Implementation Priority of the ITIL framework based on a Process Sequencing Model

by Alma C. H. Miller

B.S. in Electrical Engineering, May 2003, Catholic University of America
M.S. in Electrical Engineering, December 2007, The George Washington University
M.S. in Technical Management, May 2009, Johns Hopkins University

A Praxis submitted to

The Faculty of
The School of Engineering and Applied Science
Of the George Washington University
in partial fulfillment of the requirements
for the degree of Doctor of Engineering

January 31, 2017

Praxis directed by

Shahram Sarkani
Professor of Engineering Management and Systems Engineering

Thomas Mazzuchi
Professor of Engineering Management and Systems Engineering & Decision Sciences

The School of Engineering and Applied Science of The George Washington University certifies that Alma C. H. Miller has passed the Final Examination for the degree of Doctor of Engineering as of October 20, 2016. This is the final and approved form of the praxis.

Implementation Priority of the ITIL framework based on a Process Sequencing Model

Alma C.H. Miller

Praxis Research Committee:

Shahram Sarkani, Professor of Engineering Management and Systems Engineering, Praxis Director

Thomas Mazzuchi, Professor of Engineering Management and Systems Engineering & of Decision Sciences, Committee Member

Quentin Cantlo, Senior VP of Information Technology Services, CAEI, Committee Member

© Copyright 2016 by Alma C.H. Miller
All rights reserved

Dedication

The author wishes to dedicate this praxis to her husband, Wesley R. Miller. He has supported her unconditionally through the entire research process.

Acknowledgements

The author wishes to acknowledge her husband, Wesley R. Miller, her children (Wesley J., Jaxson, and Louis), her mother (Alma Hinton), and her mentor (Quentin Cantlo).

Abstract of Praxis

Implementation Priority of the ITIL framework based on a Process Sequencing Model

The information technology infrastructure library (ITIL) provides a framework that information technology (IT) organizations can use to establish and enhance their operations. One obstacle to implementing ITIL is failure to fully understand the sequence of implementation for the 26 processes present in the library. Two major conclusions resulting from our research into implementation priority of ITIL processes is a process sequencing model and a process priority list that identifies the order in which processes should be implemented in order to have mature IT operations.

Table of Contents

Dedication iv

Acknowledgements v

Abstract of Praxis vi

List of Figures xi

List of Tables xii

List of Equations xv

List of Symbols / Nomenclature xvi

Glossary of Terms xvii

Chapter 1: Introduction 1

1.1 Background 1

1.2 Problem Statement 5

1.3 Research Contribution 5

1.4 Significance of Research 5

1.5 Research Methodology: Design Science Research Method 6

1.5.1 Activity 1: Problem Identification 6

1.5.2 Activity 2: Define Objectives 7

1.5.3 Activity 3: Design & Development 8

1.5.4 Activity 4: Demonstration 8

1.5.5 Activity 5: Evaluation 8

1.5.6 Activity 6: Communication 8

1.6 Assumptions & Limitations 8
1.7 Organization of the Praxis 9
2 Chapter 2: Literature Review 11
2.1 Introduction 11
2.2 Purpose and Goals 12
2.3 Search Process 12
2.4 Inclusion and Exclusion Criteria 13
2.5 Descriptive Data Collection 13
2.6 Critique of Scholarly Literature 14
2.6.1 ITIL Challenges 15
2.6.2 Critical Success Factors 18
2.6.3 ITIL Adoption and Implementation 23
2.6.4 ITIL Process Sequencing Strategies 26
2.7 Research Inferences 30
3 Chapter 3: Method 31
3.1 Introduction 31
3.2 DSR Activity 1: Problem Identification 31
3.2.1 Problem Definition 31
3.2.2 Problem Importance 32
3.3 DSR Activity 2: Define Objectives 32
3.4 DSR Activity 3: Design & Development 33
3.4.1 Model Functionality 33

3.4.2 Model Architecture 33
4 Chapter 4: Results 44
4.1 Introduction 44
4.2 DSR Activity 4: Demonstration 44
4.2.1 Model Development Step 1 44
4.2.2 Model Development Step 2 51
4.2.3 Model Development Step 3 52
4.2.4 Model Development Step 4 53
4.3 DSR Activity 5: Evaluation 54
4.3.1 Research Questions 55
4.3.2 Evaluation Procedures 56
4.3.3 Evaluation Results 56
5 Chapter 5: Discussion/Conclusion 58
5.1 Organization 58
5.2 Results Discussion 58
5.2.1 Strengths 58
5.2.2 Limitations 58
5.3 Process Selection Variable Comparison 59
5.4 Sensitivity Analysis 60
5.4.1 Process Level Secondary Sensitivity Analysis 62
5.4.2 Information Distribution Secondary Sensitivity Analysis 68
5.4.3 Process Centrality Secondary Sensitivity Analysis 71

5.5 Potential Future Work 74

References 75

Appendix A – Variable 1 Detailed Analysis 83

Appendix B – Variable 2 Detailed Analysis 97

Appendix C – Delphi Study Questionnaire 104

Appendix D – Delphi Study Details 116

List of Figures

Figure 1: ITIL Product/Service Lifecycle 2

Figure 2: Graphical Illustration of DSRM Process 7

Figure 3: Number of Studies Published Per Year 15

Figure 4: Flowchart of Procedures for Model Development 34

Figure 5: Input/Output Matrix 46

Figure 6: Pareto Chart of Information Distribution of ITIL Processes 47

Figure 7: Network Node Analysis of the ITIL Process Framework 49

Figure 8: Paired Comparison Matrix 53

Figure 9: Process Sequencing Variable Radar Chart 60

Figure 10: Process Level Secondary Analysis Chart 65

Figure 11: Process Level Secondary Analysis Chart - Scenario 6 68

Figure 12: Required Process Input Histogram 92

Figure 13: Delphi Study Round 2 Results – How much did the experts agree? 120

Figure 14: Paired Comparison Results from Round 2 121

List of Tables

Table 1: ITIL Processes 3

Table 2: ITIL v2 PMF vs CMMI Five Level Maturity Model 26

Table 3: Harmon's Process Complexity Continuum..... 36

Table 4: Process Level and Decision Horizon Time Mapping..... 37

Table 5: Process Level Determination Factors 38

Table 6: Scale Criteria for Process Level Factors..... 38

Table 7: Variable 1 (Process Level) Assessment and Results..... 45

Table 8: Variable 2 (Information Distribution) Results..... 48

Table 9: ITIL Framework Eigenvector Centrality 50

Table 10: Process Relevance for each Sequencing Variables.....51

Table 11: Process Sequencing Variable Rankings 52

Table 12: Process Priority List Generated from Process Selection Model..... 54

Table 13: Delphi Study Summary Results 55

Table 14: Cross Comparison Between Ranked Lists.....57

Table 15: Spearman Rank Correlation Analysis on Process Selection Variables 59

Table 16: Sensitivity Analysis Scenarios 61

Table 17: Spearman Rank Correlation Analysis of Sensitivity Analysis Scenarios.....61

Table 18: Initial Sensitivity Analysis Results.....61

Table 19: Process Level Secondary Analysis - Sensitivity Analysis Scenarios..... 62

Table 20: Process Level Secondary Analysis – Scenario 1..... 64

Table 21: Process Level Secondary Analysis – Scenario 4..... 66

Table 22: Process Level Secondary Analysis – Scenario 4 67

Table 23: Information Distribution Secondary Analysis - Sensitivity Analysis Scenarios 69

Table 24: Information Distribution Secondary Analysis – Scenario 2 70
Table 25: Information Distribution Secondary Analysis – Scenario 3 70
Table 26: Information Distribution Secondary Analysis – Scenario 6 71
Table 27: Process Centrality Secondary Analysis - Sensitivity Analysis Scenarios 72
Table 28: Information Distribution Secondary Analysis – Scenario 2 72
Table 29: Process Centrality Secondary Analysis – Scenario 4 73
Table 30: Process Centrality Secondary Analysis – Scenario 5 74
Table 31: Factor 1 Analysis of ITIL Processes 83
Table 32: Factor 2 Analysis of ITIL Processes 86
Table 33: Factor 3 Analysis of ITIL Processes 88
Table 34: Required Processes Reference Table 90
Table 35: Factor 4 Analysis of ITIL Processes 93
Table 36: Factor 5 Analysis of ITIL Processes 94
Table 37: Variable 2 Analysis – Seven Step Improvement Process 97
Table 38: Variable 2 Analysis – Access Management Process 97
Table 39: Variable 2 Analysis – Availability Management Process 97
Table 40: Variable 2 Analysis – Business Relationship Management Process 97
Table 41: Variable 2 Analysis – Capacity Management Process 98
Table 42: Variable 2 Analysis – Change Evaluation Process 98
Table 43: Variable 2 Analysis – Change Management Process 98
Table 44: Variable 2 Analysis – Design Coordination Process 98
Table 45: Variable 2 Analysis – Demand Management Process 99
Table 46: Variable 2 Analysis – Event Management Process 99
Table 47: Variable 2 Analysis – Financial Management Process 99
Table 48: Variable 2 Analysis – Incident Management Process 99
Table 49: Variable 2 Analysis – Information Security Management Process 100

Table 50: Variable 2 Analysis – IT Service Continuity Management Process..... 100

Table 51: Variable 2 Analysis – Knowledge Management Process..... 100

Table 52: Variable 2 Analysis – Problem Management Process 100

Table 53: Variable 2 Analysis –Release & Deployment Management Process 101

Table 54: Variable 2 Analysis – Request Fulfillment Process 101

Table 55: Variable 2 Analysis – Service Asset & Configuration Management Process ...101

Table 56: Variable 2 Analysis –Service Catalogue Management Process 101

Table 57: Variable 2 Analysis – Service Level Management Process 102

Table 58: Variable 2 Analysis – Service Portfolio Management Process 102

Table 59: Variable 2 Analysis – Supplier Management Process 102

Table 60: Variable 2 Analysis – Service Validation & Testing Process 102

Table 61: Variable 2 Analysis – Transition Planning & Support Process.....103

Table 62: Category Numeric Value Table 117

Table 63: Round 1 Delphi Study Results on ITIL Process Importance 118

Table 64: Round 2 Input Data for Delphi Study.....119

Table 65: Round 2 Delphi Study Results on ITIL Process Importance..... 120

Table 66: Round 3 Input Data for Delphi Study.....122

List of Equations

Equation 1: Process Level Score Equation 39

Equation 2: Eigenvector Centrality Equation 42

Equation 3: Equation for Spearman Rank Correlation 56

List of Symbols / Nomenclature

** Listed in order of appearance

1.	A	Adjacent Matrix used in the Eigen Centrality Equation
2.	n	Number of vertices (nodes) used in Eigen Centrality Equation
3.	λ	Largest Eigenvector for A used in Eigen Centrality Equation
4.	ρ	Spearman Rank Order Correlation Coefficient
5.	d	Distance between ranks used in the Spearman Rank Correlation Equation
6.	i	The referenced term

Glossary of Terms

Acronym	Definition
7Step	7 Step Improvement
AM	Access Management
AvailM	Availability Management
BRM	Business Relationship Management
CapM	Capacity Management
CE	Change Evaluation
CM	Change Management
CMMI	Capability Maturity Model Integration
CoBIT	Control Objects from Information Related Technology
DC	Design Coordination
DM	Demand Management
DSRM	Design Science Research Method
EM	Event Management
FM	Financial Management for IT Services
IEC	International Electrotechnical Commission
IM	Incident Management
IS	Information Systems
ISM	Information Security Management
ISO	International Standards Organization
IT	Information Technology
ITIL	Information Technology Infrastructure Library

Acronym	Definition
ITSCM	IT Service Continuity Management
ITSM	Information Technology Service Management
ITUP	IBM Tivoli Unified Process
KM	Knowledge Management
MOF	Microsoft Operations Framework
PM	Problem Management
RDM	Release and Deployment Management
RF	Request Fulfillment
SACM	Service Asset and Configuration Management
SCM	Service Catalogue Management
SLM	Service Level Management
SM	Strategy Management for IT Services
SPM	Service Portfolio Management
SupM	Supplier Management
SVT	Service Validation and Testing
TTF	Task Technology Fit
TPS	Transition Planning and Support

Chapter 1: Introduction

For decades, information technology (IT) executives have been plagued by the question of what is the best approach to optimize IT operations, improve customer satisfaction, and ensure continued return on technological investments. IT organizations need to go beyond managing IT assets by responding quickly to complex market conditions and growing business needs in a proactive manner [1] [2] [3] [4]. With the development of new technologies, enhanced methodologies, and innovative management practices within the last ten years, IT is starting to address those concerns.

As IT becomes more complex and integrated in day to day business operations, IT organizations are turning to Information Technology Service Management (ITSM) frameworks to provide the needed services between IT and business organizations. ITSM enables an IT organization to redirect its focus from a structure centered on technology management towards a more client-based service performance organization [1] [5] [6] [7]. It represents a paradigm shift that merges business management acumen with IT process-centric thinking [8].

This praxis is an investigative study on a prominent ITSM framework, Information Technology Infrastructure Library (ITIL), and the development and demonstration of a process sequencing model applied to the framework.

1.1 Background

The study of information systems involves the examination of business models based on theoretical foundations of business management and computer science. One particular information systems methodology that has evolved within the industry is ITSM. There are six key ITSM process frameworks.

- ISO/IEC TR 20000-4:2010 Information technology -- Service management -- Part 4: Process reference model

- Control Objects for Information Related Technology (CoBIT®)
- Capability Maturity Model Integration for Services (CMMI®-SVC)
- Microsoft Operations Framework (MOF)
- IBM Tivoli Unified Process (ITUP)
- ITIL v2 and its predecessor v3

ITIL has become the most globally influential ITSM approach [9], and has been established as the de facto standard [1]. It has emerged as the methodology of choice by industry practitioners because it has the capability to turn reactive IT environment management practices into controlled, proactive IT management processes [10].

The concept of ITIL first emerged in 1980 because the British government wanted a standard that would improve the quality of IT services. In 2001, the ITIL framework was enhanced with the release of version 2. In 2007, version 3 was release which expanded the library of processes.

ITIL v3 is an overarching framework of twenty-six (26) processes across a five phase product/service lifecycle that ensures alignment of business goals and objectives**. Figure 1** illustrates the five (5) phases of the product/service lifecycle as depicted in the ITIL literature [11] [12] [13] [14] [15].

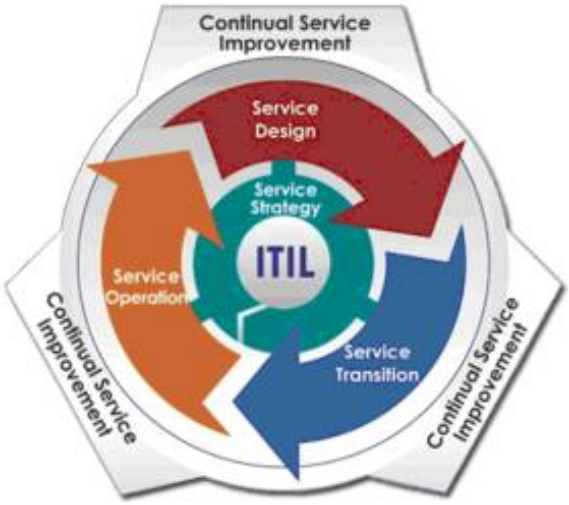


Figure 1: ITIL Product/Service Lifecycle

The twenty-six (26) processes that are defined in the ITIL framework provide recommendations on how an IT organization can achieve the desired IT goals and objectives [16] while ensuring that business needs are met in a measureable, objective way. **Table 1** lists the twenty-six (26) ITIL process and provides a brief description of each.

