efficacy, and action control predict physical activity changes: A moderated mediation analysis. *British Journal of Health Psychology*, *18*(2), 395–406.
- Pavlou, P.A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International Journal of Electronic Commerce*, 7(3), 69–103.
- Payne, J.W. (1982). Contingent decision behavior. *Psychological Bulletin*, 92(2), 382-402.
- Pettigrew, A. M. (1975). The industrial purchasing decision as a political process. *European Journal of Marketing*, *9*(1), 4–19.
- Pijnenburg, F. (2011). DCS obsolescence what is real? Retrieved from http://www.wib.nl/files/MiniSeminar2012\_FrankPijnenburg.pdf

- Power, D.J. (2007). A brief history of decision support systems. Version 4.0. Retrieved from http://dssresources.com/history/dsshistory.html
- Prayag, G., Hosany, S., Nunkoo, R., & Alders, T. (2012). London residents' support for the 2012 Olympic Games: The mediating effect of overall attitude. *Tourism Management*, *36*(3), 629-640.
- Puvanasvaran, A.P., Teoh Y. S., & Tay, C. C. (2012). Interrelationship between availability with planning factor and mean time between failures (MTBF) in overall equipment effectiveness (OEE). *Journal of Advanced Manufacturing Technology*, 6(2), 29-38.
- Quattrone, G. A., & Tversky, A. (1987). Contrasting rational and psychological analyses of political choice. Mimeo, Stanford University.
- Rainie, L., & Fox, S. (2012). Just-in-time information through mobile connections. Retrieved from http://lbmacanada.com/files/200-PIP\_Just\_In\_Time\_Info.pdf
- Ram, J., & Corkindale, D. (2014). How "critical" are the critical success factors (CSFs)?:

  Examining the role of CSFs for ERP. *Business Process Management Journal*, 20(1), 151-174.
- Rich, C. (1978). Using life-cycle analysis to improve plant design. *Plant Engineering*, *32*, 151-154.
- Robinson, J. P., Shaver, P. R., & Wrightsman, L. S. (1991). Criteria for scale selection and evaluation, In *Measures of personality and social psychological attitudes*. San Diego, CA: Academic Press.
- Rojo, R. F., Baguley, P., Shaikh, N., Roy, R., & Kelly, S. (2012). TOMCAT: An obsolescence management capability assessment framework. *Journal of Physics: Conference Series*, 364(1), 1-11. doi:10.1088/1742-6596/364/1/012098

- Rosenthal, D. S. (2010). Format obsolescence: assessing the threat and the defenses. *Library Hi Tech*, *28*(2), 195-210.
- Rousseau, J. J. (1762). *The social contract*. Translated 1782 by Cole, G.D.H. Retrieved from http://www.constitution.org/jjr/socon.htm
- Rumelt, R. P. (1995). Inertia and transformation. In Montgomery, C.A. (Ed.), *Resource based and evolutionary theories of the firm*. (pp. 101-32). Boston, MA: Kluwer Academic Publishers.
- Ryan, K., Brady, J., Cooke, R., Height, D., Jonsen, A., King, P., Lebacqz, K., Louisell, D., Seldin, D., Stellar, E., & Turtle, R. (1979). *The Belmont Report: Ethical principles and guidelines for the protection of human subjects of research*. Retrieved December 13, 2011, from http://hhs.gov/ohrp/humansubjects/guidance/belmont.html
- Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making, *Journal of Risk* and *Uncertainty*, *I*(1), 7-59.
- Sandborn, P., Herald, T., Houston, J., & Singh, P. (2003). Optimum technology insertion into systems based on the assessment of viability. *IEEE Transactions on Components and Packaging Technologies*, 26(4), 734-738.
- Sandborn, P. (2007). Software obsolescence Complicating the part and technology obsolescence management problem. *IEEE Transactions on Components and Packaging Technologies*, 30(4), 886-888.
- Sandborn, P., Jung, R., Wong, R., & Becker, J. (2007). A taxonomy and evaluation criteria for DMSMS tools, databases and services. *Proceedings of the 2007 Aging Aircraft Conference*, Palm Springs, CA. Retrieved from http://www.enme.umd.edu/ESCML/Papers/AgingAircraft07-Taxonomy.pdf

- Sandborn, P., Prabhakar, V., & Ahmad, O. (2011). Forecasting electronic part procurement lifetimes to enable the management of DMSMS obsolescence. *Microelectronics Reliability*, *51*, 392-399.
- Santos, J. R. A. (1999). Cronbach's Alpha: a tool for assessing the reliability of scales. *Journal of Extention*, *37*(2) Retrieved from http://www.joe.org/joe/1999april/tt3.php
- Scharmer, O., & Kaufer, K. (2013a). Leading from the emerging future: From ego-system to eco-system economies. Oakland, CA: Berrett-Koehler Publishers
- Scharmer, O., & Kaufer, K. (2013b). 10 Insights on the ego 2 eco economy revolution. Retrieved from https://www.presencing.com/engage/blog/10-insights-ego-2-eco-economy-revolution
- Scheel, C. (2005). Creating economic value added through enabling technologies. *Transactions* of the Society for Design and Process Science, 9(4), 41-59.
- Scheepers, H., & Scheepers, R. (2008). A process focused decision framework for analyzing the business value potential of IT investments. *Information System Frontiers*, 10, 321-330. Doi: 10.1007/s10796-008-9076-5
- Schneiderman, R. (2010). Innovation, time-to-market pressures boost PLM across all industries. *Electronic Design*, 58(12), 1A-5A.
- Schunk, D. H., & Meece, J. L. (2005). Self-efficacy development in adolescences. In Pajares, F. *Self-Efficacy beliefs of adolescents*, (pp. 71-96). Charlotte, NC: Information Age Publishing
- Schunk, D. H., & Zimmerman, B. J. (2012). *Motivation and self-regulated learning*. London, England: Routledge

- Seaman, J.E., & Allen, I. E. (2011). Not significant, but important? *Quality Progress*, *10*(13), 1-3. Retrieved from http://asq.org/quality-progress/2011/08/statistics-roundtable/not-significant-but-important.html
- Sekaran, U. (2003). *Research methods for business: As skill building approach* (4<sup>th</sup> ed). Southern Illinois University at Carbondale: Wiley.
- Sekerka, L. E., & Stimel, D. (2012). Environmental sustainability decision-making: clearing a path to change. *Journal of Public Affairs*, 12(3), 195–205.
- Sentosa, I., & Nik Mat, N. K. (2012). Examining a theory of planned behavior (TPB) and technology acceptance model (TAM) in internet purchasing using structural equation modeling. *Journal of Arts, Science & Commerce*, 3(2), 62-77.
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). Experimental and quasi-experimental designs for generalized casual inference. Boston, MA: Houghton Mifflin.
- Shotter, J. (2012). *Burden of obsolescence becomes more acute*. London: The Financial Times Limited. Retrieved from http://search.proquest.com.library.capella.edu /docview/1011298124?accountid=27965
- Sim, E.W., Griffin, A., Price, R.L., & Vojak, B.A. (2007). Exploring differences between inventors, champions, implementers and innovators in creating and developing new products in large, mature firms. *Creativity and Innovation Management*, 16(4), 422-436.
- Singh, K. N. (2006). Reliable, scalable and interoperable internet telephony (Doctoral dissertation, Columbia University). Retrieved from http://kundansingh.com/papers/thesis.pdf
- Singh, P., & Sandborn, P. (2006). Obsolescence driven design refresh planning for sustainment-dominated systems. *The Engineering Economist*, *51*(2), 115-139.