Table 1: ITIL Processes

Process	Acronym	Description
7 Step Improvement	7Step	The Seven Step Improvement process defines and manages improvement initiatives across the service/product lifecycle [13].
Access Management	AM	The Access and Identity Management process identifies and manages appropriate rights and privileges for users to access services [15].
Availability Management	AvailM	The Availability Management process ensures that IT services meet current and future availability needs for the business [12].
Business Relationship Management	BRM	The Business Relationship Management process manages the relationship between IT and their customers, and identifies future needs of the customer [11].
Capacity Management	CapM	The Capacity Management process ensures that IT services meet current and future capacity needs for the business [12].
Change Evaluation	CE	The Change Evaluation process provides guidelines for determining the performance and expectations of changes to services in the context of impacts to the business [14].
Change Management	CM	The Change Management process controls changes to a service through the entire lifecycle to ensure a minimum amount of service disruption [14].
Demand Management	DM	The Demand Management process analyzes, anticipates, and projects customer demand across the lifecycle of a product or service [11].
Design Coordination	DC	The Design Coordination process ensures that the objectives and goals for the service design phase are met for every service [12].
Event Management	EM	The Event Management process detects, manages, and escalates events that are triggered during service operation [15].
Financial Management for IT Services	FM	The Financial Management process manages the balance between cost and quality of services developed and delivered by IT to the business [11].
Incident Management	IM	The Incident Management process documents service degradation and outages, and executes procedures to restore service as quickly as possible [15].
Information Security Management	ISM	The Information Security Management process protects the integrity, confidentiality, and availability of information managed and provided by the services that IT manages [12].

Process	Acronym	Description
IT Service Continuity Management	ITSCM	The IT Service Continuity Management process ensures that IT can provide a minimum continuity of services to the business [12].
Knowledge Management	KM	The Knowledge Management process provides a central location to store and share information including but not limited to decisions and lessons learned in regards to services that IT delivers to the business [14].
Problem Management	PM	The Problem Management process manages problems discovered within a service or product and remediates the causes and identifies proactive steps to reduce continued service degradation [15].
Release and Deployment Management	RDM	The Release and Deployment Management process plans, schedules, and controls the testing and deployment of releases [14].
Request Fulfillment	RF	The Request Fulfillment process manages all service requests from users/customers through the lifecycle of a service or product [15].
Service Asset and Configuration Management	SACM	The Service Asset and Configuration Management process controls and manages information for all assets that are required to deliver a service [14].
Service Catalogue Management	SCM	The Service Catalogue Management process provides and maintains a single source location for all services provided by IT [12].
Service Level Management	SLM	The Service Level Management process certifies that all services are delivered to achievable operational and delivery targets [12].
Strategy Management for IT Services	SM	The Strategy Management process defines and maintains an organization's strategic position by articulating how an organization will be able to achieve their business outcomes through their IT services [11].
Service Portfolio Management	SPM	The Service Portfolio process tracks IT investments in services throughout their entire lifecycle to ensure they deliver appropriate returns [11].
Supplier Management	SupM	The Supplier Management process ensures that suppliers meet their contractual commitments to ensure seamless quality of services to the business [12].
Service Validation and Testing	SVT	The Service Validation and Testing process ensures that new or modified IT services match the agreed to design specifications and meet the desired business needs [14].
Transition Planning and Support	TPS	The Transition Planning and Support provides overall planning and management of services during the transition process [14].

ITIL v3 comprises five official reference guides providing understanding into the principles and concepts of a service-oriented IT management structure. These five books present the complete ITIL v3 suite of processes grouped by their presence in the IT product/service lifecycle. These books are extremely insightful to ITIL practitioners because they provide supporting information for each process, their interfaces, and

deliverables throughout the product/service lifecycle. However, these reference guides read like an encyclopedia and provide an overabundance of information that most IT leaders find difficult to digest [17]. Research to decipher, simplify, and apply the concepts presented in these books has been conducted since their creation nearly ten years ago.

1.2 Problem Statement

The current ITIL body of knowledge is without guidance for companies to use in determining the appropriate order of implementation of ITIL processes that is based on quantitative research. Surveys revealed that organizations are not maximizing the return on their investment in ITIL because they are selecting a couple of processes for "quick win[1]s" [18]. Most IT organizations take an ad hoc approach to their ITIL implementation which often times results in the most efficient and applicable processes not being enacted [2], or IT leaders rely on recommendations from ITIL/ITSM consultants provided at an exuberant cost.

1.3 Research Contribution

This praxis ultimately will provide IT leaders and ITIL practitioners a tool that will generate an implementation priority list for the ITIL framework that can be applied within their IT organization.

1.4 Significance of Research

This praxis has significance in the practice and execution of IT operations. Many IT organizations worldwide are adopting the ITIL framework, however commonly encounter difficulty in choosing suitable processes in their initial efforts. ITIL does not currently provide guidance to determine the priority of the various processes, thus allowing IT leaders to make a subjective decision that may not yield optimal results. By applying the

[1] A "quick win" is defined as an accomplishment achieved quickly to secure support from a team or organization

model developed through this research, the need for guidance on prioritization is addressed.

1.5 Research Methodology: Design Science Research Method

ITIL research is a domain under Information Systems (IS) research. IS research is an intersection of disciplines (economics, computer sciences, social science, etc.) applied to the management of technology and IT organizations [19]. The Design Science Research Method (DSRM) is a methodology used in IS research whose main objective is to create and evaluate IT artifacts that support solutions that are used to solve real world engineering problems [19]. DSRM defines four fundamental principles for researchers.

1. Researcher must identify a solution that addresses an important business problem [19].
2. Researchers need to develop an artifact that supports the solution [19].
3. Researchers need to apply rigor and draw from existing theories to develop the artifact [19].
4. Researches must rigorously evaluate the artifacts "utility, quality, and efficacy." [19]

The DSRM process is illustrated in **Figure 2: Graphical Illustration of DSRM Process**. The preceding sections provide details of each activity of the DSRM process.

1.5.1 Activity 1: Problem Identification

The first activity in the DSRM process is to define the specific research problem [19]. This involves breaking the problem down to small conceptual pieces to reduce the complexity of the problem while ensuring the solution is able to address all its components. Additionally, this activity provides justification for the solution and supporting reasoning for the researchers understanding of the problem.

1.5.2 Activity 2: Define Objectives

During the second activity, the researchers identify the quantitative and qualitative objectives of the solution. Quantitative objectives are defined as objectives that compare the proposed artifact to the current solutions. Qualitative objectives provide a description of how the artifact supports the overall solution which in turn addresses the problem.

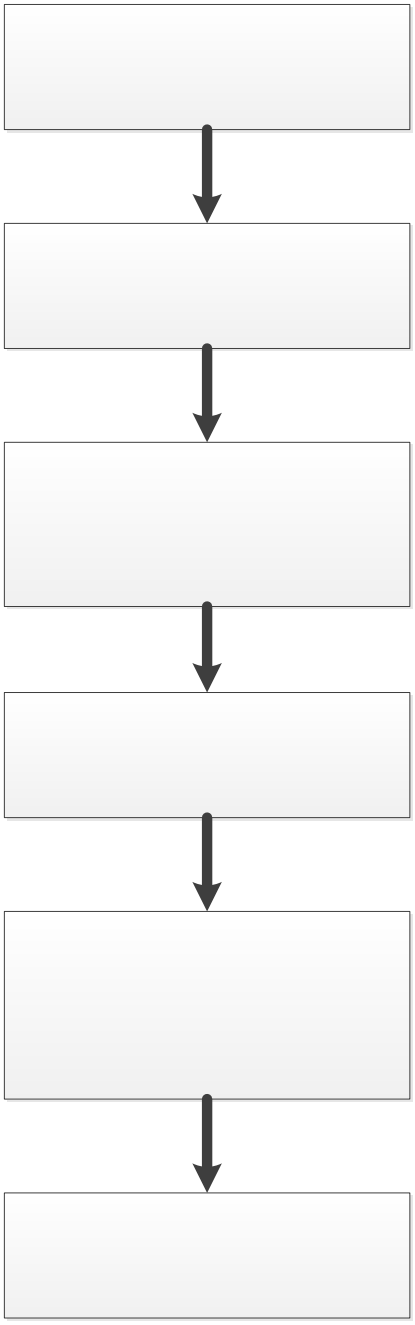


Figure 2: Graphical Illustration of DSRM Process

1.5.3 Activity 3: Design & Development

The third activity in the DSRM process involves creating the artifact for the proposed solution [19]. This includes defining the functionality and architecture of the artifact as well as creating it. An artifact, itself, can be considered a research contribution and can be in the form of models or methods, or be embedded in the overall solution design [19].

1.5.4 Activity 4: Demonstration

The fourth activity is a demonstration of the use of the artifact to solve the problem stated in activity 1 of the DSRM process. The demonstration can be executed as a simulation, case study, proof, or experimentation [19].

1.5.5 Activity 5: Evaluation

The fifth activity of the DSRM process is evaluation. This activity requires observation and measurement of how well the artifact addresses the problem [19]. The evaluation can be conducted in several ways:

- comparing the artifacts functionality with the objectives of the solution,
- quantitative performance measures,
- satisfaction surveys, or
- simulations.

The results from the evaluation are used to determine if the artifact needs to be improved before moving onto the next activity in the DSRM process, or if the researchers should continue onto activity 6 and leave the improvements for future research [19].

1.5.6 Activity 6: Communication

Communication is the sixth activity of the DSRM process. Activities 1 through 5 are documented and published so relevant audiences can reference the material [19].

1.6 Assumptions & Limitations

There are some general assumptions made in order to set boundaries for this investigative study.

1. It is assumed any organization using this tool plans to implement all the processes in the ITIL process library.
2. All processes will be implemented in sequential order to support the notion that a new process capitalizes off of existing processes.
3. All processes will be executed with resources that are internal to the company and the work will not be outsourced.
4. The organization does not have any ITIL-compliant processes currently in place.

All studies have some limitations in in their validity or application. For this particular study, the analysis of the ITIL processes and the Delphi study used to validate the model were the two areas that could inject some bias. The researchers that conducted the analysis of the ITIL framework were ITIL Expert certified with over ten (10) years of experience. The experts that participated in the Delphi study were also certified ITIL experts with IT experience ranging from ten (10) to thirty (30) years. The experts provided their opinion based on their professional experience which could contain some bias. Additionally, the assumptions listed in **Section 1.6** provide some limitations to the model itself by forcing a situation for all ITIL processes to be used even though that may not be practical for all IT organizations.

1.7 Organization of the Praxis

This praxis is organized in five (5) chapters and includes appendices that contain supporting documentation. *Chapter 1: Introduction* provides the reader with an overview of the research to include the problem statement, research significance, and the theoretical framework that was used. *Chapter 2: Literature Review* provides a critical review of ITIL research and a high level summary of the findings. The researchers also identified gaps in the current body of knowledge. *Chapter 3: Method* provides the reader with a set of procedures to create the model, specifically the researchers discuss the first three activities

of the DSRM process. The researchers discuss activities four (4) and five (5) of the DSRM process in *Chapter 4: Results.* This chapter provides the reader with demonstration of the model with a step by step simulation. Additionally, the researchers evaluate the model against results from a Delphi study conducted of ITIL experts. *Chapter 5: Discussion/Conclusion* provides the reader with a comprehensive analysis of the model and results including a sensitivity analysis.

Chapter 2: Literature Review

This chapter presents a summary of relevant research currently available in the ITIL body of knowledge. The researchers conducted a systemic literature review of the current body of knowledge on ITSM and ITIL, which allowed the researchers to identify and qualify the research that is currently available [20]. This type of review provided greater rigor and depth in analysis in order to justify the current research methodology for the purposes of demonstrating the novelty in its contribution [21]. Along with critiquing the current literature, the researchers identified gaps in the current literature, and provided a basis for the current research endeavors.

2.1 Introduction

As part of this systemic literature review, the researchers identified, classified, and synthesized the existing research on ITIL implementation and identified potential research areas. The review was based on guidelines presented by Levy and Ellis (2006) and Okoli and Schabram (2010), and modeled after the systematic literature review conducted by Iden and Eikebrokk [22]. The guidelines used in this praxis for the systematic literature review are documented below.

1. Purpose and Goals – Describe the purpose and goals of the literature review.
2. Search Process – Search process conducted on available literature.
3. Inclusion and Exclusion Criteria – Document the screening criteria of literature and filter the articles based on the data extracted.
4. Descriptive Data Collection– Determine and extract the pertinent descriptive data to collect about each article.
5. Critique of Scholarly Literature

2.2 Purpose and Goals

The primary purpose of this chapter is to identify the gaps in the current ITIL body of knowledge in regards to the process-sequencing order for ITIL implementation. By performing the literature review, the authors were able to gain insights into variables that impact the implementation of an ITIL framework, as well as influences for developing the model.

2.3 Search Process

The authors searched to find relevant publications and started with a generic keyword search. The below search strings were used in the initial search.

- Information Technology Service Management
- IT Service Management
- Service Oriented IT Management
- Information Technology Infrastructure Library
- ITSM
- ITIL

Based on the search results from the initial search, the authors started the second phase of investigation. Grounded in the Levy and Ellis systematic research method, the authors conducted a *Backward References* search. This refers to reviewing the references of the articles resulted from the initial keyword search [21]. Next, the authors conducted a *Backward Authors* search. This search focuses on reviewing what the subsequent authors have published prior to the article resulting from the keyword search [21]. Lastly, the authors conducted a *Previously Used Keywords* search. This search focuses on searching the keywords listed in the articles yielded from the keyword search [21].

Once the backward search was complete, the authors performed a forward search. This was executed using two specific searches: *Forward References* search and *Forward Authors* search. *Forward References* search evaluates additional articles that have cited

the articles found in the initial keyword search [21]. *Forward Authors* search analyzes what authors have published following the primary article returned in the initial search [21]. Based on results from searches conducted using those platforms, the authors filtered publications based on the inclusion and exclusion criteria stated in **Section 2.4 Inclusion and Exclusion Criteria.**

2.4 Inclusion and Exclusion Criteria

The authors' review targeted peer-reviewed published research on ITIL process sequencing, and any supporting articles highlighting critical success factors, challenges, benefits, and lessons learned from ITIL implementations. All works considered were published between January 1, 2000 and June 30, 2016. Only articles published in English were considered.