- Sjöberg, L. (2000). Factors in risk perception. *Risk Analysis: An International Journal*, 20(1), 1-
- Slade, G. (2006). *Made to Break: Technology and Obsolescence in America*. Cambridge, MA: Harvard University Press.
- Slotegraaf, R. J., & Atuahene-Gima, K. (2011). Product development team stability and new product advantage: The role of decision-making processes. *Journal of Marketing*, 75(1), 96–108.
- Somers, T.M., & Nelson, K. (2002). The impact of critical success factors across the stages of enterprise resource planning implementations. *Proceedings of the 34th Annual Hawaii International Conference on System Sciences*. 1-10. DOI: 10.1109/HICSS.2001.927129
- Spencer, A. J., Buhalisa, D., & Moitala, M. (2012). A hierarchical model of technology adoption for small owner-managed travel firms: An organizational decision-making and leadership perspective. *Tourism Management*, *33*(5), 1195–1208.
- Sproten, A., Diener, C., Fiebach, C., & Schwieren, C. (2010). Aging and decision making: How aging affects decisions under uncertainty. *Discussion Paper Series No. 508. University of Heidelberg*. Retrieved from http://www.uni-heidelberg.de/md/awi/forschung/dp508.pdf
- Straub, D. W., Keil, M., & Brenner, W. (1997). Testing the technology acceptance model across cultures: A three country study. *Information & Management*, *33*(1), 1–11.
- Straub, D. W. (2010). Quantitative, positivist research methods in information systems.

  Retrieved from http://dstraub.cis.gsu.edu:88/quant/default.asp
- SurveyMonkey. (2012). FAQ. Retrieved from http://help.surveymonkey.com/app/answers/detail/a\_id/231

- Survey Systems. (2010). Sample size calculator. Retrieved from http://www.surveysystem.com/sscalc.htm
- Swanson, E.B. (1982). Measuring user attitudes in MIS research: A review. *Omega*, 10(2), 157-165.
- Swanson, E.B. (1987). Information channel disposition and use. *Decision Sciences*, *18*(1), 131-145.
- Swanson, E.B., & Dans, E. (2000). System life expectancy and the maintenance effort: Exploring their equilibration, *MIS Quarterly*, 24(2), 277-297.
- Tarafdar, M., Tu, Q., Ragu-Nathan, B. S., & Ragu-Nathan, T. S. (2007). The impact of technostress on role stress and productivity. *Journal of Management Information Systems*, 24(1), 301–328.
- Taylor, S. & Todd, P. (1995). Understanding information technology usage: a test of competing models. *Information Systems Research*, 6(2), 144-176.
- Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior* and Organization, 1, 39-60.
- Thamhain, H. J. (2015). Evaluating and selecting technology-based projects. In Kutz, M. *Mechanical Engineers' Handbook, Manufacturing and Management*. New York, NY:

  Wiley.
- Tomatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. *IEEE Transactions of Engineering Management*, 29(1), 28-45.
- Triandis, H. C. (1977). *Interpersonal Behavior*. Monterey, CA: Brooks/Cole.

- Trochim, W. M. K. (2006). External validity. Retrieved form http://www.socialresearchmethods.net/kb/external.php
- Tuten, P. M. (2009) A model for the evaluation of IS/IT Investments. (Doctoral dissertation, NOVA Southeastern) Retrieved from http://books.google.com/books/about/

  A Model for the Evaluation of IS IT Inve.html?id=rSWAbvYsso0C
- UCLA (2012). SPSS FAQ. UCLA academic technology services. Retrieved from http://www.ats.ucla.edu/stat/spss/faq/alpha.html
- Umble, E. J., Haft, R. R., & Umble, M. M. (2003). Enterprise resource planning: Implementation procedures and critical success factors. *European Journal of Operational Research*, *146*. 241–257. Retrieved from http://cas.uah.edu/guptaj/m680/erpimp.pdf
- US Census. (2007). Number of firms and establishments employing persons. Retrieved from http://www.census.gov/econ/smallbus.html
- US Census. (2008). Paid employees. Retrieved from http://www.census.gov/econ/smallbus.html
- US Department of Justice. (2003). Information resource management. Retrieved from http://www.justice.gov/jmd/irm/lifecycle/ch1.htm
- Van Bennekom, F. C. (2002). *Customer Surveying, A Guidebook for Service Managers*. Boston, MA: Customer Service Press.
- Venkatesh, V., & Davis, F. (2000). A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46(2), 186-204.
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478.
- Verhoef, P. C. (2003). Understanding the effect of customer relationship management efforts on customer retention and customer share development. *Journal of Marketing*, 67(4), 30–45.

- Vogt, W. P. (2007). *Quantitative Research Methods for Professionals*. Boston, MA: Allyn & Bacon.
- Vroom, V. H. (1964). Work and Motivation. New York, NY: Wiley.
- Wagner, C. (2014). Model Driven Software Migration: A Methodology for Reengineering,

  Recovery, and Modernization of Legacy Systems. Weisbaden, GE: Springer Fachmedian
- Walter, J., Kellermans, F. W. & Lechner, C. (2012). Decision making within and between organizations rationality, politics, and alliance performance. *Journal of Management*, 38(5), 1582-1610.
- Ward, J., & Peppard, J. (2007). *Strategic Planning for Information Systems 3<sup>rd</sup> ed.* San Francisco, CA: Wiley
- Weerasuriya, G. T., & Wijayanayake, M. J. (2014). An evaluation of factors affecting information systems obsolescence. *Journal of Emerging Trends in Computing and Information Sciences*, 5(3), 158-164.
- White, G. E., & Ostwald, P. H. (1976). Life cycle costing. *Management Accounting*, 57(7), 39-42.
- Women in Technology Education Foundation (WITEF). (2008). Women in Technology Education Foundation. Retrieved from http://www.womenintechnology.org/witef/resources.
- Witt, R. C. (1973). Pricing and underwriting risk in automobile insurance: A probabilistic view. *Journal of Risk and Insurance*, 40(4), 509-531.
- Whitten, D., Chakrabarty, S., & Wakefield, R. (2010). The strategic choice to continue outsourcing, switch vendors, or backsource: Do switching costs matter? *Information & Management*, 45(3), 167-175.

- Woodward, D. G. (1997). Life cycle costing—Theory, information acquisition and application. *International Journal of Project Management*, 15(6), 335-344. doi:10.1016/S0263-7863(96)00089-0
- Wortman, P. M. (1983). Evaluation research A methodological perspective. *Annual Review of Psychology 34*, 223–260. doi:10.1146/annurev.ps.34.020183.001255
- Wu, J., & Lederer, A.(2009). A meta-analysis of the role of environment-based voluntariness in information technology acceptance. *MIS Quarterly*, *33*(2), 419–432.
- Yeganeh, S. H., Tootoonchian, A., & Ganjali, Y. (2013). On scalability of software defined networking. *IEEE Communications*, *51*(2), 136-141.
- Zahra, S.A. (1987). Organizational politics and the strategic process. *Journal of Business Ethics*, 6(7), 579-587.
- Zhang, X., Ryan, S. D., Prybutok, V. R., & Kappelman, L. (2012). Perceived obsolescence, organizational embeddedness, and turnover of it workers: an empirical study. *ACM SIGMIS*, 43(4), 12-32.

#### APPENDIX A. SURVEY INSTRUMENT

The survey was hosted on SurveyMonkey at the following web address.

Https://www.surveymonkey.com/r/MarchekDissertationSurveyPilot

As lifetime availability of the survey in an on-line accessible form cannot be guaranteed, a copy of it is presented here for visibility. The size has adjusted to fit standard page designs, on screen is standard 12 point font. Also, the SurveyMonkey web interface presents all of the material as a single contiguous interactive page.

# Survey This survey contains a total of 41 questions divided into eight sections. It will take about 45 minutes to complete. ROADMAP The survey is broken up into 8 sections The first section collects general demographic information. The remaining 7 sections examine different aspects of the decision to replace obsolete systems: \* Obsolescence \* Costs \* Benefits \* Organizational Support \* Technical \* Ranking of the 5 above \* Assessment of perceptions **PART 1: DEMOGRAPHICS** Instructions- For this section, please identify which most appropriately applies to you. \* 2. What is your gender? O Male Female \* 3. Which category below includes your age? 18 or younger 36-45 66 or older 15-25 O 46-55 26-35 O 56-65 \* 4. How many years of experience have you had in the IT field? Years \* 5. For how many years have you been involved with the decisions to acquire or replace IT systems? Years

Figure 10. Page 1 of 14 image of the survey instrument

\* 6. Please think of an obsolete system that you were involved in or may be involved in the decision to replace.

## Please describe that system:

	Systems types
Servers (e.g. data storage, e-mail, web, database)	0
Software program (e.g. Antivirus, engineering tool, desktop utility, database)	0
Operating Systems (e.g. Windows, Linux, Solaris, AIX, OS X)	0
E-Services (e.g. Web sites, e-tools, access to software packages and updates, remote systems administration)	
Entertainment (e.g. Games, Emulators)	0
Network Infrastructure (e.g. Router, Switch, Hub, Firewall, IDS)	
Peripheral Devices (e.g. Printers, copiers, scanners, SAN, )	0
Specialty Equipment (e.g. Spectrum Analyzer, Programmable Logic Controller, Cryptographic unit)	
Embedded Systems (e.g. GPS modules, Flight Control Computers, Instrument Landing System in airplanes)	0
Other (please specify)	

Figure 11. Page 2 of 14 image of the survey instrument

### Part 2: Obsolescence Imperative

This section (questions 7-12) identifies how different elements of obsolescence may be important to your decision to replace an obsolete system.

Please use the system you identified above (in question 6) as as your frame of reference for these questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question.
(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

#### \* 7. Is this element of obsolescence (listed below on the left) important to your decision to replace an obsolete system?

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
c) Technological limitations of the obsolete system (e.g. transmission speed variances between copper and fiber communications wires)	0	0	0	0	0	0	0
i)The declining knowledge base of persons who can repair or maintain the obsolete system	0	0	0	0	0	0	0
f) The inability of the obsolete system to adapt to new market demands, causing loss of business	0	0	0	0	0	0	0
b) Discontinuance of software support after end of life (EOL)	0	0	0	0	0	0	0
d) The inability to pursue business opportunities because of the obsolete systems limitations	0	0	0	0	0	0	0
e) The inability of the obsolete system to adapt to changing regulatory demands	0	0	0	0		0	0
h) The rising cost of maintaining and operating the obsolete system	0	0	0	0	0	0	0
a) The lack of materials availability (e.g. parts, suppliers, or support)	0	0	0	0	0	0	0
g) The inability of the obsolete system to support its business function or mission	0	0	0	0	0	0	0

\* 8. Are any of these terms or the meaning of the question unclear? Please explain.

Figure 12. Page 3 of 14 image of the survey instrument

▼ The I	lack of materials availability (e.g. parts, suppliers, or support)
▼ Disc	ontinuance of software support after end of life (EOL)
▼ Tech	nological limitations of the obsolete system (e.g. transmission speed variances between copper and fiber communications wires)
▼ The i	inability to pursue business opportunities because of the obsolete systems limitations
▼ The i	inability of the obsolete system to adapt to changing regulatory demands
▼ The i	inability of the obsolete system to adapt to new market demands, causing loss of business
▼ The i	inability of the obsolete system to support its business function or mission
▼ The	rising cost of maintaining and operating the obsolete system
▼ The	declining knowledge base of persons who can repair or maintain the obsolete system
	the element you selected as most important (ranked #1): Why is this element most important to your replacement decision?  The element you selected as least important (ranked #9): Why is this element least important to your replacement decision?

Figure 13. Page 4 of 14 image of the survey instrument

## Part 3: Business Costs

This section (questions 13-18) describes issues of concern and importance to you as the business acquisition decision-maker for the replacement system.

Please use the system you identified above as your frame of reference for these questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question.
(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

#### \* 13. Is this element of cost (listed below on the left) important to your decision to replace an obsolete system?

	Strongly Disagree		Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
a) Financial costs (e.g. Net Present Value (NPV), Discounted Cash Flow (DCF), or Return on Investment (ROI)) of the replacement system	n 🔾	0	0	0	0	0	0
k) The legacy system is no longer sustainable or too expensive to maintain	0	0	0	0	0	$\circ$	$\bigcirc$
f) The amount of time it will take to switch from the legacy system to the replacement system	0	0	0	0	0	0	0
i) The cost to own and operate the replacement system over its productive lifecycle (including parts, maintenance and software lifecycles		0	0	0	0	$\circ$	0
g) The concern that the replacement system will not yield its proposed results	0	0	0	0	0	0	0
h) The impact the replacement system will have on my department and my department's budget	0	0	0	0	0	$\circ$	0
d) Transitioning to the replacement system will cost jobs and may make some of my skills obsolete	0	0	0	0	0	0	0
b) The cost to acquire the replacement system	$\bigcirc$	0	0	0	0	$\bigcirc$	$\bigcirc$
e) The cost to switch from the legacy system to the replacement system	0	0	0	0	0	0	0
c) The investment the organization already has in the legacy system (Sunk Cost)	0	0	0	0	0	0	0
j) The availability of qualified people to work on the replacement system	0	0	0	0	0	0	0
c) Business Intangibles (e.g. increased organizational transparency, increased accuracy and accessibility to data, and increased interoperability with suppliers and vendors acquired by the replacement system)	$\circ$	$\circ$	$\bigcirc$	$\circ$	0	$\bigcirc$	$\bigcirc$

 $^{st}$  14. Are any of these terms or the meaning of the question unclear? Please explain.

Figure A5. Page 5 of 14 image of the survey instrument

- 10	Financial costs (e.g. Net Present Value (NPV), Discounted Cash Flow (DCF), or Return on Investment (ROI)) of the replacement system
•	The cost to acquire the replacement system
•	Business Intangibles (e.g. increased organizational transparency, increased accuracy and accessibility to data, and increased interoperability with suppliers and vendors acquired by the replacement system)
•	The investment the organization already has in the legacy system (Sunk Cost)
•	Transitioning to the replacement system will cost jobs and may make some of my skills obsolete
•	The cost to switch from the legacy system to the replacement system
•	The amount of time it will take to switch from the legacy system to the replacement system
•	The concern that the replacement system will not yield its proposed results
•	The impact the replacement system will have on my department and my department's budget
•	The cost to own and operate the replacement system over its productive lifecycle (including parts, maintenance and software lifecycles)
•	The availability of qualified people to work on the replacement system
•	The legacy system is no longer sustainable or too expensive to maintain
16. F	or the cost you selected as most important (ranked #1): Why is this cost most important to your replacement decision?
17. F	or the cost you selected as least important (Ranked #12): Why is this cost least important to your replacement decision

Figure 14. Page 6 of 14 image of the survey instrument

## Part 4: Benefits

This section (questions 19-24) describes the perceived benefits of the replacement system and the importance of its improvements to the replacement decision.