2.5 Descriptive Data Collection

The data extracted from each study published in an academic journal were as follows:

- The title of article
- The authors and their associated institutions
- The name of the journal publication
- The year the article was published
- The country of publication
- The journal ranking (based on Australian Council Of Professors and Heads of Information Systems Inc. [ACPHIS] ranking list discussed in greater depth in Section 2.4 Inclusion and Exclusion Criteria)
- Number of citations as of June 30, 2015
- Classification of research method
- Research method used in study
- Primary, secondary, and tertiary research objectives
- ITIL version referenced

The data extracted from each study published in a conference proceeding were as follows:

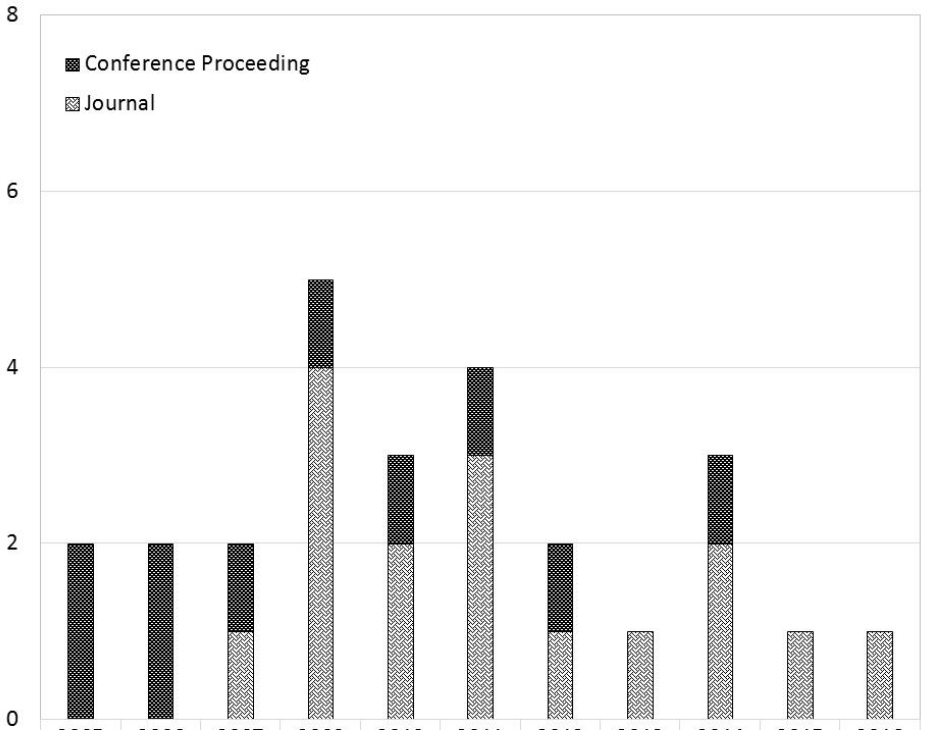
- The title of article
- The authors and their associated institutions
- The year the article was published
- The name of the conference
- The primary association affiliated the conference
- Number of citations as of June 30, 2015
- Classification of research method
- Research method used in study
- Primary, Secondary, and Tertiary research objectives
- ITIL version referenced

Figure 3 shows the number of journal articles and conference proceedings published each year. It excludes the two systematic literatures used as points of reference and evaluation of the current available research. Additionally, the authors reviewed citations from the articles and included relevant research that could be obtained through a search engine. In total, the authors identified twenty-six (26) relevant studies published in fifteen journals and ten conference proceedings.

2.6 Critique of Scholarly Literature

As part of the literature review, the researchers explored concepts surrounding ITIL implementations. The next four subsections are organized to cover relevant studies to support the research foundation of this praxis.

- **2.6.1 ITIL Challenges** discusses the current research published on the challenges of implementing the ITIL framework.



	2005	2006	2007	2009	2010	2011	2012	2013	2014	2015	2016
Conference Proceeding	2	2	1	1	1	1	1	0	1	0	0
Journal	0	0	1	4	2	3	1	1	2	1	1

Figure 3: Number of Studies Published Per Year

- **2.6.2 Critical Success Factors** highlights the prominent critical success factors that are required to adopt the ITIL framework in an IT organization.
- **2.6.3 ITIL Adoption and Implementation** focuses on theories for successful ITIL implementations
- **2.6.4 ITIL Process Sequencing Strategies** discusses the current models and methods that have been published.

2.6.1 ITIL Challenges

As the ITIL framework matured, it faced many challenges in its execution and implementation. The research presented in this section targets the complex nature of the challenges identified across the industry in regards to ITIL.

IT standards evolve over time based on the value they deliver in response to market demands [23]. In order to address the complexities of a continuously evolving

environment, IT organizations choose to adopt IT service management in order to change the focus from technologies to service capabilities [23]. Johnson et al presented a model for the implementation of a Change Management Database (CMDB) based on the ITIL framework of processes. Though their research was targeted at the implementation of a particular ITIL process using a specific technology, they were able to uncover challenges of ITIL implementations. Firstly, they noted that ITIL lacked specifics on interoperability between the various processes and questioned if it brought value to IT standards. Secondly, the authors mentioned that ITIL avoided providing sufficient details in regards to specific process interfaces. This conclusion presented by the authors was based on ITIL v2. This was a limitation; however, more descriptive information was added to its successor, ITIL v3. Still, each ITIL process necessitated a given level of outside detailed knowledge in order to design and implement a robust process.

In 2009, Winniford, Conger, and Erickson-Harris evaluated survey results conducted by a Colorado-based company called Enterprise Management Associates [24]. The primary goal of the survey was to gather data in regards to ITSM initiatives and levels of familiarity with ITIL terminology and concepts. The survey participants were IT systems managers from US-based companies or subsidiaries. A few major conclusions were drawn from this research. Lynch conducted a survey in 2006 that suggested 90% of IT organizations use ITIL processes [25]; however, the research conducted by Winniford et al indicated that most IT professionals were not familiar with ITIL concepts. The authors imply that many organizations are actually using ITIL-based processes, but using different terminology and nomenclature. Because the survey participants used broad terms to describe their IT operational model, they could not correlate the molarities between the ITIL framework and their own organizational structure. Lastly, the majority of survey participants did not define service management using a definition similar to that defined within ITSM and ITIL, but rather a non-specific definition that limited the usefulness of

the ITIL framework in practice. These findings would suggest that the survey participants did not actually know and understand the process model their IT organization had instituted, and had little knowledge of industry best practices. This can be a challenge when trying to implement the ITIL framework because IT professionals have a false notion that their organization has employed industry-best practices; when, in fact, the processes have been implemented within the context to fit in IT organization with little regard to how the framework is structured and the standards are defined [24]. While their research formed a good base for reference in terms of identifying some of the fundamental challenges with ITIL and its implementation, they failed to present any possible solutions to address the issue. Additionally, this limitation will continue to be present in ITIL implementations because organizations are allowed the flexibility to implement the framework as they choose, applying the language as they feel is appropriate.

Galup et al. conducted an investigation that focused on IT operations, in particular service delivery and service support [6]. This investigation was based on the ITIL v2 framework. The authors articulated that there are a limited number of resources that aid IT managers and executives with gaining a quick understanding of the various ITIL process areas. Additionally, the researchers noted that the current ITIL body knowledge lacked guidance on how to effectively apply ITIL processes within various IT organizational environments.

All the articles cited above identify current challenges with implementing ITIL, but fail to recommend any solutions, clearly implying a lack of guidance on strategies for ITIL implementation. The result: most IT managers taking an ad-hoc approach to ITIL implementation, which can be very costly, can consume many resources, and the true benefits of ITIL may not be realized. This established the rationale for research to institute an ITIL implementation maturity model.

2.6.2 Critical Success Factors

Hochstein et al initiated their research in the field of IT service management by observing realized benefits and cost implications through case studies of internationally known commercial companies [26] [27]. Their research confirmed that service-oriented IT Management implemented using ITIL can increase customer orientation and improve efficiency in IT processes [26]. Furthermore, all cost implications incurred during an ITIL implementation are justified due to the benefits attained by its implementation. Hochstein et al continued their research by conducting a survey of 52 Swiss IT organizations to determine benefit categories of IT service management (ITIL v2) and identify three critical success factors in its implementation [5]. They were able to identify that most organizations implemented more operational ITIL processes than tactical processes. Additionally, most organizations choose to neglect strategic processes because of their complexity and overall lack of understanding. Lastly, the researchers noted that a frame of reference for implementation was not present in the ITIL v2 framework, and most organizations viewed this as a limitation. The researchers identified a prevalent lack of guidance within the current body of knowledge, thus leaving companies without any clear direction with regard to which ITIL processes to select in a service-based IT management structure [5].

Pollard and Cater-Steel conducted a cross-case analysis on private and public firms to identify critical success factors when implementing the ITIL v2 framework [7]. Through their research, they were able to identify three additional critical success factors that had not been identified in previous case studies. These three additional critical success factors supported the notion of IT as a service organization that assists business operations. In particular, the researchers concluded that process priority was a new critical success factor and should be used as guidance for managers during ITIL implementations. The

researchers provided limited direction on how to satisfy the critical success factors, as well as no recommendations for the implementation order for processes.

Esteves and Alves evaluated the resistance of an organization to adopt the ITIL Configuration Management process [28]. They conducted a case study on the Portuguese Culture, Tourism, and Transport Regional Department of Madeira Autonomous Region. As part of this case study, their primary goal was to create an assessment instrument to evaluate the implementation status of the configuration-management process in order to present recommendations to the organization. Their particular research did not yield many conclusions because of the disinterest of the participants and their reluctance to provide information. One conclusion that was made by the authors was the fact that the Change Management process should be a priority in the implementation of the ITIL process suite in public organizations because it has the capability to standardize IT infrastructure changes, but also transcend to organizational change management processes as well.

Ahmad and Shamsudin used a multivariate decision-making methodology called Analytical Hierarchy Process (AHP) [29]. The research methodology simplified the decision-making process by providing structural steps that analyzed both qualitative and quantitative data. The researchers analyzed the current ITIL research to develop a comprehensive list of critical success factors grouped by classification. Within this list, there were critical success factors that directly related to implementation maturity: Goal Setting through Process Maturity Framework (under Project Management and Governance CSF category); and Process Priority (under ITIL Process Implementation and Applied Technology CSF category) [29]. This research took an additional step by collecting opinions of the CSF classification categories of various ITIL implementation stakeholders (Users, IT Staff, and Management) and ranked them based on importance. These perspectives were based on a recent ITIL project that was deemed successful. Their

research showed there was no consistency in ranking across the three groups of stakeholders. Additionally, they did not provide rationale for the differences in ranking. This research limited its scope by only presenting an analysis of other research and collecting stakeholder perspectives.

Cater-Steel et al. conducted a case study of five organizations in 2006 [30]. Through their research, they recommended narrowing the scope of an ITIL implementation based on the company's business strategy. Based on their findings, if organizations adopt this approach, they should be able to establish a tailored implementation plan that can provide an appropriate blend of ITIL processes. Their research also identified execution leadership and the staff's openness to organizational change as core critical success factors for ITIL implementation. A major limitation in their research centered on the five organizations chosen for the case studies. Each organization had a limited number of ITIL processes implemented, thus questioning how effective their ITIL implementation truly was. In 2007, the same set of researchers, this time lead by Tan, conducted another case study, but focused on one government organization, Queensland Health [31]. During this study, the researchers noted three defining attributes that contributed to the success of Queensland Health ITIL implementation. Those three attributes are listed below:

- Strong executive support
- Support of outside consultants
- A collaborative engagement model

The researchers also noted three areas that presented a challenge during the implementation:

- Too many parallel activities
- Baseline performance measures were not defined in enough detail
- Realization of short term goals

This case study only interviewed individuals directly involved with the ITIL implementation; therefore, the participants may have a bias opinion on the success of the initiative. The researchers should have involved an array of individuals within the organization to accurately capture the collective voice of the organization. In 2009, the researchers published a continuation of the case study on Queensland Health by providing additional analysis on the organization to observe their improvement over time [32]. They added a few more critical success factors to the list established in 2007. Those factors included project champion, vendor relationships, and project execution. Again, the researchers opted to only interview individuals who participated in the ITIL implementation initiative and thus failed to capture unbiased opinions. In 2010, Gacenga, Cater-Steel, and Toleman conducted an empirical study on survey results and case studies to further their investigation on benefits of implementing ITIL and performance frameworks used in its evaluation [18]. They concluded that many organizations were not maximizing the return on investment and value when conducting an ITIL implementation because they selected a small number of processes to establish "quick wins" rather than integrating the needed processes for a truly successful implementation.

Since the initiation of ITIL, IT organizations have struggled with an effective approach to its execution. Iden and Langelan conducted a Delphi study with fifteen industry experts from the Norwegian Armed Forces [33]. The major contribution provided from the study was a prioritized list of the twelve most important critical success factors during an ITIL implementation. Their study concluded that identifying a small subset of ITIL processes for implementation would yield the greatest opportunity of success. This was identified as a critical success factor in any ITIL implementation. The researchers also concluded that most companies do not implement the entire ITIL suite; this is not because of lack of need, but because of lack of understanding [33]. This conclusion was subjective and unsupported by definitive data.

Iden et al continued research on the ITIL framework by conducting an empirical investigation to determine the level of IT governance the ITIL-process reference model provided in its implementation [34]. This investigation included data collected in a survey of members of Nordic (Sweden, Denmark, Norway, and Finland) itSMF chapters who were using ITIL. The primary objective of the study was to validate positive relationships between a set of precursors for successful ITIL implementations, as well as evaluate consequences resulting from successful ITIL implementations. Their research suggested that ITIL used as a process-reference model would stimulate the use of process-management practices, thus improving the IT governance over an organization. This was concluded by showing a positive relationship between 5 of the 7 process-management indicators (using partial least squares). A major limitation of this study was the mechanism by which they collected data. By using a survey, the questions and interpretation was left up to the respondent. Additionally, since they only used members of itSMF chapters, a holistic view of the ITIL implementation could not be captured and evaluated. However, this research provided a basis for managing ITIL as a process-management practice.

Marrone and Kolbe conducted a survey in 2010 of 441 IT firms [35]. This research substantiated a positive relationship between the number of ITIL v3 processes an IT organization applied and the organization's perception of its current maturity level. The researchers performed a Kruskal-Wallis analysis on the data collected from the survey. The results suggested that maturity on one process would peak at a certain point. The researchers concluded that when applying the Law of Diminishing Returns to a continuous maturity-model approach, continual improvement of one particular process would start to decline in effectiveness after it reached a certain maturity level. Additionally, the researchers applied Cohen's benchmark their data. They observed a medium to large change in the number of processes implemented as an organization's maturity increased.

Their research confirmed that the sequence and quantity of implemented processes chosen impacted the overall maturity of an organizations ITIL implementation, and it was more important than the maturity of an individual process [35] [8]. Their research identified that the order and quantity of ITIL processes to implement was more valuable than the overall improvement of one single process. Marrone and Kolbe concluded that since most IT managers use an ad hoc method toward ITIL implementation, the most effective and applicable ITIL v3 processes for their particular organization may not be instituted [35]. The only limitation of Marrone and Kolbe's research involved the survey participants' interpretation of maturity. Because the research participants spanned across different organizations and industries, their perceptions of maturity in their organizations as compared to another's obviously varied. However, this demonstrated an intrinsic flaw when incorporating personal opinion and perception in research.

2.6.3 ITIL Adoption and Implementation

Yamakawa et al performed a case study on the use and compliance of change-management practices to support and improve ITIL v3 implementations in the finance sector [36]. Through observation of four Peruvian financial institutions, the researchers made several conclusions.

1) Similarities: Each firm considered their ITIL implementation successful. They opted to conduct a phased-implementation method and had a high level of senior management commitment. These observations supported previous research about the critical success factors for ITIL implementations.
2) There was a positive correlation between the level of ITIL compliance and the number of change-management practices incorporated into the ITIL implementation. The authors suggested that the use of change-management practices had a positive influence over the ITIL compliance and maturity of the organization.

3) ITIL had a change-management process as part of its suite. The researchers proposed implementing this process toward the beginning of the ITIL implementation in order to ingrain some of the change-management practices within other processes, as well as the implementation as a whole.

This study was limited in the number of case studies observed and presented research that was concentrated in one industry. Therefore, many of the processes and systems were homogenous to the industry and therefore, and as such did not properly characterize behavior and correlations of IT organizations in different industries. However, this research provided a recommendation of prioritization of implemented processes.