Please use the system you identified above as your frame of reference for these questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question.
(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

#### \* 19. Is this benefit (listed below on the left) important to your decision to replace an obsolete system?

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
e) The increased availability of skilled workers for the replacement system	0	0	0	0	0	0	0
d) Decreasing maintenance costs by replacing the obsolete system	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$		$\bigcirc$	$\bigcirc$
h) Increased customer satisfaction from replacing the obsolete system	0	0	0	0	0	0	0
c) Improvements in competitiveness by replacing the obsolete system	0	0	0	0	0	0	0
i) Increased effectiveness of other systems and business processes from replacing the obsolete system	0	0	0	0	0	0	0
f) Increased competitive advantage from replacing the obsolete system	0	0	0	0	0	0	0
b) The ability to pursue new business by replacing the obsolete system	0	0	0	0	0	0	0
a) Improvements in interoperability with vendors, suppliers and customers offered by the replacement system	0	0	0	0	0	0	0
g) Increased market share from replacing the obsolete system	0	0	0	0	0	0	0

* 20.	Are any	of these	terms or	the meaning	of the question	unclear?	Please explain.
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Figure 15. Page 7 of 14 image of the survey instrument

•	Improvements in interoperability with vendors, suppliers and customers offered by the replacement system
•	The ability to pursue new business by replacing the obsolete system
•	Improvements in competitiveness by replacing the obsolete system
•	Decreasing maintenance costs by replacing the obsolete system
•	The increased availability of skilled workers for the replacement system
•	Increased competitive advantage from replacing the obsolete system
•	Increased market share from replacing the obsolete system
•	Increased customer satisfaction from replacing the obsolete system
•	Increased effectiveness of other systems and business processes from replacing the obsolete system
	For the benefit you selected as most important (Ranked #1): Why is this benefit most important to your replacement decision?  For the benefit you selected as least important (Ranked #9): Why is this benefit least important to your replacement decision?

Figure 16. Page 8 of 14 image of the survey instrument

## Part 5: Organizational Support

This section (questions 25-30) describes issues of concern and importance to you as the organizational acquisition decision-maker for the replacement system.

Please use the system you identified above as your frame of reference for these questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question.
(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

### \* 25. Is this element of organizational support (listed below on the left) important to your decision to replace an obsolete system?

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
d) My concern about the reputation of the replacement system	0	0	0	0	0	0	0
b) My concern that the replacement system will change our department's political orientation in the organization	0	0	0	0	0	0	
i) The ability of the replacement system to support and help the organization expand core competencies	0	0	0	0	0	0	0
e) My concern that I will regret the replacement decision	0	$\circ$	0	0	$\circ$	$\bigcirc$	$\circ$
c) My anticipation that the replacement system will improve the manner in which we interact with suppliers and customer	er:	0	0	0	0	0	0
a) My concern that the replacement system will replace some people's jobs	0	$\circ$	0	0	$\circ$	$\circ$	
j) My concern that acquiring the replacement system will cost me or my department political capital	0	0	0	0	0	0	0
My concern about the implementation success record of the replacement systems implementation team/vendor	0	0	0	0	0	0	0
k) My concern that replacing the legacy system will cost me or my department political capital	0	0	0	0	0	0	0
f) My concern that, if the replacement implementation does not go well, I will be blamed	0	$\bigcirc$	0	0		$\bigcirc$	
h) The ability of the replacement system to support our business strategy	0	0	0	0	0	0	0
g) My concern that, if the replacement implementation does not go well, my department's future budgets will be cut	0	0	0	0	0	0	0

#### \* 26. Are any of these terms or the meaning of the question unclear? Please explain.

Figure 17. Page 9 of 14 image of the survey instrument

•	My concern that the replacement system will replace some people's jobs
•	My concern that the replacement system will change our department's political orientation in the organization
•	My anticipation that the replacement system will improve the manner in which we interact with suppliers and customers
•	My concern about the reputation of the replacement system
•	My concern about the implementation success record of the replacement systems implementation team/vendor
•	My concern that I will regret the replacement decision
•	My concern that, if the replacement implementation does not go well, I will be blamed
•	My concern that, if the replacement implementation does not go well, my department's future budgets will be cut
•	The ability of the replacement system to support our business strategy
•	The ability of the replacement system to support and help the organization expand core competencies
•	My concern that acquiring the replacement system will cost me or my department political capital
•	My concern that replacing the legacy system will cost me or my department political capital
3. F	or the support element you selected as most important (Ranked #1): Why is this element most important to your replacement decision
. F	or the support element you selected as least important (Ranked #12): Why is this element least important to your replacement decision

Figure 18. Page 10 of 14 image of the survey instrument

	Part	6:	Techni	cal
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This section (questions 31-36) describes perceptions of how important the technical elements of the replacement system are to the replacement decision.

Please use the system you identified above as your frame of reference for these questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question.
(1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

### \* 31. Is this technical element (listed below on the left) important to your decision to replace an obsolete system?

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
b) Ease of using the replacement system	0	0	0	0	0	0	0
h) The adaptability of the system to new market or regulatory demands	0	0	$\circ$	0		$\circ$	0
a) Increases in usefulness from the replacement system	0	0	0	0	0	0	0
e) The scalability of the replacement system	0	0	0	0	0	0	0
c) The interoperability of the replacement system with my other IT systems and networks	0	0	0	0	0	0	0
g) The Mean Time Between Failure of the significant components	$\circ$	0	0	$\bigcirc$	0	0	0
d) The interoperability of the replacement system with my suppliers and customers systems and networks	0	0	0	0	0	0	0
f) The projected product lifetime and manufacturer support projection	0	0	0	0	0	0	0

* 32.	Are an	y of these	terms or th	e meaning	of the	question	unclear?	Please	explain.
					-				

Figure 19. Page 11 of 14 image of the survey instrument

	Increases in usefulness from the replacement system
•	Ease of using the replacement system
•	The interoperability of the replacement system with my other IT systems and networks
•	The interoperability of the replacement system with my suppliers and customers systems and networks
•	The scalability of the replacement system
•	The projected product lifetime and manufacturer support projection
•	The Mean Time Between Failure of the significant components
•	The adaptability of the system to new market or regulatory demands
34. F	or the technical element you selected as most important (ranked #1): Why is this element most important to your replacement decision

Figure 20. Page 12 of 14 image of the survey instrument

<b>Part</b>	7:	Ran	king

This section (questions 37.39) evaluates which of the discussed elements of the replacement decision you find to be most important and least important to your replacement decision.

* 37. Please rank order each response: Place a 1 for the element most important to the replacement decision. It will then move to the top of the list.	
Then select 2 for the next most important, which will move to that position. Continue to 5 for the least important,  Obsolescence elements	
▼ Business Costs	
▼ Benefits	
▼ Organizational Support	
▼ Technical aspects	
* 38. For the element you selected as most important (ranked #1): Why is this element most important to your replacement decision?	
* 39. For the element you selected as least important (ranked #5): Why is this element least important to your replacement decision?	

Figure 21. Page 13 of 14 image of the survey instrument

Part 8: P	erceptions
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This section describes your perceptions of the replacement decision.

In the context of the obsolete system you described above, please answer the following questions.

Instructions- Please, fill out the following scale by selecting the response which best corresponds to your opinion about each question. (1) Strongly Disagree, (2) Disagree, (3) Somewhat Disagree, (4) Neutral, (5) Somewhat Agree, (6) Agree, (7) Strongly Agree.

\* 40. Please describe your perception regarding the decision to replace the obsolete system.

	Strongly Disagree	Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Agree	Strongly Agree
I do not advise replacing the obsolete system	0	0	0	0	0	0	0
If I could, I would replace my obsolete system	0	$\circ$	0	0	0	0	
It is highly likely I would replace my obsolete system	0	0	0	0	0	0	0
The obsolete system should be replaced	0	0	0	0	0	0	0

## Part 9: Other

This is the last section. When completed, please click the submit button. Thank you for your participation.

\* 41. Beyond the elements identified in the questions of the survey, are there any additional factors that influence your replacement decision that you believe would be important for improving this survey?

Prev Done

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Figure 22. Page 14 of 14 image of the survey instrument

# APPENDIX B. ANALYSIS CHARTS

This appendix provides the charts and data employed for the analysis of the survey results.

Table 41. Pearson's Chi Squared GFI for expected distribution

Variable	Chi Square X2	X2 Asymp Sig	X2 df	Table
Gender	4.56	0.033	1	3.84
Age	5.765	0.124	3	7.81
OI_DMSMS	19.523	0.003	6	12.59
OI_SW_EOL	10.069	0.073	5	11.07
OI_Tech_Limits	12.91	0.012	4	9.49
OI_Lost_Bus_Op	3.722	0.59	5	11.07
OI_No_Reg_Change	26.375	0	5	11.07
OI_No_Market_Change	14.173	0.007	4	9.49
OI_No_Bus_Mission_Sup	17.672	0.003	5	11.07
OI_Rise_O_M_Cost	9.164	0.165	6	12.59
OI_Decline_O_M_Know	4.375	0.497	5	11.07
C_Financial_Cost	6.585	0.253	5	11.07
C_Acq_Cost	13.439	0.02	5	11.07
C_Bus_Intang	10.922	0.027	4	9.49
C_Sunk_Cost	2.682	0.848	6	12.59
C_Trans_Jobs_Skills	6.366	3.83	6	12.59
C_Switch_Cost	17.35	0.004	5	11.07
C_Switch_Time	13.69	0.018	5	11.07
C_Failure	8.537	0.201	6	12.59
C_Dept_Impact	5.531	0.355	5	11.07
C_Lifecycle_Cost	8.302	0.14	5	11.07
C_Personnel_Avail_New	7.804	0.253	6	12.59
C_Legacy_Mx	11.796	0.038	5	11.07
B_Imp_Interop	13.984	0.016	5	11.07
B_New_Bus	6.761	0.239	5	11.07
B_Imp_Comp	4.503	0.479	5	11.07
B_Decr_MX_Cost	4.158	0.527	5	11.07
B_Inc_Avail_Personnel	12.383	0.03	5	11.07
B_Imp_Comp_Adv	1.941	0.747	4	9.49
B_Imp_Market_Share	6.18	0.289	5	11.07
B_Inc_Cust_Sat	9.8	0.044	4	9.49
B_Incr_Bus_Proc_Effect	5.579	0.134	4	9.49
OS_Replaced_Jobs	19.36	0.002	5	11.07
OS_Dept_Political_Pos	8.597	0.198	6	12.59
OS_Imp_Supl_Cust_Interact	6.944	0.225	5	11.07
OS_Repl_Sys_Rep	11.6	0.072	6	12.59
OS_Vendor_Success_Record	16.49	0.011	6	12.59
OS_Regret	36.52	0	6	12.59
OS_Fear_Failure_Blame	18.4	0.006	6	12.59
OS_Fear_Failure_Budget_Cut	13.36	0.02	5	11.07

Table B1. Pearson's Chi Squared GFI for expected distribution (Continued)

Variable	Chi Square X2	X2 Asymp Sig	X2 df	Table
OS_New_Sup_Bus_Strategy	2.351	0.672	4	9.49
OS_New_Sup_Core_Comp	9.321	0.097	5	11.07
OS_New_Acq_Political_Cost	14.8	0.011	5	11.07
OS_Lose_Old_Political_Cost	4.108	0.662	6	12.59
T_PU	2.152	0.708	4	9.49
T_PEOU	7.725	0.052	3	7.81
T_Inc_Interop_Sys	2.207	0.82	5	11.07
T_Inc_Interop_Sup_Cust	6.574	0.254	5	11.07
T_Scalability	2.905	0.574	4	9.49
T_Product_Lifetime	3.461	0.629	5	11.07
T_MTBF	1.876	0.866	5	11.07
T_Adaptability	6.472	0.263	5	11.07

Table 42. *Means and Deviations* 

Variable	Means: Most	Standard	Variable	Means: Most	Standard
	Important	Deviation		Important	Deviation
IT_Exp	26.7	N/A	C_Dept_Impact	5.06	1.49
AP_Exp	16.9	N/A	C_Lifecycle_Cost	5.43	1.28
OI_DMSMS	4.98	1.145	C_Personnel_Avail_New	5	1.44
OI_SW_EOL	5.8	1.18	C_Legacy_Mx	5.82	1.09
OI_Tech_Limits	5.2	1.36	C_Rank_Financial_Cost	3.49	2.84
OI_Lost_Bus_Op	5.16	1.54	C_Rank_Acq_Cost	3.58	1.92
OI_No_Reg_Change	4.92	1.78	C_Rank_Bus_Intang	5.63	3.3
OI_No_Market_Change	5.53	1.43	C_Rank_Sunk_Cost	8.78	3.02
OI_No_Bus_Mission_Sup	5.78	1.42	C_Other_Solicit	N/A	N/A
OI_Rise_O_M_Cost	5.56	1.2	B_Imp_Interop	5.31	1.35
OI_Decline_O_M_Know	5.24	1.26	B_New_Bus	5.25	1.62
OI_Unclear	N/A	N/A	B_Imp_Comp	5.61	1.46
OI_Rank_DMSMS	5.75	2.36	B_Decr_MX_Cost	5.55	1.03
OI_Rank_SW_EOL	4.51	2.81	B_Inc_Avail_Personnel	4.76	1.19
OI_Rank_Tech_Limits	5.08	2.54	B_Imp_Comp_Adv	5.57	1.49
OI_Rank_Lost_Bus_Op	4.73	2.43	B_Imp_Market_Share	5.14	1.6
OI_Rank_No_Reg_Change	5.16	2.75	B_Inc_Cust_Sat	5.67	1.11
OI_Rank_No_Market_Change	5.16	2.5	B_Incr_Bus_Proc_Effect	6	0.87
OI_Rank_No_Bus_Mission_Sup	3.94	2.51	B_Unclear	N/A	N/A
OI_Rank_Rise_O_M_Cost	4.78	2.38	B_Rank_Imp_Interop	4.94	2.44
OI_Rank_Decline_O_M_Know	5.9	2.58	B_Rank_New_Bus	4.78	2.4
C_Financial_Cost	5.71	1.15	B_Rank_Imp_Comp	4.06	2.34
C_Acq_Cost	5.66	1.22	B_Rank_Decr_MX_Cost	4.87	2.59
C_Bus_Intang	5.32	1.32	B_Rank_Inc_Avail_Personnel	6.92	2.34
C_Sunk_Cost	3.76	1.66	B_Rank_Imp_Comp_Adv	4.43	2.52
C_Trans_Jobs_Skills	3.33	1.6	B_Rank_Imp_Market_Share	5.76	2.57
C_Switch_Cost	5.67	1.28	B_Rank_Inc_Cust_Sat	4.49	2.27
C_Switch_Time	5.43	1.19	B_Other_Solicit	N/A	N/A
C Failure	4.96	1.56	_		