Marrone et al conducted a recent survey on the adoption of ITIL v2 and v3 across the IT industry [37]. They categorized processes by process level based on their presence within the product/service lifecycle. The three process levels chosen were operational, tactical, and strategic. The researchers were able to conclude that there was a significant difference between the adoption rate levels of ITIL v3 operational processes as compared to tactical/strategic-level processes. Using the normal distribution test, they deduced that operational level support processes had a larger adoption rate than tactical/strategic level processes. They believed this was due in part because most operational-level support processes were present in the ITIL v2 framework and many companies continued to evolve their current ITIL framework when moving to version 3. Additionally, they also noted that the adoption rate could be influenced by cultural, political, and economic factors placed on an IT organization. Their area of research was further expanded with the conclusions presented in this dissertation by addressing some of their research limitations. Instead of evaluating each process on an individual basis, the researchers opted to cluster the processes into the process-level groups. For example, *Transition Planning and Support* process is considered an operational level process because it was grouped with the transitional-lifecycle process group. This process should be considered a

tactical/strategic-level process because it involved a higher level of planning and coordination. It is possible this limitation falsely categorized and correlated processes because of its generic groupings.

Ahmad, Amer, Qutaifan, and Alhilali attempted to develop a roadmap for IT decision makers that helped to determine which ITIL processes to implement that align for better business performance [38]. They developed a 12-step approach based on four implementation critical-success factors they believed addressed the challenges of ITIL implementation. Those four factors were: performance expectancy, effort expectancy, social influence, and facilitating conditions. The intention of this process was to identify the critical processes that should be implemented within a particular IT organization when implementing the ITIL v3 framework. The authors attempted to address the challenge of mapping ITIL processes to real-world applications present in the United Arad Emirates (UAE). This particular research provided meaningful findings on a process-selection approach; although, it did not provide a recommendation on process prioritization and clustering. Instead, this research provided an analysis on the critical success factors of an ITIL implementation. The authors did conclude that all ITIL processes do not need to be implemented in every organization. Additionally, organizations must be able to clearly identify the critical and non-critical processes applicable to their organization in order to realize the true benefits of ITIL. Lastly, since ITIL had many processes integrated with each other component, some processes must be implemented before others because of this dependency. All concepts the researchers presented were predicated on the assumption that the audience was ITIL experts and already had a strong knowledge base in ITIL. Secondly, the research offered a practical view, though limited in potential test cases to validate the research presented. The major contribution relevant to the research presented in this paper was that the researchers confirmed that process prioritization and implementation strategy and design were needed for successful implementations.

2.6.4 ITIL Process Sequencing Strategies

CMMI, ITIL, and CoBIT (the three most widely known industry frameworks) addressed software engineering, IT Management, and IT Governance disciplines, respectively. Alfaraj and Qin stated there was little to no overlap between the frameworks, and that the frameworks became complimentary to each other [39]. CMMI, the most widely accepted maturity model, had five distinct maturity phases in the staged approach. ITIL v3's predecessor, v2, proposed a process maturity framework (PMF) that aligned with CMMI to measure the overall maturity of an organization [40]. (See **Table 2: ITIL v2 PMF vs CMMI Five Level Maturity Model.)** When ITIL v2 evolved to Version 3 (v3), and increased the number of processes from 10 to 26, it abandoned PMF as a maturity approach. The decision to publish ITIL v3 without an outlined maturity model made many v2 practitioners wary of PMF's flexibility and effectiveness [39] [40] [41].

Table 2: ITIL v2 PMF vs CMMI Five Level Maturity Model

Level	ITIL, v2 PMF	CMMI Five Level Maturity Model
1	Initial	Initial
2	Repeatable	Repeatable
3	Defined	Defined
4	Managed	Quantitative
5	Optimized	Optimized

McNaughton, Ray, and Lewis performed a survey on all the available ITIL evaluation frameworks and their application to ITIL [42]. From this initial analysis, they summarized nine potential evaluation frameworks for ITIL. The authors developed their own evaluation framework to address the gaps and limitations present in the nine frameworks currently available. Their framework evaluated ITIL on two separate levels: Corporate (macro) and Process (micro). The corporate-level evaluation looked at the implemented ITIL process holistically in terms of user perspective, IT employee perspective, management perspective, and technology perspective. The process level evaluated the implementation of each process on an individual performance. The researchers conducted a contextual inquiry with experts to assess their framework and its application with the

ITIL process suite. Their findings indicated their framework could be used in broad context to evaluate ITIL improvement projects, assess ITIL performance, and find additional areas for improvement. A major limitation in their study was the lack of integration between the four corporate-level perspectives. This evaluation method did not provide a concise method to determine maturity, nor did it provide guidance on how to obtain a certain maturity. Rather, this particular evaluation framework could be used after the fact to provide assessments on how well a particular area was performing.

Alojail and Corbitt conducted a two-year study that involved a focus group to develop a model that showed the relationship between ITIL v3 adoption and the quality of IT outsourcing [43]. They presented inferences from the focus group they studied that suggested ITIL adoption can be measured based on the number of processes implemented. Additionally, their model suggested that more ITIL v3 processes implemented within an IT organization, the better the quality of the IT outsourcing relationship; thus, the more mature the organization. This particular research had a very narrow scope because it focused solely on the aspects of ITIL embedded with customer and vendor-based processes that support IT outsourcing. The main conclusion focused on the argument that the ITIL maturity level of an IT organization could be measured by the extent of the number of ITIL v3 processes adopted, implemented, and integrated into the IT organization's culture and practices.

Pereira and Mira da Silva published a handful of conference proceedings covering research in support of the ITIL maturity model they developed [40] [41]. In their research, they evaluated several frameworks to determine the base for their proposed staged maturity model. The authors opted to use the Action Research Methodology by first presenting their proposed model and then assessing its validity via responses from a questionnaire of five Portuguese organizations. The questionnaire only inquired about the implementation of the Incident Management process and Service Desk function. The

authors limited the scope of the questionnaire to evaluate the maturity of a single-process rather than the maturity of the entire ITIL implementation––one major limitation in their research. The major contribution the researchers provided was a staged maturity model detailing the cluster of processes that needed to be implemented at each maturity stage. However, this research left many unanswered questions, such as: how they determined which process belonged to which maturity stage; the environment and organizational factors that supported this model; and the constraints on, and limitations of, the maturity model. While this research seemed generic in nature, it was attempt at presenting a logical breakdown of process priority and clustering in regards to maturity during an implementation.

Lema et al determined the first process that should be implemented as part of the ITIL suite. They based their research off of the notion that the first process selected and implemented influenced the subsequent processes; therefore, a high level of importance was placed on the initial processes implemented. Their research consisted of two parts. The first part was a systematic literature review, which resulted in a recommendation of the top processes for an ITIL implementation. Their results showed that Incident Management, Problem Management, Configuration & Asset Management, and Change Management were identified as the most important processes to implement. The second part of the research was a Delphi study of five (5) professionals with substantial ITIL experience, accompanied by a survey of ITIL experts. This study was the first significant step toward developing a comprehensive implementation-sequencing order for ITIL. Lema et al. concluded that Incident Management was the most important process implementation. Their research was primarily anecdotal because it was based on expert opinion rather than a definitive selection approach. In this article, the researchers built upon this by providing a methodological, objective selection process. The results from the selection process were validated by experts via Delphi study. Since no organization had

been documented to have implemented all ITIL processes successfully, expert opinion from practitioners provided the needed validation.

More recently, Shrestha et. al. developed a structured method for selecting processes to improve based on the service processes present in the ISO/IEC standard. The 12 service processes selected in their research is also present in the ITIL v3 framework. They used a combination of the Task Technology Fit (TTF) theory and DSRM. The TTF theory was used to justify the design of the model and DSRM was used to justify the research process [44]. Their process involved four steps.

1. Identify the initial list of IITL processes implemented in the IT organization that has clearly defined objective and expected outcomes [44].
2. Select key business drivers based on criteria within the organizations balanced scorecard [44].
3. Conduct a service gap perception survey based on the SERVQUAL model [44].
4. Calculate process scores based on steps 2 and 3. Use those process score as inputs to the process selection matrix which provides stakeholders with recommended processes for improvement.

This research provided a major contribution to the ITIL body of knowledge by providing a decision support model that helps practitioners determine which ITIL service based processes should be improved for an IT organization. However, to effectively use this model, processes must already be established within the organization and the stakeholders need to have a strong knowledge and understanding of all the processes that are being evaluated and not just the ones they are responsible for. The model presented in this processes takes a difference approach entirely. First, the process selection model presented in this praxis does not assume any processes are implemented within the IT organization where the model will be used. Second, the process selection model takes

form stakeholders only at the initial step and not continuously throughout the decision process.

2.7 Research Inferences

The current body of knowledge indicated that most research had been conducted to identify implementation strategies and determine effective implementation approaches. Though most of the literature was insightful, it did not answer the fundamental question for which most ITIL practitioners and IT executives were looking. This question was raised in most of the literature and identified as a challenge when implementing an ITIL model. The question is: What should be the appropriate priority of processes to implement within any IT organization? The problem with answering this question was that no two IT organizations were alike; therefore, they have different variables and factors that need to be considered when determining the proper implementation order of ITIL processes for the greatest efficiency. This research presented a model to determine the implementation strategy for ITIL based on two proven variables for ITIL implementation success.

Chapter 3: Method

To date, there have not be any published research for an ITIL-process sequencing model based on three process management and improvement variables using the Design Research Method. The authors presented a process sequencing model that assisted ITIL practitioners and IT professionals in determining the processes for a complete ITIL implementation.

3.1 Introduction

This chapter describes the first three activities of the DSRM process conducted by the researchers outlined in **Figure 2 Graphical Illustration of DSRM Method**. In **Section 3.2**, the researchers identified the specific problem that is addressed with this research. In **Section 3.3**, the researchers defined the objectives of the artifact (ITIL process sequencing model) that will support the solution. In **Section 3.4**, the researchers designed and developed the artifact. Specifically, the researchers identified the variables used as inputs to the model and provide background information to support the rationale of selection. The supporting detailed analysis of the first and second variables are documented in the appendices.

3.2 DSR Activity 1: Problem Identification

The first activity of the DSRM process is to define the problem and document its importance.

3.2.1 Problem Definition

The current ITIL body of knowledge is without guidance for companies to use in determining the appropriate order of implementation of ITIL processes that is based on quantitative research rather than expert opinion. Companies should have a tool that can identify the implementation order of ITIL processes [44]. Having a guideline, in the form of a processing sequence model, to identify the implementation sequence order for

processes will address the current challenges with implementing the entire ITIL suite. Additionally, having an ITIL process sequencing model and resulting process implementation priority list would reduce the number of resources required to launch an ITIL project and costs to support the effort. A process-sequencing model would help IT organizations realize the benefits of ITIL in a short period of time [38]. As a result, IT organizations will see the benefits of ITIL manifest in a more condensed period of time [38].

3.2.2 Problem Importance

Surveys revealed that organizations are not maximizing the return on their investment in ITIL because they are selecting a couple of processes for "quick wins[2]" [18]. Most IT organizations take an ad hoc approach to their ITIL implementation which often times results in the most efficient and applicable processes not being enacted [2], or IT leaders rely on recommendations from ITIL/ITSM consultants provided at an exuberant cost.

3.3 DSR Activity 2: Define Objectives

The second activity of the DSRM process is to define the objectives of the solution. Below are the quantitative objectives of the research presented in this praxis. No qualitative objectives were identified.

1. Perform several quantitative analyses on the ITIL process framework.
2. Provide a decision framework for selecting ITIL processes that best align to an IT organizations. The decision framework is in the form of a process sequencing model that is derived from three variables.
3. Provide a logical and effective ITIL process implementation priority list based on the three variables.

[2] A "quick win" is defined as an accomplishment achieved quickly to secure support from a team or organization

4. Validate the list generated from the model against a list derived from a Delphi study of ITIL experts.
5. Evaluate the sensitivity of the sequencing model to variations from the three variables and identify the model's current limitations.

3.4 DSR Activity 3: Design & Development

The third activity of the DSRM process is to:

1. determine functionality,
2. determine architecture, and
3. create artifacts.

3.4.1 Model Functionality

3.4.1.1 Inputs

The model uses ranked lists of ITIL processes based on a pool of pre-selected relevant variables. These variables are derived from process management and improvement concepts considered relevant to the ITIL framework.

3.4.1.2 Processes

The ranked lists are merged into one comprehensive list using paired comparison analysis.

3.4.1.3 Outputs

The basic function of the model is to provide an implementation sequence order for ITIL processes.

3.4.2 Model Architecture

The researchers constructed the model in four high level steps.

- **Step 1: Implementation Sequencing Variables -** The researchers identified three relevant variables to use as inputs to the model.
- **Step 2: Order by Rank** - The researchers ranked each ITIL process by relevance based on each of the implementation sequencing variables.

- **Step 3: Paired Comparison** - The researchers compared the ranks of each process across each of the ranked lists.
- **Step 4: List Aggregation** - The researchers used the results from step 3 to aggregate the lists into on comprehensive ranked list.

Figure 4 summarizes the procedures used to develop the model. The following sections provide details for facilitating each high-level procedural step and the rationale behind it.

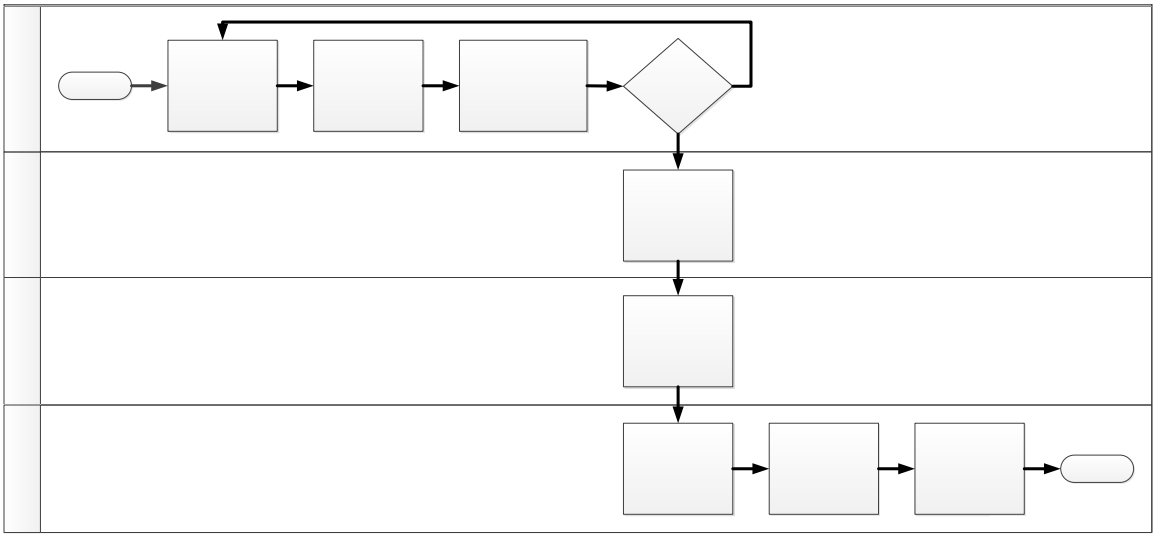


Figure 4: Flowchart of Procedures for Model Development

3.4.2.1 Step 1: Implementation Sequencing Variables

The researchers conducted an analysis process management and improvement principles to identify three variables for the model. The researchers selected (1) Process Level, (2) Information Distribution, and (3) Process Centrality. **Sections 3.4.2.1.1, 3.4.2.1.2,** and **3.4.2.1.3** go into depth about how the researchers analysed each variable.