Table B2. *Means and Deviations (Continued)* 

Variable	Means: Most	Standard	Variable	Means: Most	Standard
	Important	Deviation		Important	Deviation
OS_Replaced_Jobs	3.12	1.3	T_Rank_Scalability	4.37	1.9
OS_Dept_Political_Pos	2.98	1.53	T_Rank_Product_Lifetime	5.55	2.09
OS_Imp_Supl_Cust_Interact	5.6	1.11	T_Rank_MTBF	5.84	5.14
OS_Repl_Sys_Rep	4.16	1.75	T_Rank_Adapability	2.33	2.71
OS_Vendor_Success_Record	4.78	1.66	T_Most_Imp_Why	N/A	
OS_Regret	3.02	1.41	R_C	2.49	1.19
OS_Fear_Failure_Blame	3.7	1.62	R_B	1.84	1.08
OS_Fear_Failure_Budget_Cut	3.6	1.34	R_OS	4.01	1.18
OS_New_Sup_Bus_Strategy	6	1.01	R_T	3.25	1.02
OS_New_Sup_Core_Comp	5.75	1.09	R_Most_Imp_Why	N/A	
OS_New_Acq_Political_Cost	3.2	1.37	R_Least_imp_Why	N/A	
OS_Rank_Replaced_Jobs	7.9	3.03	BI_Do_Not_Adv	2.55	1.49
OS_Rank_Dept_Political_Pos	6.94	2.75	BI_Should	6.08	1.1
OS_Rank_Imp_Supl_Cust_Interact	3.2	2.41	BI_Would	5.86	1.22
OS_Rank_Repl_Sys_Rep	5.33	1.99	BI_High_Likely	5.84	1.28
OS_Other_Solicit	N/A				
T_PU	5.94	1.1			
T_PEOU	5.98	0.65			
T_Inc_Interop_Sys	5.82	1.21			
T_Inc_Interop_Sup_Cust	5.75	1.2			
T_Scalability	5.96	1			
T_Product_Lifetime	5.76	1.14			
T_MTBF	5.33	1.47			
T_Adapability	5.43	1.28			
T_Unclear	N/A				
T_Rank_PU	2.9	2.15			
T_Rank_PEOU	3.65	1.76			
T_Rank_Inc_Interop_Sys	3.9	1.92			
T_Rank_Inc_Interop_Sup_Cust	4.65	1.9			

Table 43. Fleiss Kappa Inter Rater Reliability

				Lower 95% CI	Upper 95% CI
Variable	Карра	ASE	Z-Value	Bound	Bound
OI	.090	.012	7.368	.066	.114
С	.105	.009	11.915	.087	.122
В	.168	.013	13.301	.143	.192
OS	110	.005	-21.235	121	100
Т	.136	.016	8.747	.105	.166
BI	.220	.028	7.895	.165	.275

Table 44. *ANOVA of Variables to BI* 

	ANOVA		Brown-
Variable	Significance	Welch	Forsythe
OI	0.094	0.052	0.052
С	0.071	0.038	0.038
В	0.676	0.473	0.473
OS	0.121	0.175	0.175
Т	0.055	0.071	0.071

Table 45. Regression of the Variable Ranking and Cumulative Averages amongst factors for prediction of BI

		ANOVA	Coefficient
Variable	Predictor	Regression	Significance
OI	Obsolescence Elements	0.042	0.042
OI	OI Cum Avg	0.187	0.187
OI	Both	0.066	
С	Business Costs	0.25	0.25
С	C Cum Avg	0.796	0.796
С	Both	0.516	
В	Benefits	0.663	0.663
В	B Cum Avg	0.144	0.144
В	Both	0.347	
OS	Organizational Support	0.65	0.65
OS	OS Cum Avg	0.869	0.869
OS	Both	0.183	
Т	Technical Aspects	0.327	0.327
T	T Cum Avg	0.469	0.469
T	Both	0.554	

Table 46. Regression of the Summary Ranking Amongst Factors for Prediction of BI

	R	R	Adjusted	Std.	ANOVA	Beta	t	Significance
		Square	R Square	Error of	Regression			
				the				
				Estimate				
Constant	.355 <sup>a</sup>	.126	.050	.92657	.175 <sup>b</sup>		5.956	.000
Obsolescence elements						391	-2.126	.039
Business Costs						060	327	.745
Benefits						166	876	.385
Technical aspects						247	-1.395	.170
Organizational Support						*	*	.000

 Table 47.
 Regression of Gender for Prediction of Variables

			Adjusted	Std. Error of the	ANOVA		
Variable	R	R Square	R Square	Estimate	Regression	Beta	t
BI	0.142	.020	.000	.95076	0.322	142	-1.001
OI	0.069	.005	016	.81705	0.631	0.069	0.483
С	0.038	.001	019	.78410	0.791	038	267
В	0.16	.026	.006	.85660	0.261	.160	1.136
OS	0.111	.012	008	.92913	0.441	111	777
T	0.209	.044	.024	.69800	0.14	.209	1.499

Table 48. Regression of Age for Prediction of Variables

		Std. Error						
			Adjusted	of the	ANOVA			
Variable	R	R Square	R Square	Estimate	Regression	Beta	t	
BI	0.092	.009	012	.95632	0.519	.092	.649	
OI	0.274	.075	.056	.78760	0.051	274	-1.996	
С	0.188	.035	.016	.77073	0.187	188	-1.338	
В	0.09	.008	012	.86432	0.532	090	630	
OS	0.23	.053	.033	.90982	0.108	230	-1.640	
Т	0.131	.017	003	.70769	0.36	131	923	

 Table 49.
 Regression of IT EXP for Prediction of Variables

			Adjusted	Std. Error of the	ANOVA		
Variable	R	R Square	R Śquare	Estimate	Regression	Beta	t
BI	0.072	.005	015	.95791	.614	072	508
OI	0.253	.064	.045	.79243	.074	253	-1.828
С	0.273	.074	.056	.75490	.053	273	-1.985
В	0.28	.078	.060	.83307	.047	280	-2.042
OS	0.293	.086	.067	.89390	.039	293	-2.124
T	0.322	.104	.085	.67576	.021	322	-2.382

 Table 50.
 Regression of AP EXP for Prediction of Variables

				Std. Error			
			Adjusted	of the	ANOVA		
Variable	R	R Square	R Square	Estimate	Regression	Beta	t
BI	0.107	.011	009	.95496	.457	.107	.750
OI	0.188	.035	.016	.80438	.186	188	-1.340
С	0.008	.000	020	.78464	.953	.008	.060
В	0.161	.026	.006	.85649	.259	161	-1.142
OS	0.017	.000	021	.93483	.908	017	116
T	0.139	.019	001	.70692	.332	139	980

Table 51. Cronbach's Alpha Reliability Measure

	Cronbach's Alpha					
	Cronbach's	Based on	N of			
Variable	Alpha	Standardized Items	Items			
OI	.756	.736	9			
C	.819	.831	12			
В	.820	.796	9			
OS	.881	.872	12			
T	.764	.776	8			

Table 52. Factor Analysis of OI

		Initial Eigenvalu		Loadings		
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	3.490	38.781	38.781	3.355	37.274	37.274
2	1.826	20.294	59.075	1.555	17.278	54.552
3	1.060	11.782	70.857	1.467	16.304	70.857
4	.885	9.832	80.688			
5	.557	6.189	86.877			
6	.470	5.222	92.099			
7	.302	3.356	95.455			
8	.263	2.921	98.376			
9	.146	1.624	100.000			

*Note:* Factor analysis of OI. Using principal component analysis as the extraction method and Verimax with Kaiser normalization as the rotation method.

Table 53. Factor Analysis of C

		Initial Eigenvalu	es		Loadings	
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	4.483	37.355	37.355	2.897	24.142	24.142
2	1.623	13.521	50.876	2.624	21.871	46.013
3	1.145	9.538	60.415	1.728	14.402	60.415
4	.919	7.658	68.072			
5	.856	7.133	75.206			
6	.740	6.166	81.372			
7	.656	5.464	86.836			
8	.438	3.650	90.487			
9	.373	3.105	93.591			
10	.335	2.794	96.386			
11	.290	2.414	98.799			
12	.144	1.201	100.000			

*Note:* Using principal component analysis as the extraction method and Verimax with Kaiser normalization as the rotation method.