3.4.2.1.1 Variable 1: Process Level

The authors selected Process Level as the first variable because it was rooted in business process management (BPM) principles. A business process is defined as a sequence of pre-defined tasks that when executed should deliver an expected outcome [45]. BPM is the management practice of aligning business processes with an organization's strategic objectives to continually improve the fundamental activities of a

company's operation [45]. ITIL is, by definition, a library of processes, that when executed, optimize IT operations and provide continuity between IT and the business. The purpose of ITIL directly aligns with the principles of BPM; therefore, deriving the first variable from this domain created a strong foundation for the process-sequencing model.

3.4.2.1.1.1 Rationale

IT processes are categorized into one of three distinctive process levels: *strategic, tactical, and operational* [16]. This research proposed that processes in the operational-process level should be implemented first, followed by tactical-level processes, and ending with strategic-level processes.

The authors proposed implementing processes at lower levels first because they are simplistic and require less resources. Swiftly implementing a single process could bring value because it is a "quick win" [29]. A quick win is a notable critical success factor in an ITIL v3 implementation [30] [17] [2] [8] [7] [4]. In order to quantify the process levels, the authors developed a Process Level scoring model. This model is based on two theories in the process management disciple, Process Complexity and Graph of Results and Actions Interrelated (GRAI).

3.4.2.1.1.2 Process Complexity

Process level analysis identifies and categorizes each process based on ease of implementation and execution. There is a unique relationship between the three process levels. Harmon conducted research on the relationship between the three process levels and defined that as the process-complexity continuum [46]. **Table 3** summarizes the research conducted by Harmon. Harmon's research was used as the foundation to define the three process levels used in this praxis.

Table 3: Harmon's Process Complexity Continuum

Process Level	Complexity	Number of Decisions	Domain Competence	Tool Automation
Operational	Simple	Little to None	Little to None	Easy to Automate
Tactical	Hard	Few	Low to Medium	Challenging
Strategic	Very Complex	Many	High	Hard to Impossible

3.4.2.1.1.2.1 Operational Process Level

Any process that falls within the operational process level is responsible for transforming strategic long-term goals into short-term procedural tasks [47]. Procedure-based processes are the easiest to understand and to implement. Operational processes contain step-by-step sequential procedures with few decision points. The types of resources needed to execute these processes do not require a high level of domain knowledge. Most training can be performed on the job. Operational processes are self-contained, and do not rely heavily on inputs from other processes in order to perform their core functions. Because operational processes are simplistic, tools can be integrated into the processes to allow for automation. There are many off-the-shelf tools on the market that can help facilitate many of the operational and more procedural ITIL processes. To summarize, an operational process is the vehicle by which work is conducted across an organization.

3.4.2.1.1.2.2 Tactical Process Level

The purpose of tactical-level processes is to implement the decisions and policies established and defined by strategic level processes [16]. Project prioritization, technology standardization, and the alignment of IT skills and resources are among the main defining components of this process level. When there is cohesion between the tactical and operational process levels, the implemented IT projects will deliver the intended business benefits [48].

3.4.2.1.1.2.3 Strategic Process Level

The strategic process level establishes the link between the business-planning process and the IT-planning process [16]. The strategic level provides the environment and oversight whereby the other two process levels will be aligned [49]. This process level establishes overarching IT policies, determines the rules that an IT organization must follow, and establishes the framework within which an IT organization must operate. Due to the complexity of processes on this level, a high level of domain knowledge is required by any resource executing these processes. Individuals within those positions tend to have more industry experience or have a greater level of education. Typically top tiers of leadership within an IT organization have the required domain knowledge to facilitate these processes.

3.4.2.1.1.3 GRAI

The GRAI method is a theory grounded in the belief that all management decisions have an associated amount of time that spans a period of any given decision from initial planning to execution. This is defined as decision-horizon time. There is a negative linear relationship between decision horizon time and process granularity, where process granularity is defined as the degree of depth or level of abstraction and complexity required to execute a process [50]. This is a differentiating factor that distinguished the three process levels. **Table 4** provides ranges for the decision-horizon time for the three process levels [49].

Table 4: Process Level and Decision Horizon Time Mapping

Process Level	Decision Horizon Time
Strategic Level	3 to15 years
Tactical Level	1 to 3.5 years
Operational Level	0 to 1.5 years

3.4.2.1.2 Process Level Score Calculation

The authors generated a scoring model called *Process Level Score* (PLS) in order to classify each process with the appropriate process level. PLS is based on five factors that

are critical to an IT process and expand on the concepts of process complexity continuum and the two GRAI-defined factors (decision horizon time and process granularity). The five factors that were chosen are listed in **Table 5.**

Table 5: Process Level Determination Factors

Factor ID	Factor
F1	The level of effort required for the initial setup and launch for each particular process.
F2	Level of Competency for on-going Execution Amount/Degree of Routine Analysis
F3	Level of Decision Making
F4	Level of Dependency on other ITIL Processes
F5	Value to Business & Long Term Cost Implications

These factors were each evaluated against every ITIL v3 process on a three-tier, non-numeric ordinal scale (High, Medium, and Low). A three-tier ordinal scale allowed for the logical, ordered relationship between the processes to be observed without focusing on the amount of difference between the non-numeric categories. **Table 6** defines the criteria for each scale value for each factor.

Table 6: Scale Criteria for Process Level Factors

Factor ID	Scale Value	Criteria/Definition
1	LOW	Most solutions are cookie cutter out of the box approaches with slight tailoring based on current needs in the environment
	MEDIUM	A moderate amount of tools and methodologies need to be established in order for the process to be usable and effective. These tools and frameworks need to be established by an individual with a medium level of knowledge. (5 to 10 years of professional experience and college education)
	HIGH	Complicated tools and methodologies need to be established in order for the process to be usable and effective. The establishment of policies impacting or governing several other process areas would also be included. These tools, policies and frameworks need to be established by an individual with a high level of knowledge
2	LOW	Entry level engineers with novice level of experience can execute the process.
	MEDIUM	Mid-tier level of experience is needed to facilitate the process on an ongoing basis.
	HIGH	Senior level leadership or expert level of experience is needed to facilitate this process on an ongoing basis.
3	LOW	Decisions performed within this process should be conducted on an individual contributor level
	MEDIUM	Decisions performed within this process should be conducted on an management level
	HIGH	Decisions performed within this process should be conducted by executive project level leadership.
4	LOW	Little to no other process areas can impact the success or failure of the particular process area in question.

Factor ID	Scale Value	Criteria/Definition
	MEDIUM	An average number of processes contribute to its risk of implementation.
	HIGH	The process area heavily relies on other process areas to feed complete and accurate information in order perform successfully.
5	LOW	Business value from these processes can be equated to less than $100K for a single incident or improvement.
	MEDIUM	This process brings a large level of value to the business (Between $100K - $1M) for a single incident or improvement.
	HIGH	This process brings an extremely high level of value to the business (potentially $1M +) for a single incident or improvement.

A numeric value was assigned to each tier of the un-weighted ordinal-factor scale. High values were given 5, medium equated to 3, and low was given 1. The PLS equation, depicted in **Equation 1**, was used to calculate the PLS Score.

Equation 1: Process Level Score Equation

$$PLS = (20\%)F1 + (20\%)F2 + (20\%)F3 + (20\%)F4 + (20\%)F5$$

The factors are initially unweighted however those weights are adjusted and evaluated in a sensitivity analysis presented later in Chapter 5.

3.4.2.1.3 Variable 2: Information Distribution

The second variable is Information Distribution. This variable is based on the principles of process architecture. Information distribution is defined as the directional flow of data and its effectiveness in delivery. The inputs and outputs of a process represent the transactional relationship between two processes, where information acts as the currency. This variable prioritizes processes based on how much information it sends to other processes.

3.4.2.1.3.1 Rationale

The authors propose that it is more logical to implement processes that deliver more information before implementing processes that deliver less information, when using a sequential approach. This yields the highest probability of processes having the needed inputs as the implementation progresses.

3.4.2.1.3.2 Information Distribution Principles

There are four basic principles of information distribution. The first is accessibility, which describes how readily available the information is for tasks within a process [51]. The second, timeliness, describes the availability of the information when it is needed by another process or stakeholder [51]. The third, transparency, describes how understandable the information is once it is received [51]. The fourth, granularity, describes how well the information is presented at the right level of detail [51].

The principles of accessibility and timeliness have direct application for this praxis with regard to the interdependencies between ITIL processes. Accessibility and timeliness need to be managed to optimize communication flow in order for an IT organization to remain competitive. The other two principles, transparency and granularity, address the usefulness of the information once delivered [51]. These two principles focus on quality of information, which is outside the scope of this research.

3.4.2.1.3.3 Information Distribution Value (IDV) Calculation

In order to identify the ITIL process that distribute the most information, the authors conducted an abbreviated Suppliers-Inputs-Process-Outputs-Customers (SIPOC) analysis and focused solely on Input, Process, and Outputs. SIPOC is a six-sigma tool used to identify and map basic relationships of a process [52]. Suppliers and Customers are ignored because they are outside the scope of this analysis. The authors defined two types of inputs/outputs:

- **Required:** Information from one process to another, where the process receiving the information relies on it in order execute some of its basic functions.
- **Optional:** Information that may or may not enhance a process's performance. The absence of this information will not hinder the process from delivering its key artifacts.

For this analysis, the authors made the following assumptions:

1. There is no direct correlation between a process' inputs and its outputs.
2. Connections are only allowed between two unique processes.
3. The amount of data is ignored and only the classification of "required" or "optional" is considered.

The authors conducted a cross-comparison of all the inputs and outputs documented in in the five ITIL books. In cases where there was a conflict between required and optional information the value of required was selected. For example, SACM states it sends optional information to CM; however, CM states it received required information from SACM. All the outputs were totaled for each ITIL process, which the authors defined as the IDV.

3.4.2.1.4 Variable 3: Process Centrality

The third variable is process centrality. The authors applied the principles of process modeling to the ITIL framework. Process centrality (based on the Eigenvector Centrality) is defined as the resulting value of the sums of the centralities of connecting processes; thus, equating its over-relevance to the entire process network.

3.4.2.1.4.1 Rationale

The authors propose that the relevance of a particular process should be determined by its relationship to other relevant processes in the framework. Operational improvement projects should target processes that are the most important to the entire process network first, in order to realize higher returns due to trickle-down effects. Thus, the more central the process, the greater the impact.

3.4.2.1.4.2 Process Centrality Principles

A process model is defined as a set of activities/tasks and their respective execution constraints [53]. A process model is comprised of nodes and edges. Nodes represent processes, and edges represent data sent and received between the processes. This

relationship mirrors bi-directional network models and therefore, many of the principles and theories of network analysis can be applied to this scenario.

3.4.2.1.4.3 Eigenvector Centrality Calculation

The eigenvector centrality is a value calculated in network analysis. Eigenvector centrality is based on the principle that a node is important if it is connected to other important nodes, thus taking the entire network pattern into account [54]. **Equation 2** shows the calculation for the eigenvector centrality, where A is the adjacent matrix, *n* is the number of vertices (nodes), and λ is the largest eigenvector for *A*.

Equation 2: Eigenvector Centrality Equation

$$Ax = \lambda x$$

$$\lambda x_i = \sum_{j=1}^{n} a_{ij} x_j$$

$$i = 1, \ldots\ldots n$$

For the context of this research, this calculation is defined as process centrality due to its direct application to a process network.

3.4.2.2 Step 2: Order by Rank

The second step of the model creation procedure is ordering and ranking the process list resulting from each individual variable analysis. The researchers take the results from step 1 and order the list from most-relevant process to least-relevant process for each variable. For variable 1, the PLS score of the various processes were ordered from least to greatest. This signified that operational-level processes should be implemented prior to the tactical-level processes and strategic-level process. For variable 2, the number of outputs were ordered from greatest to least. This signified that processes that distributed more information should be implemented prior to processes that distributed less information. For variable 3, the eigenvector centrality value was ordered from greatest to least. This signified that processes that were more valuable to the over-network were implemented prior to processes that were less valuable.

Within each list, the processes were assigned a rank. If more than one value had the same rank, the average rank was given.

3.4.2.3 Step 3: Paired Comparison

The third step of the model creation procedure is conducting a paired-comparison analysis based on Condorcet's Theory on each process (based on the list developed from step 2). Condorcet's Theory aims to find the most likely order that would produce a ranking with the highest probability [55]. The intent of this theory is to find "the most probable combination of opinions" that supports the largest number of pairwise votes [55]. In each case, two processes will be compared and the value of +1 will be given to a process if it ranked higher than the other process; this identified rank-order dominance. Likewise, if a particular process rank was lower, the process would receive a -1; this identified rank-order inferiority. All scenarios where two processes had the same rank received a 0; this identified rank-order equivalence. This analysis quantifies the relevance of each process against the other processes, which results in a comparison matrix. No circular triads will be present in the comparison matrix because the data used in the paired comparison is already ranked, thus eliminating the possibility of this is occur.

3.4.2.4 Step 4: List Aggregation

The researchers use the Borda score methodology to consolidate the comparison matrix into on aggregated list. The Borda Score calculates the item, which on average, has the highest rank. To calculate the Borda Score, the rank-order dominance for each row of the matrix resulting from step 3 is summed. The Borda Scores are ordered from greatest to least. The authors note that while it is critical that the implementation order of the ITIL v3 processes be understood, the amount of difference between each ordered process is not significant. This final process priority list depicts the order in which to implement the ITIL v3 process suite in order to yield the highest probability of success.

Chapter 4 walks through activities 4 and 5 of the DSRM process.

Chapter 4: Results

4.1 Introduction

Chapter 3 detailed the model creation procedure used to construct the process selection model including rationale for the three variables chosen and the step by step process to aggregate the results from the variable analysis. This chapter presents steps 4 and 5 of the DSRM process with a demonstration of the process selection model and an evaluation of its results.

4.2 DSR Activity 4: Demonstration

The further activity of the DSRM process is to conduct a demonstration of the artifact. The researchers conducted the artifact demonstration through simulation.

4.2.1 Model Development Step 1

Using **Figure 4: Flowchart of Procedures for Model Development,** the first step of the model creation procedure is broken into three sub steps:

1. Select *Process Sequencing Variables*
    a. Process Level
    b. Information Distribution
    c. Process Centrality
2. Analyze ITIL framework based on the variable
3. Order resulting sequencing variables list based on relevance

4.2.1.1 Step 1.1: Select the Process Sequencing Variables

The researchers chose all three process sequencing variables (Process Level, Information Distribution, and Process Centrality) for analysis and use in the process sequencing model. In Chapter 5, the researchers analyzed how the results change with only using two of the three variables for the model as part of the sensitivity analysis.

4.2.1.2 Step 1.2: Analyze ITIL Framework based on Variable

The researchers analyzed the ITIL framework based on the three process sequencing variables. The next three sections are the results from that analysis.

4.2.1.2.1 Variable 1: Process Level

The researchers conducted an assessment of the five factors depicted in **Table 5** against the twenty-six processes in the ITIL framework. Appendix A contains the detail analysis for each individual factor for the complete ITIL framework. **Table 7** is a summary of the analysis of the five factors from all the ITIL processes and their resulting PLS.

Table 7: Variable 1 (Process Level) Assessment and Results

Process	F1	F2	F3	F4	F5	PLS
7Step						3.8
AM						1.4
AvailM						4.6
BRM						3.8
CapM						4.6
CE						3.4
CM						1.4
DC						3.0
DM						3.4
EM						2.6
FM						4.2
IM						2.2
ISM						4.2
ITSCM						4.2
KM						2.6
PM						3.8
RDM						3.0
RF						1.0
SACM						2.6
SCM						2.6
SLM						4.2
SM						4.2
SPM						4.6
SupM						4.2
SVT						2.6
TPS						3.0
	High (5)					
	Medium (3)					
	Low (1)					

4.2.1.2.2 Variable 2: Information Distribution

The researchers conducted an IPO assessment for all twenty-six ITIL processes. The detailed analysis of variable 2 of each ITIL process is documented in **Appendix B.** **Figure 5** presents an Input/Output Matrix summarizing the results from the analysis.

Figure 5: Input/Output Matrix

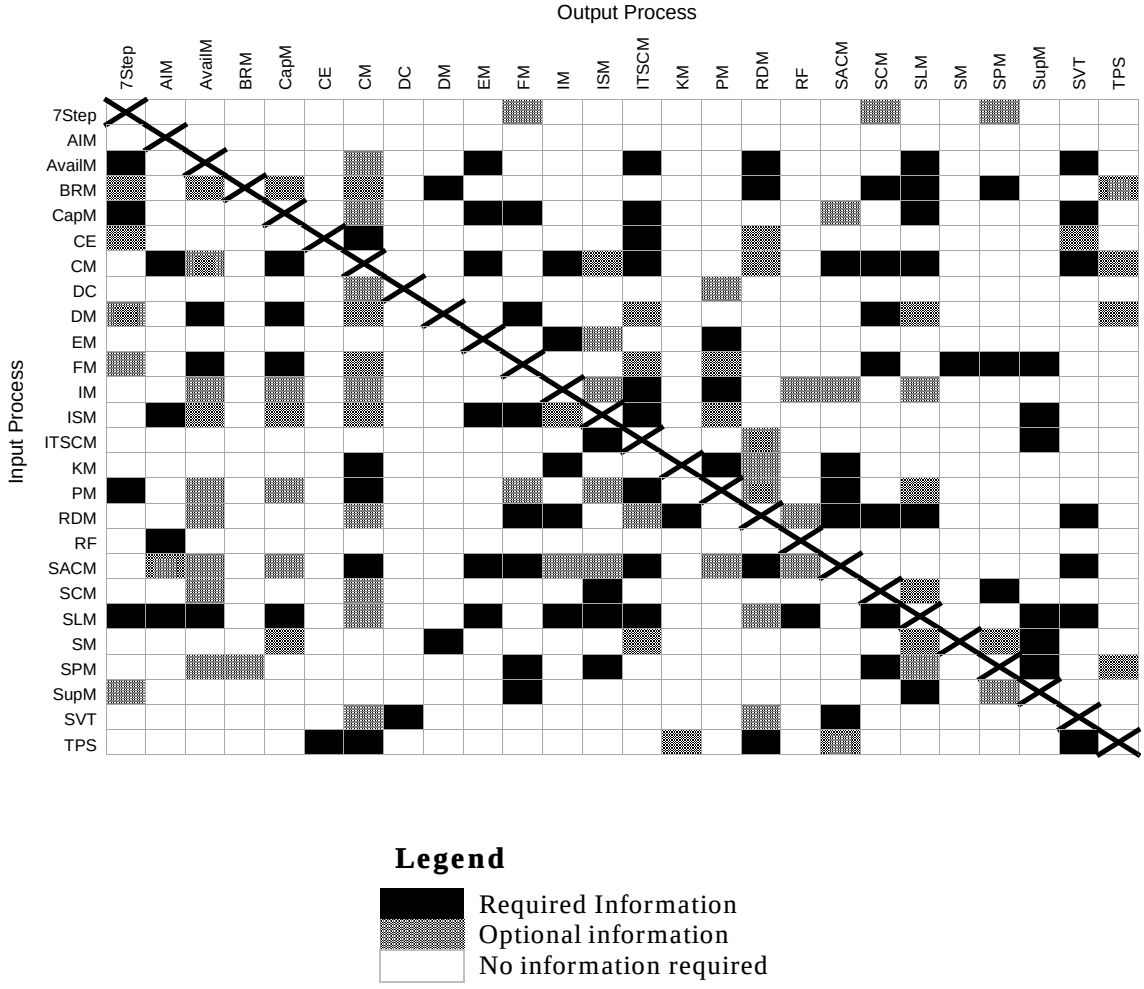


Figure 6 represents a Pareto Chart of the information distribution of all the ITIL processes. The Pareto chart sums the total number of outputs from each process, both required and optional. **Table 8** summarizes the results from **Figure 5**.

Figure 6: Pareto Chart of Information Distribution of ITIL Processes

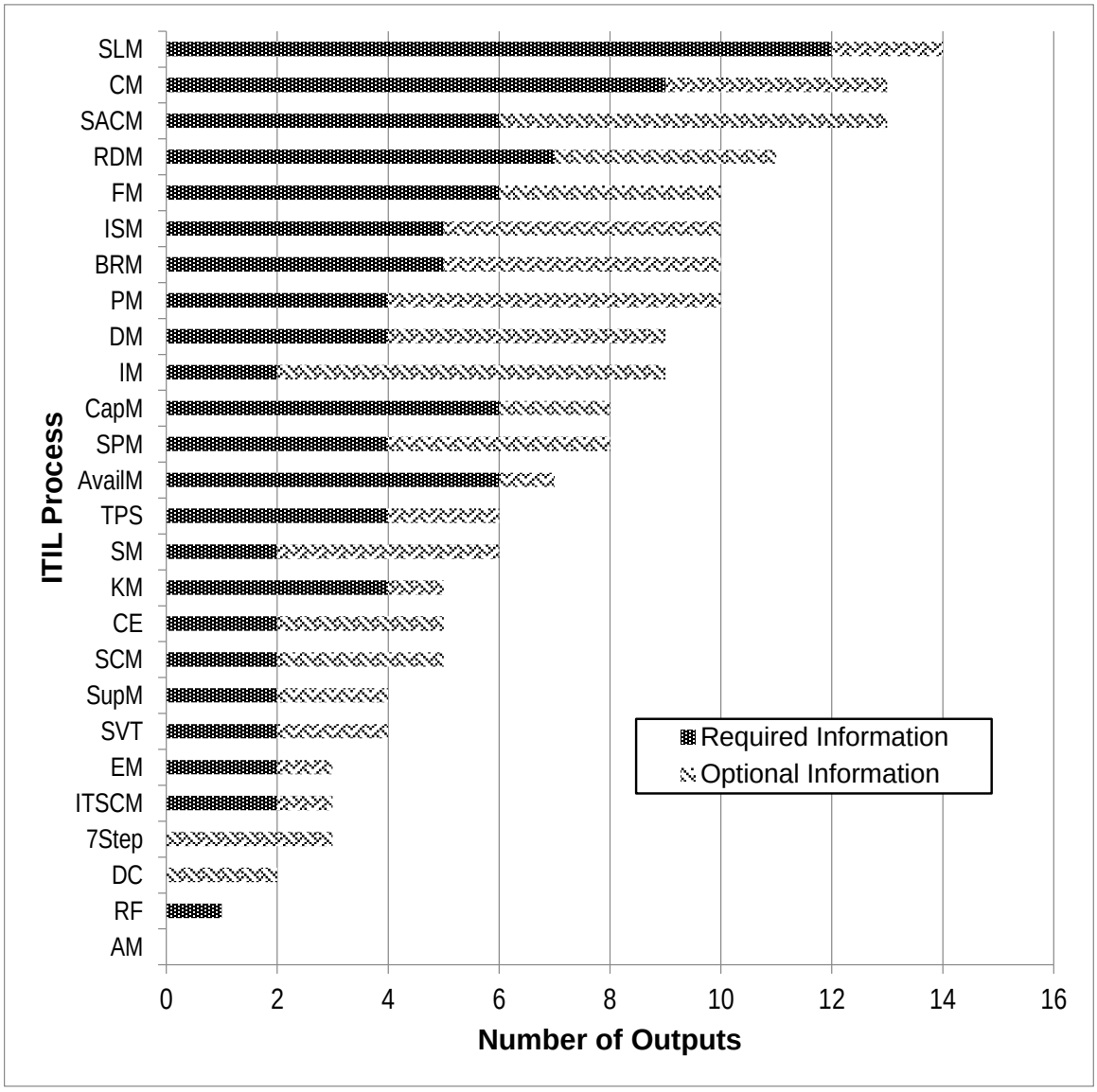


Table 8: Variable 2 (Information Distribution) Results

Process	Number of *Required* Outputs	Number of *Optional* Outputs	IDV
7Step	0	3	3
AM	0	0	0
AvailM	6	1	7
BRM	5	5	10
CapM	6	2	8
CE	2	3	5
CM	9	4	13
DC	0	2	2
DM	4	5	9
EM	2	1	3
FM	6	4	10
IM	2	7	9
ISM	5	5	10
ITSCM	2	1	3
KM	4	1	5
PM	4	6	10
RDM	7	4	11
RF	1	0	1
SACM	6	7	13
SCM	2	3	5
SLM	12	2	14
SM	2	4	6
SPM	4	4	8
SupM	2	2	4
SVT	2	2	4
TPS	4	2	6

4.2.1.2.3 Variable 3: Process Centrality

The authors conducted a bidirectional network node analysis on the complete ITIL process framework. The processes represented nodes and the process's inputs and outputs were represented by arcs. **Figure 7** is a diagram showing the ITIL process network analysis. Through network analysis, the authors were able to localize processes (nodes) of high importance to the network by calculating the eigenvector centrality. The computation quantified processes that are connected to other relevant processes as well as their value to the centrality of the entire framework.

Figure 7: Network Node Analysis of the ITIL Process Framework

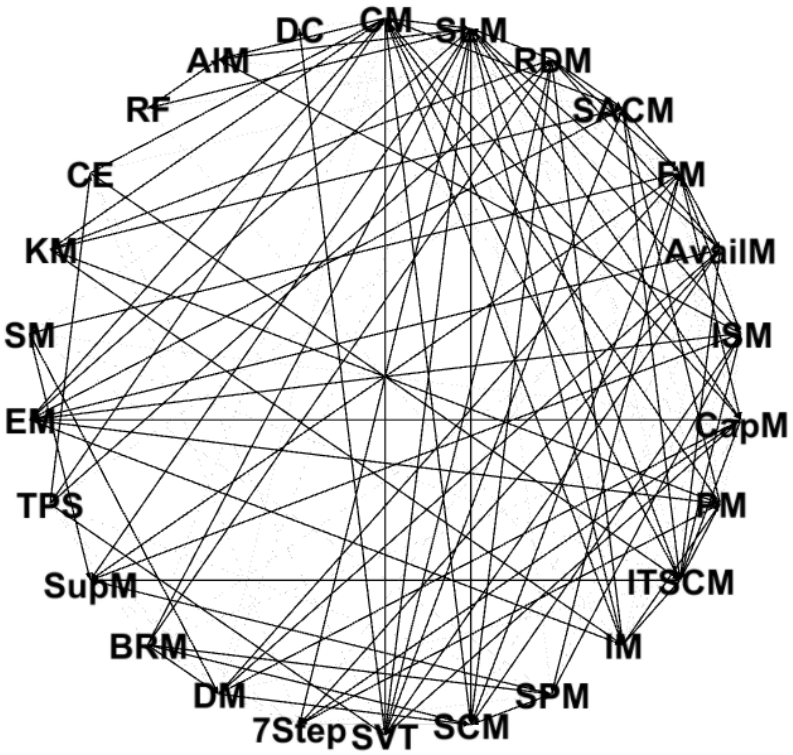


Table 9 lists the ITIL processes and their calculated eigenvector centrality value.

Table 9: ITIL Framework Eigenvector Centrality

Process	EVC
7Step	0.50
AM	0.45
AvailM	0.83
BRM	0.04
CapM	0.64
CE	0.03
CM	1.00
DC	0.08
DM	0.02
EM	0.60
FM	0.58
IM	0.60
ISM	0.75
ITSCM	0.93
KM	0.12
PM	0.43
RDM	0.73
RF	0.35
SACM	0.57
SCM	0.53
SLM	0.75
SM	0.08
SPM	0.29
SupM	0.44
SVT	0.63
TPS	0.18

4.2.1.3 Step 1.3: Order Sequencing Variables based on Relevance

The results from step 1.2 were ordered from most relevant process to least relevant process for each variable. For the process level variable, the PLS was sorted from lowest to highest. For the information distribution variable, the IDV was sorted from greatest to least. For the process centrality variable, the EVC was sorted from greatest to least. **Table 10** documents the results from step 1.3.

Table 10: Process Relevance for each Sequencing Variables

Variable 1		Variable 2		Variable 3	
Process	**PLS**	**Process**	**IDV**	**Process**	**EVC**
RF	1.0	SLM	14	CM	1.00
AM	1.4	CM	13	ITSCM	0.93
CM	1.4	SACM	13	AvailM	0.83
IM	2.2	RDM	11	ISM	0.75
EM	2.6	BRM	10	SLM	0.75
KM	2.6	FM	10	RDM	0.73
SACM	2.6	ISM	10	CapM	0.64
SVT	2.6	PM	10	SVT	0.63
SCM	2.6	DM	9	EM	0.60
DC	3.0	IM	9	IM	0.60
RDM	3.0	CapM	8	FM	0.58
TPS	3.0	SPM	8	SACM	0.57
CE	3.4	AvailM	7	SCM	0.53
DM	3.4	SM	6	7Step	0.50
7Step	3.8	TPS	6	AM	0.45
BRM	3.8	CE	5	SupM	0.45
PM	3.8	KM	5	PM	0.43
FM	4.2	SCM	5	RF	0.35
ISM	4.2	SupM	4	SPM	0.29
ITSCM	4.2	SVT	4	TPS	0.18
SLM	4.2	7Step	3	KM	0.12
SM	4.2	EM	3	DC	0.08
SupM	4.2	ITSCM	3	SM	0.08
AvailM	4.6	DC	2	BRM	0.04
CapM	4.6	RF	1	CE	0.03
SPM	4.6	AM	0	DM	0.02

4.2.2 Model Development Step 2

Within each list, the processes were assigned a rank. If more than one value had the same rank, the average rank was given. **Table 11** shows the resulting ranking.