Table 54. Factor Analysis of B

		Initial Eigenvalu	Loadings			
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	3.922	43.578	43.578	3.265	36.277	36.277
2	1.589	17.658	61.236	1.698	18.862	55.139
3	1.060	11.780	73.016	1.609	17.877	73.016
4	.870	9.669	82.685			
5	.730	8.111	90.796			
6	.341	3.793	94.589			
7	.249	2.763	97.353			
8	.129	1.435	98.788			
9	.109	1.212	100.000			

*Note:* Using principal component analysis as the extraction method and Verimax with Kaiser normalization as the rotation method.

Table 55. Factor Analysis of OS

-		Initial Eigenvalu	ies		Loadings	
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	5.418	45.151	45.151	4.485	37.379	37.379
2	1.548	12.899	58.050	1.956	16.303	53.681
3	1.100	9.170	67.220	1.625	13.539	67.220
4	.818	6.813	74.033			
5	.724	6.033	80.066			
6	.655	5.454	85.521			
7	.450	3.749	89.270			
8	.419	3.493	92.763			
9	.350	2.918	95.681			
10	.223	1.856	97.537			
11	.172	1.432	98.969			
12	.124	1.031	100.000			

*Note:* Using principal component analysis as the extraction method and Verimax with Kaiser normalization as the rotation method.

Table 56. Factor Analysis of T

	Initial Eigenvalues				Loadings			
Component	Total	% of	Cumulative %	Total	% of	Cumulative %		
		Variance			Variance			
1	3.194	39.922	39.922	2.702	33.780	33.780		
2	1.267	15.837	55.759	1.758	21.980	55.759		
3	.852	10.647	66.406					
4	.815	10.184	76.590					
5	.676	8.446	85.037					
6	.460	5.749	90.785					
7	.404	5.046	95.831					
8	.334	4.169	100.000					

*Note:* Using principal component analysis as the extraction method and Verimax with Kaiser normalization as the rotation method.

Table 57. Factor Analysis with Egan Values Greater Than 1

		Initial Eigenvalu	ec
Component	Total	% of	Cumulative %
		Variance	
1	2.834	56.689	56.689
2	.882	17.631	74.320
3	.742	14.832	89.152
4	.300	6.009	95.161
5	.242	4.839	100.000

*Note:* Extraction method: Principal Component Analysis of the cumulative average of each element with Egan Values greater than 1

Table 58. Factor Analysis with Egan Values Greater Than 0.5

		Initial Eigenvalı	ies		Loadings	
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	2.834	56.689	56.689	1.619	32.390	32.390
2	.882	17.631	74.320	1.523	30.461	62.851
3	.742	14.832	89.152	1.315	26.301	89.152
4	.300	6.009	95.161			
5	.242	4.839	100.000			

*Note:* Extraction method: Principal Component Analysis of the cumulative average of each element with Egan Values greater than 0.5.

Table 59. Factor Analysis of the Cumulative Average of Each Element with Demographic Elements Added

		Initial Eigenvalu	ies		Loadings	
Component	Total	% of	Cumulative %	Total	% of	Cumulative %
		Variance			Variance	
1	3.335	37.057	37.057	2.870	31.894	31.894
2	1.733	19.259	56.316	2.177	24.194	56.088
3	1.165	12.945	69.261	1.186	13.173	69.261
4	.866	9.621	78.882			
5	.749	8.326	87.209			
6	.460	5.106	92.315			
7	.294	3.268	95.583			
8	.230	2.556	98.139			
9	.167	1.861	100.000			

*Note:* Extraction method: Principal Component Analysis of the cumulative average of each element with demographic elements added.

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Coefficients <sup>a</sup>																		
	DV: 1)		DFV: 2)		DV: 3)		DV: 4)		DV: 5)		DV: 6)		DV: 7)		DV: 8)		DV: 9)	
Variables	Tolerance	VIF																
1) OI_DMSMS			.377	2.653	.465	2.150	.440	2.274	.456	2.192	.475	2.103	.638	1.568	.439	2.280	.454	2.204
2) OI_SW_EOL	.265	3.772			.387	2.581	.453	2.206	.491	2.035	.407	2.459	.343	2.919	.340	2.938	.365	2.739
3) OI_Tech_Limits	.399	2.506	.473	2.116			.377	2.653	.668	1.497	.459	2.179	.387	2.581	.404	2.477	.481	2.080
4) OI_Lost_Bus_Op	.415	2.409	.608	1.644	.415	2.411			.451	2.215	.336	2.978	.415	2.407	.436	2.292	.481	2.078
5) Ol_No_Reg_Change	.334	2.990	.512	1.953	.571	1.751	.351	2.852			.327	3.055	.363	2.758	.460	2.173	.319	3.138
6) Ol_No_Market_Change	.422	2.369	.513	1.948	.475	2.105	.316	3.166	.396	2.523			.377	2.655	.397	2.518	.507	1.971
7) Ol_No_Bus_Mission_Sup	.563	1.778	.430	2.328	.398	2.510	.388	2.577	.436	2.293	.374	2.673			.450	2.222	.495	2.019
8) OI_Rise_O_M_Cost	.431	2.320	.475	2.104	.462	2.163	.454	2.202	.617	1.621	.439	2.275	.501	1.995			.331	3.017
9) OI_Decline_O_M_Know	.379	2.640	.433	2.307	.468	2.136	.426	2.349	.363	2.755	.477	2.096	.469	2.132	.282	3.550		

Figure 23. Multicollinearity assessment of OI elements. Pink highlights excessive collinearity.

Coefficients <sup>a</sup>																								
	1	1)	2	2)	3	3)	4	.)		5)	6	6)	7	<u>'</u> )	8	3)	9	9)	1	0)	1	1)	1	2)
	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF												
1) C_Financial_Cost			.238	4.200	.539	1.855	.581	1.722	.259	3.860	.384	2.602	.340	2.940	.372	2.688	.342	2.926	.452	2.213	.587	1.703	.606	1.649
2) C_Acq_Cost	.524	1.909			.729	1.372	.585	1.708	.345	2.900	.491	2.036	.431	2.322	.624	1.603	.446	2.244	.789	1.267	.699	1.431	.589	1.699
3) C_Bus_Intang	.409	2.444	.252	3.975			.417	2.401	.176	5.680	.355	2.816	.245	4.085	.370	2.705	.304	3.291	.520	1.925	.453	2.206	.465	2.151
4) C_Sunk_Cost	.515	1.940	.236	4.234	.487	2.054			.288	3.474	.405	2.468	.308	3.248	.424	2.357	.382	2.620	.432	2.314	.592	1.689	.493	2.029
5) C_Trans_Jobs_Skills	.460	2.174	.278	3.592	.412	2.429	.576	1.736			.565	1.769	.426	2.349	.623	1.605	.560	1.787	.447	2.239	.502	1.991	.680	1.470
6) C_Switch_Cost	.455	2.196	.265	3.780	.554	1.804	.541	1.848	.377	2.650			.285	3.509	.500	1.999	.499	2.005	.468	2.137	.467	2.140	.666	1.501
7) C_Switch_Time	.538	1.858	.310	3.227	.510	1.959	.549	1.821	.380	2.635	.381	2.627			.456	2.194	.515	1.943	.588	1.701	.433	2.309	.694	1.441
8) C_Failure	.346	2.893	.264	3.795	.452	2.210	.444	2.251	.326	3.067	.392	2.550	.268	3.738			.518	1.929	.480	2.085	.438	2.281	.456	2.191
9) C_Dept_Impact	.390	2.564	.231	4.325	.457	2.189	.491	2.037	.360	2.780	.480	2.081	.371	2.695	.637	1.571			.393	2.545	.433	2.308	.613	1.631
10) C_Lifecycle_Cost	.383	2.613	.304	3.292	.579	1.726	.412	2.426	.213	4.694	.334	2.990	.314	3.180	.437	2.287	.292	3.430			.444	2.250	.382	2.619
11) C_Personnel_Avail_New	.506	1.976	.274	3.654	.514	1.944	.575	1.739	.244	4.103	.340	2.943	.236	4.242	.407	2.460	.327	3.058	.452	2.211			.419	2.388
12) C_Legacy_Mx	.388	2.576	.171	5.838	.392	2.550	.356	2.813	.245	4.077	.360	2.779	.281	3.562	.314	3.180	.344	2.908	.289	3.465	.311	3.215		

Figure 24. Multicollinearity assessment of C elements. Pink highlights excessive collinearity.