Table 11: Process Sequencing Variable Rankings

Variable 1		Variable 2		Variable 3	
Process	**Rank**	**Process**	**Rank**	**Process**	**Rank**
RF	1	SLM	1	CM	1
AM	2.5	CM	2.5	ITSCM	2
CM	2.5	SACM	2.5	AvailM	3
IM	4	RDM	4	ISM	4
EM	6.5	BRM	6.5	SLM	5
KM	6.5	FM	6.5	RDM	6
SACM	6.5	ISM	6.5	CapM	7
SVT	6.5	PM	6.5	SVT	8
DC	10.5	DM	9.5	EM	9
RDM	10.5	IM	9.5	IM	10
SCM	10.5	CapM	11.5	FM	11
TPS	10.5	SPM	11.5	SACM	12
DM	13	AvailM	13	SCM	13
7Step	15.5	SM	14.5	7Step	14
BRM	15.5	TPS	14.5	AM	15
CE	15.5	CE	17	SupM	16
PM	15.5	KM	17	PM	17
FM	20	SCM	17	RF	18
ISM	20	SupM	19.5	SPM	19
ITSCM	20	SVT	19.5	TPS	20
SLM	20	7Step	22	KM	21
SM	20	EM	22	DC	22
AvailM	24.5	ITSCM	22	SM	23
CapM	24.5	DC	24	BRM	24
SPM	24.5	RF	25	CE	25
SupM	24.5	AM	26	DM	26

4.2.3 Model Development Step 3

The researchers conducted a paired-comparison analysis based on Condorcet's Theory on each process (based on the list developed from step 2**). Figure 8** documents the paired comparison analysis based on the data from **Table 11.**

Prefer \ Over	7Step	AM	AvailM	BRM	CapM	CE	CM	DC	DM	EM	FM	IM	ISM	ITSCM	KM	PM	RDM	RF	SACM	SCM	SLM	SM	SPM	SupM	SVT	TPS
7Step		2	1	1	1	1	0	2	1	0	1	0	1	1	1	1	0	2	0	0	1	2	2	2	0	1
AM	1		1	2	1	2	0	2	2	1	1	1	1	1	2	2	1	1	1	1	1	2	2	2	1	2
AvailM	2	2		1	1	2	0	2	1	2	1	1	1	1	2	1	1	2	1	2	1	2	1	2	2	2
BRM	1	1	2		2	2	0	1	2	1	1	1	1	2	1	0	0	1	0	1	1	2	2	2	1	1
CapM	2	2	1	1		2	0	2	1	2	1	1	0	1	2	1	0	2	1	2	0	2	1	2	2	2
CE	2	1	1	1	1		0	1	1	1	1	0	1	2	0	1	0	1	0	0	1	1	1	2	1	0
CM	3	2	3	3	3	3		3	3	3	3	3	3	3	3	3	3	2	2	3	2	3	3	3	3	3
DC	1	1	1	2	1	2	0		2	0	1	0	1	1	0	1	0	1	0	0	1	2	1	1	0	0
DM	2	1	2	1	2	1	0	1		1	1	0	1	2	1	1	0	1	0	1	1	2	2	2	1	1
EM	2	2	1	2	1	2	0	3	2		2	1	1	1	1	2	1	2	1	2	1	2	2	2	0	2
FM	2	2	2	1	2	2	0	2	2	1		1	0	1	2	1	0	2	1	2	0	2	3	2	1	2
IM	3	2	2	2	2	3	0	3	2	2	2		1	2	3	2	1	2	2	3	1	3	3	3	2	3
ISM	2	2	2	1	3	2	0	2	2	2	1	2		1	2	1	1	2	1	2	1	2	3	2	2	2
ITSCM	1	2	2	1	2	1	0	2	1	1	1	1	1		1	1	1	2	1	1	1	1	2	1	1	1
KM	2	1	1	2	1	2	0	3	2	1	1	0	1	2		1	1	1	0	1	1	2	1	2	1	1
PM	1	1	2	1	2	2	0	2	2	1	1	1	1	2	2		0	2	0	1	1	3	3	2	1	2
RDM	3	2	2	3	3	3	0	2	3	2	3	2	2	2	2	3		2	1	2	1	3	3	3	2	2
RF	1	2	1	2	1	2	1	2	2	1	1	1	1	1	2	1	1		1	1	1	2	2	1	1	2
SACM	3	2	2	3	2	3	0	3	3	1	2	1	2	2	2	3	2	2		3	1	3	3	3	1	3
SCM	3	2	1	2	1	2	0	3	2	1	1	0	1	2	1	2	1	2	0		1	2	2	3	1	2
SLM	2	2	2	2	3	2	1	2	2	2	2	2	1	1	2	2	2	2	2	2		2	3	2	2	2
SM	1	1	1	1	1	2	0	1	1	1	0	0	0	1	1	0	0	1	0	1	0		1	1	1	0
SPM	1	1	1	1	0	2	0	2	1	1	0	0	0	1	2	0	0	1	0	1	0	2		1	1	2
SupM	1	1	1	1	1	1	0	2	1	1	0	0	0	1	1	1	0	2	0	0	0	1	2		0	1
SVT	3	2	1	2	1	2	0	3	2	2	2	1	1	2	1	2	1	2	1	2	1	2	2	2		2
TPS	2	1	1	2	1	3	0	2	2	1	1	0	1	2	2	1	0	1	0	1	1	2	1	2	1	

Figure 8: Paired Comparison Matrix

4.2.4 Model Development Step 4

Table 12 shows the Borda score that was calculated based on data from step 3. Those values were sorted from largest to smallest and then ranked. This list represents the implementation priority for processes that practitioners should use when implementing the entire ITIL suite based on pre-defined variables.

Table 12: Process Priority List Generated from Process Selection Model

Process	Borda Score	Rank
CM	71	1
RDM	56	2
SACM	55	3
IM	54	4
SLM	49	5
ISM	43	6
SVT	42	7
EM	38	8.5
SCM	38	8.5
AvailM	36	11
FM	36	11
PM	36	11
AM	34	13.5
RF	34	13.5
CapM	33	15
KM	31	16.5
TPS	31	16.5
ITSCM	30	18
BRM	29	19
DM	28	20
7Step	24	21
CE	21	22.5
SPM	21	22.5
DC	20	24
SupM	19	25
SM	17	26

4.3 DSR Activity 5: Evaluation

The researchers conducted a Delphi study using ITIL experts by way of a three-round electronic survey. They used the results from the Delphi study and compared it to the results generated by the process selection model.

The primary purpose of the Delphi study was to gather two pieces of information. The first was a proposed priority-selection list of ITIL processes based on level of importance. The second piece of information collected from the Delphi study was an evaluation by the experts of the process-priority list generated by the process selection model developed in this praxis. **Appendix C** contains the questions used in the Delphi study. **Appendix D** contains the details of the analysis from the Delphi study. **Table 13** is a summary of the analysis from the Delphi study.

Table 13: Delphi Study Summary Results

Process	Borda Score	Rank
IM	143	1
CM	142	2
SACM	138	3
SLM	136	4
PM	131	5
RDM	113	6
KM	107	7
SCM	106	8
SPM	105	9
RF	100	10
ISM	99	11
7Step	73	12.5
BRM	73	12.5
EM	72	14
CapM	71	15.5
FM	71	15.5
AvailM	48	17
ITSCM	47	18
DM	44	19
SupM	40	20
AM	31	21
SM	24	22
SVT	11	23
DC	10	24.5
TPS	10	24.5
CE	5	26

4.3.1 Research Questions

The researchers defined one research question based on the problem statement to evaluate the process selection model.

1. Is the list resulting from the process selection model similar to a list generated by expert opinion?

To further elaborate, the researchers pose a hypothesis and null hypothesis question for this research question.

H1: There is a positive rank order association between the process priority list developed through expert opinion and the list generated by the process selection model; $\rho >$ Critical ρ (N, α), Where N = 26 and α = 0.01

H0: There is no positive rank order association between the process priority list developed through expert opinion and the list generated by the process selection model; ρ ≤ Critical ρ (N, α), Where N = 26 and α = 0.01

4.3.2 Evaluation Procedures

To evaluate the findings from the process selection model, the ITIL process-priority list developed through the Delphi study and the process-priority list resulting from the selection model were compared against each other using significance testing with the Spearman Rank-Order Correlation Coefficient. The Spearman Rank-Order Correlation measures the direction and strength of association between two lists [56]. In order to use the Spearman Rank-Order Correlation, the data must be ordinal-level measurements, meaning that the data has a logical hierarchy while the magnitude between the ranks can be ignored [57]. The Spearman Rank-Order Correlation Coefficient, denoted by ρ, is a modified Pearson Product that is adjusted for ordinal-level data [56]. The formula for the rank order correlation coefficient is represented in **Equation 3.**

Equation 3: Equation for Spearman Rank Correlation

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Where d_i is the distance between ranks of the *ith* ITIL process
n is the number of ITIL processes (which is 26)

Its value ranges from 1, denoting a prefect positive correlation, to -1, denoting a perfect negative correlation. The value 0 indicates that there is no relationship between the two lists. For this particular research, ρ would need to be larger than the critical value of 0.457 (for α = 0.01) for a one-tailed test. By conducting this test, the researchers will address the null hypothesis question.

4.3.3 Evaluation Results

Table 14 shows the results from the Delphi study (column A) alongside the results generated from the process sequencing model (column B).

Table 14: Cross Comparison Between Ranked Lists

Process	Column A Delphi Study Rank	Column B Selection Model Rank	d	d^2
7Step	12.5	21	-8.5	72.25
AM	21	13.5	7.5	56.25
AvailM	17	11	6	36
BRM	12.5	19	-6.5	42.25
CapM	15.5	15	0.5	0.25
CE	26	22.5	3.5	12.25
CM	2	1	1	1
DC	24.5	24	0.5	0.25
DM	19	20	-1	1
EM	14	8.5	5.5	30.25
FM	15.5	11	4.5	20.25
IM	1	4	-3	9
ISM	11	6	5	25
ITSCM	18	18	0	0
KM	7	16.5	-9.5	90.25
PM	5	11	-6	36
RDM	6	2	4	16
RF	10	13.5	-3.5	12.25
SACM	3	3	0	0
SCM	8	8.5	-0.5	0.25
SLM	4	5	-1	1
SM	22	26	-4	16
SPM	9	22.5	-13.5	182.25
SupM	20	25	-5	25
SVT	23	7	16	256
TPS	24.5	16.5	8	56.25

$$\rho = 1 - \frac{6(1005)}{26(26^2 - 1)} = 1 - \frac{6030}{17550} = 1 - 0.34359 = 0.66$$

The spearman rank correlation coefficient using the one tailed test and $\alpha = 0.01$ yielded a value of 0.65641. Based on those results, the researchers rejected the null hypothesis that there is no association between the implementation priority list developed by ITIL experts and that priority list generated by the process selection model. They concluded that there is a statistically significant positive correlation between the two lists.

Chapter 5: Discussion/Conclusion

5.1 Organization

Chapter 5 provides an in depth discussion of the results detailed in Chapter 4. Additionally, the researchers conducted a sensitivity analysis of the model to identify variables of positive or negative influence and areas for potential improvement. Lastly, the researchers provided recommendations for future research and enhancements to the current model.

5.2 Results Discussion

Based on the results from Chapter 4, the spearman rank correlation coefficient using the one tailed test and $\alpha = 0.01$ yielded a value of 0.66. Based on those results, the researchers rejected the null hypothesis. They concluded that there is a statistically significant positive correlation between the implementation priority list developed by ITIL experts through a Delphi study and the priority list generated by the process selection model based on the three selected variables.

5.2.1 Strengths

This model gives IT practitioners a definitive list of ITIL v3 processes ordered by priority for implementation. It takes the guesswork out of determining the order of implementation. Additionally, other factors proven to be statistically significant can be added to refine the model based on the factors that are important to IT organizations engaged in ITIL v3 implementation.

5.2.2 Limitations

This model can only be used in environments where IT operations are not outsourced, IT to business internal charging structures are simplified, and complete ITIL v3 implementation is the goal. This model does not address how to implement particular

processes or how they should be integrated with each other – that is left to the discretion of the implementer.

5.3 Process Selection Variable Comparison

The researchers began the comparative analysis between the three variables by first conducting the Spearman Rank Correlation analysis based on the data in **Table 11: Process Sequencing Variable Rankings**. **Table 15** highlights the results from that analysis.

Table 15: Spearman Rank Correlation Analysis on Process Selection Variables

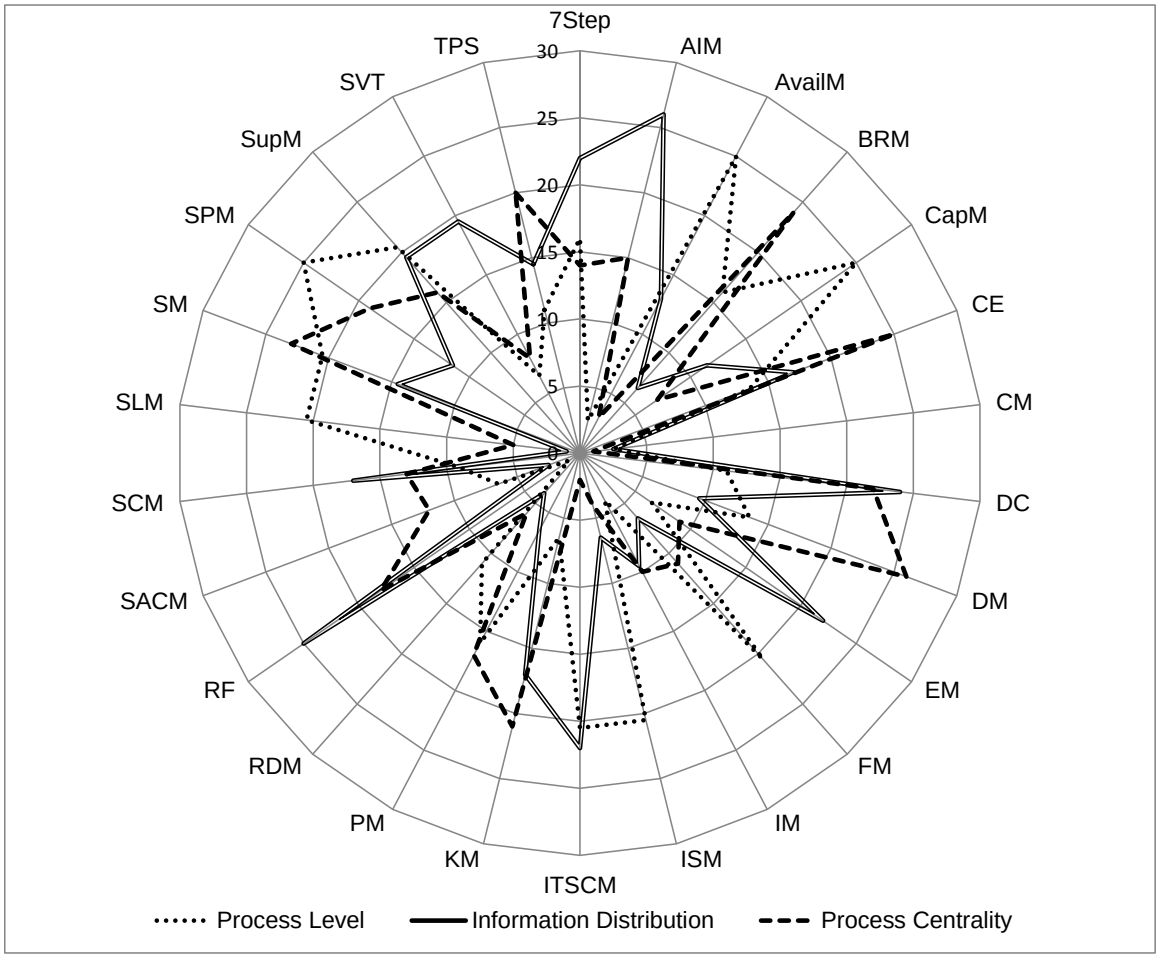
Variable 1	Variable 2	ρ	Conclusion with α = 0.01
Process Level	Information distribution	-0.21	No Rank Order Correlation
Process Level	Process Centrality	-0.08	No Rank Order Correlation
Information Distribution	Process Centrality	0.26	No Rank Order Correlation

Despite the fact that there is no rank order correlation relationship between the three variables, there are several similarities that can be observed.

1. All three process sequencing variable ranked lists have CM ranked high, either 1 or 2.5.
2. *Process Level* and *Information Distribution* ranked ITSCM low, 20.5 and 22, respectively, in comparison to *Process Centrality*.
3. *Process Level* and *Process Centrality* ranked 7Step in the middle, 14 and 16 respectively, in comparison to *Information Distribution* which ranked it low.
4. DC is ranked low with *Information Distribution* and *Process Centrality*, 22, and 24 respectively, in comparison to *Process Level* which ranked it 11.

Figure 9 presents a graphical view highlighting the similarities and differences between the process ranks of three process selection variables using a radar chart.