Coefficients <sup>a</sup>		1)	2	2)	3	3)	4	·)	ţ	5)	6	5)	7	<b>'</b> )	8	3)	9	9)
	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF												
1) B_Imp_Interop			.427	2.341	.270	3.701	.376	2.658	.267	3.751	.303	3.305	.326	3.068	.449	2.226	.369	2.711
2) B_New_Bus	.442	2.261			.221	4.527	.454	2.202	.265	3.768	.276	3.618	.315	3.174	.347	2.883	.613	1.632
3) B_Imp_Comp	.294	3.404	.232	4.311			.253	3.958	.357	2.802	.141	7.071	.332	3.016	.412	2.429	.346	2.889
4) B_Decr_MX_Cost	.335	2.989	.390	2.564	.207	4.839			.183	5.470	.277	3.608	.268	3.728	.241	4.144	.355	2.820
5) B_Inc_Avail_Personnel	.291	3.436	.280	3.573	.358	2.790	.224	4.455			.241	4.155	.315	3.174	.403	2.480	.330	3.026
6) B_Imp_Comp_Adv	.284	3.522	.250	3.992	.122	8.195	.292	3.420	.207	4.835			.134	7.487	.212	4.714	.206	4.858
7) B_Imp_Market_Share	.296	3.379	.276	3.620	.277	3.612	.274	3.652	.262	3.818	.129	7.738			.303	3.300	.477	2.095
8) B_Inc_Cust_Sat	.523	1.912	.390	2.564	.441	2.270	.316	3.166	.430	2.326	.171	5.852	.389	2.574			.462	2.165
9) B_Incr_Bus_Proc_Effect	.287	3.480	.461	2.170	.248	4.033	.311	3.220	.236	4.242	.263	3.800	.410	2.441	.309	3.235		

Figure 25. Multicollinearity assessment of B elements. Pink highlights excessive collinearity.

Coefficients <sup>a</sup>		1)	2	2)	3	3)	4	1)		5)	6	5)	7	7)	8	3)	9	)	1	0)	1	1)	1	12)
	Toler		Toler		Toler		Toler		Toler		Toler		Toler		Toler		Toler		Toler		Toler		Toler	
	ance	VIF																						
1) OS_Replaced_Jobs			.194	5.157	.215	4.654	.178	5.605	.270	3.709	.364	2.744	.392	2.549	.195	5.117	.332	3.011	.482	2.074	.203	4.934	.440	2.273
2) OS_Dept_Political_Pos	.236	4.243			.390	2.564	.300	3.330	.333	3.001	.510	1.962	.490	2.041	.208	4.797	.362	2.760	.522	1.915	.331	3.021	.239	4.184
3) OS_Imp_Supl_Cust_Interact	.341	2.931	.509	1.963			.387	2.584	.295	3.390	.569	1.758	.489	2.045	.311	3.216	.439	2.276	.597	1.676	.442	2.260	.396	2.528
4) OS_Repl_Sys_Rep	.416	2.402	.576	1.735	.569	1.758			.172	5.816	.394	2.536	.605	1.652	.196	5.099	.401	2.494	.497	2.011	.470	2.127	.503	1.987
5) OS_Vendor_Success_Record	.371	2.694	.479	2.088	.453	2.207	.273	3.665			.322	3.107	.421	2.374	.255	3.924	.510	1.959	.455	2.199	.406	2.465	.384	2.604
6) OS_Regret	.480	2.082	.447	2.235	.479	2.088	.364	2.749	.273	3.669			.289	3.464	.204	4.893	.377	2.649	.528	1.893	.399	2.508	.414	2.417
7) OS_Fear_Failure_Blame	.375	2.668	.419	2.387	.401	2.496	.272	3.676	.364	2.748	.366	2.729			.260	3.843	.436	2.292	.428	2.339	.252	3.961	.394	2.540
8) OS_Fear_Failure_Budget_Cut	.713	1.402	.441	2.270	.360	2.779	.365	2.738	.249	4.017	.468	2.136	.431	2.318			.317	3.152	.350	2.858	.341	2.936	.505	1.980
9) OS_New_Sup_Bus_Strategy	.524	1.910	.451	2.217	.377	2.654	.311	3.218	.307	3.262	.565	1.771	.480	2.084	.263	3.806			.244	4.104	.359	2.784	.452	2.211
10) OS_New_Sup_Core_Comp	.313	3.199	.509	1.965	.422	2.370	.328	3.048	.296	3.384	.391	2.558	.522	1.916	.200	4.997	.272	3.678			.294	3.405	.359	2.787
11) OS_New_Acq_Political_Cost	.348	2.872	.468	2.137	.283	3.529	.346	2.889	.323	3.097	.459	2.179	.334	2.993	.214	4.683	.374	2.674	.393	2.542			.248	4.040
12) OS_Lose_Old_Political_Cost	.500	1.999	.224	4.471	.479	2.089	.245	4.076	.202	4.941	.315	3.170	.345	2.899	.210	4.771	.312	3.208	.318	3.143	.164	6.101		

Figure 26. Multicollinearity assessment of OS elements. Pink highlights excessive collinearity.

Coefficients <sup>a</sup>	1	l)	2	2)	3	3)	4	)		5)	6	6)	7	<u>'</u> )	8	3)
	Toler ance	VIF	Toler ance	VIF	Toler ance	VIF										
1) T_PU	ance	VII	.202		.542	1.846		2.815		2.621	.486	2.058	.478	2.093		2.055
2) T_PEOU	.300	3.335			.304	3.288	.276	3.624	.498	2.007	.488	2.048	.593	1.685	.670	1.493
3) T_Inc_Interop_Sys	.380	2.631	.308	3.249			.499	2.004	.498	2.008	.516	1.939	.553	1.810	.740	1.351
4) T_Inc_Interop_Sup_Cust	.640	1.562	.457	2.189	.283	3.528			.405	2.471	.530	1.887	.604	1.656	.490	2.040
5) T_Scalability	.489	2.046	.431	2.319	.511	1.958	.404	2.475			.581	1.722	.535	1.869	.825	1.212
6) T_Product_Lifetime	.512	1.952	.348	2.877	.435	2.297	.435	2.297	.478	2.093			.564	1.774	.680	1.471
7) T_MTBF	.407	2.459	.341	2.931	.377	2.656	.401	2.495	.356	2.812	.455	2.197			.609	1.642
8) T_Adapability	.306	3.263	.285	3.510	.373	2.679	.241	4.157	.406	2.465	.406	2.462	.451	2.220		

Figure 27. Multicollinearity assessment of T elements. Pink highlights excessive collinearity.

Coefficients <sup>a</sup>	,	1)	2	2)	3	3)	4	)	5)		
	Toler ance	VIF									
Obsolescence Imperative			.476	2.100	.424	2.357	.562	1.779	.335	2.983	
Costs	.753	1.327			.538	1.859	.530	1.885	.541	1.849	
Benefits	.808	1.237	.648	1.544			.562	1.780	.587	1.703	
Organizational Support	.899	1.112	.569	1.758	.446	2.244			.450	2.224	
Technical	.726	1.377	.740	1.351	.667	1.499	.608	1.644			

Figure 28. Multicollinearity assessment for composite of all elements.