Figure 9: Process Sequencing Variable Radar Chart



5.4 Sensitivity Analysis

The researchers began the sensitivity analysis with analyzing the impact of each variable in the Process Selection model. Six scenarios were identified for the initial sensitivity analysis. **Table 16** outlines the criteria for the six scenarios.

Table 16: Sensitivity Analysis Scenarios

Scenario Ref ID	Criteria
1	Evaluate the Process Selection Model only using the Process Level variable.
2	Evaluate the Process Selection Model omitting the Process Level variable and only using the Information Distribution and Process Centrality variables.
3	Evaluate the Process Selection Model only using the Information Distribution variable.
4	Evaluate the Process Selection Model omitting the Information Distribution variable and only using the Process Level and Process Centrality variables.
5	Evaluate the Process Selection Model only using the Process Centrality variable.
6	Evaluate the Process Selection Model omitting the Process Centrality variable and only using the Process Level and Information Distribution variables.

From each of those six scenarios, the researchers generated new process priority lists using the Process Selection Model. The researchers compared each process priority list resulting from the six scenarios to the original list generated by the model via Spearman Rank Correlation analysis. **Table 17** highlights the results from that analysis. All six scenarios show a statistically significant positive correlation between the original process priority list and the list resulting from the scenarios of the sensitivity analysis, when $\alpha = 0.05$.

Table 17: Spearman Rank Correlation Analysis of Sensitivity Analysis Scenarios

Scenario	ρ	Correlation with α = 0.01	Correlation with α = 0.05
1	0.40	NO	YES
2	0.76	YES	YES
3	0.52	YES	YES
4	0.80	YES	YES
5	0.71	YES	YES
6	0.66	YES	YES

The researchers compared each list resulting from the six scenarios to the process priority list generated from the ITIL experts through the Delphi study. **Table 18** summarizes the sensitivity analysis conducted.

Table 18: Initial Sensitivity Analysis Results

Scenario	ρ – value	Reject/Fail to Reject H0 (α = 0.01)	Reject/Fail to Reject H0 (α = 0.05)
1	0.21	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
2	0.59	Reject H0 / Correlation	Reject H0 / Correlation
3	0.59	Reject H0 / Correlation	Reject H0 / Correlation
4	0.41	Fail to Reject H0 / No Correlation	Reject H0 / Correlation
5	0.38	Fail to Reject H0 / No Correlation	Reject H0 / Correlation
6	0.62	Reject H0 / Correlation	Reject H0 / Correlation

Based on the information in **Table 18**, the researchers concluded that only scenarios that utilize the Information Distribution variable show a statistically significant positive correlation to the process priority list generated through the Delphi study of ITIL experts and the list generated through the Process Selection model when $\alpha = 0.01$. This would suggest that the distribution of information between processes is extremely important when implementing the entire ITIL suite of processes and has a large positive influence on the accuracy of the Process Selection Model.

When the researchers modified the value of α from 0.01 to 0.05, all the scenarios, except one, showed there was a statistically significant positive correlation between the two lists. The one scenario that did not have a statistically positive correlation was scenario 1 which only evaluated the Process Level variable against the process priority list generated by the experts. The researchers concluded that the Process Level variable has a negative influence on the accuracy of the Process Selection Model.

5.4.1 Process Level Secondary Sensitivity Analysis

Based on the results reported in **Table 18**, the researchers concluded that the Process Level variable can offset the model. They conducted a secondary sensitivity analysis focusing on the Process Level variable. In the secondary analysis, the researchers focused on three relevant scenarios. **Table 19** highlights the three scenarios used for the secondary analysis.

Table 19: Process Level Secondary Analysis - Sensitivity Analysis Scenarios

Scenario Ref ID	Criteria
1	Evaluate the Process Selection Model only using the Process Level variable.
4	Evaluate the Process Selection Model omitting the Information Distribution variable and only using the Process Level and Process Centrality variables.
6	Evaluate the Process Selection Model omitting the Process Centrality variable and only using the Process Level and Information Distribution variables.

5.4.1.1 Secondary Analysis – Scenario 1

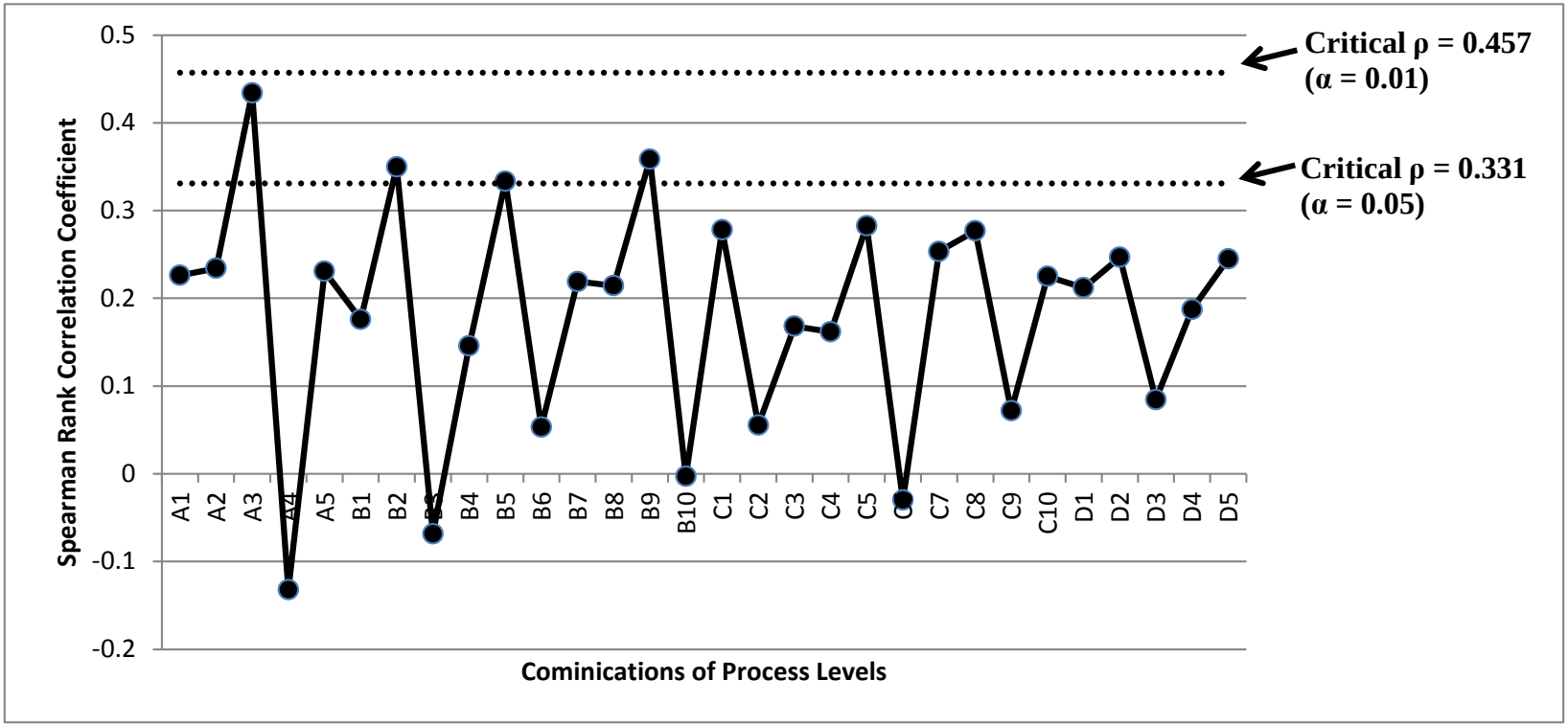
The researchers evaluated each combination of the five factors that derived the PLS in order to find the most dominating factor that provides a correlation against the process

priority list generated by ITIL experts. The main objective of this analysis was to identify if there was a specific combination of factors that could generate a positive correlation. **Table 20** provides a summary of the results from the secondary analysis with each possible combination of process level factors. **Figure 10** provides a graphical representation of the information provided in **Table 20.**

Table 20: Process Level Secondary Analysis – Scenario 1

Ref	Factors Selected					ρ	Reject/Fail to Reject H0 (α = 0.01)	Reject/Fail to Reject H0 (α = 0.05)
	F1	F2	F3	F4	F5			
A1	X					0.23	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
A2		X				0.23	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
A3			X			**0.43**	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
A4				X		-0.13	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
A5					X	0.23	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B1	X	X				0.18	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B2	X		X			**0.35**	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
B3	X			X		-0.07	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B4	X				X	0.15	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B5		X	X			**0.33**	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
B6		X		X		0.05	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B7		X			X	0.22	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B8			X	X		0.21	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
B9			X		X	**0.36**	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
B10				X	X	-0.00	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C1	X	X	X			0.28	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C2	X	X		X		0.06	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C3	X	X			X	0.17	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C4	X		X	X		0.16	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C5	X		X		X	0.28	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C6	X			X	X	-0.03	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C7		X	X	X		0.25	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C8		X	X		X	0.28	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C9		X		X	X	0.07	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
C10			X	X	X	0.22	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
D1	X	X	X	X		0.21	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
D2	X	X	X		X	0.25	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
D3	X	X		X	X	0.08	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
D4	X		X	X	X	0.19	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation
D5		X	X	X	X	0.25	Fail to Reject H0 / No Correlation	Fail to Reject H0 / No Correlation

Figure 10: Process Level Secondary Analysis Chart



Based on the results from the secondary analysis, there are four combinations that have a statistically significant positive correlation when $\alpha = 0.05$. In each of those four combinations, either the third factor, Level of Decision Making, was the only factor considered or it was paired with one of the other factors. When more than two factors were considered, there was no longer a statistically significant relationship.

5.4.1.2 Secondary Analysis – Scenario 4

Using the four scenarios that resulted in a statistically significant positive correlation in **Section 5.4.1.1,** the researchers tested to see if there was a correlation when omitting Information Distribution variable and only using Process Level and Process Centrality. The main objective of this analysis was to identify if there were any combinations that would produce a positive correlation with the process priority list generated from the ITIL experts. **Table 21** has the results from that analysis.

Table 21: Process Level Secondary Analysis – Scenario 4

Ref	ρ	Reject/Fail to Reject H0 ($\alpha = 0.01$)	Reject/Fail to Reject H0 ($\alpha = 0.05$)
A3	0.47	**Reject H0 / Correlation**	**Reject H0 / Correlation**
B2	0.40	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
B5	0.41	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**
B9	0.44	Fail to Reject H0 / No Correlation	**Reject H0 / Correlation**

When $\alpha = 0.01$, only one situation had a statistically significant correlation. That situation used only one process level factor, Level of Decision Making. Only when α increases to 0.05 did other combinations of factors have a correlation. The researchers concluded that the process level factor, Level of Decision Making, has a positive influence over the Process Selection model.

5.4.1.3 Secondary Analysis – Scenario 6

Using the twenty-six scenarios that did not result in a statistically significant positive correlation in **Section 5.4.1.1**, the researchers tested to see if there would still be a statistically significant correlation when omitting the Process Centrality variable and only using Process Level (based on the combination of factors) and Information Distribution.

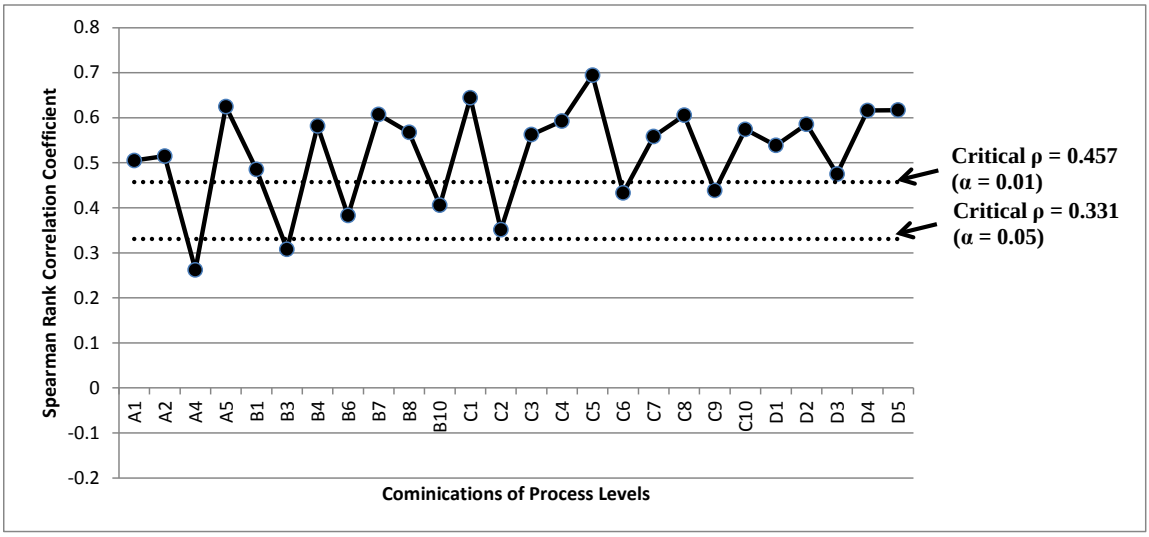
The main objective of this analysis was to identify factor combinations that would change the outcome from a statistically significant correlation to no correlation at all. **Table 22** has the results from that analysis.

Table 22: Process Level Secondary Analysis – Scenario 4

Ref	ρ	Reject/Fail to Reject H0 (α = 0.01)	Reject/Fail to Reject H0 (α = 0.05)
A1	0.50	Reject H0/ Correlation	Reject H0/ Correlation
A2	0.51	Reject H0/ Correlation	Reject H0/ Correlation
A4	0.26	Fail to Reject H0/ No Correlation	Fail to Reject H0/ No Correlation
A5	0.62	Reject H0/ Correlation	Reject H0/ Correlation
B1	0.49	Reject H0/ Correlation	Reject H0/ Correlation
B3	0.31	Fail to Reject H0/ No Correlation	Fail to Reject H0/ No Correlation
B4	0.58	Reject H0/ Correlation	Reject H0/ Correlation
B6	0.38	Fail to Reject H0/ No Correlation	Reject H0/ Correlation
B7	0.61	Reject H0/ Correlation	Reject H0/ Correlation
B8	0.57	Reject H0/ Correlation	Reject H0/ Correlation
B10	0.41	Fail to Reject H0/ No Correlation	Reject H0/ Correlation
C1	0.64	Reject H0/ Correlation	Reject H0/ Correlation
C2	0.35	Fail to Reject H0/ No Correlation	Reject H0/ Correlation
C3	0.56	Reject H0/ Correlation	Reject H0/ Correlation
C4	0.59	Reject H0/ Correlation	Reject H0/ Correlation
C5	0.69	Reject H0/ Correlation	Reject H0/ Correlation
C6	0.43	Fail to Reject H0/ No Correlation	Reject H0/ Correlation
C7	0.56	Reject H0/ Correlation	Reject H0/ Correlation
C8	0.61	Reject H0/ Correlation	Reject H0/ Correlation
C9	0.44	Fail to Reject H0/ No Correlation	Reject H0/ Correlation
C10	0.57	Reject H0/ Correlation	Reject H0/ Correlation
D1	0.54	Reject H0/ Correlation	Reject H0/ Correlation
D2	0.59	Reject H0/ Correlation	Reject H0/ Correlation
D3	0.48	Reject H0/ Correlation	Reject H0/ Correlation
D4	0.62	Reject H0/ Correlation	Reject H0/ Correlation
D5	0.62	Reject H0/ Correlation	Reject H0/ Correlation

Figure 11 provides a graphical representation of the data captured in **Table 22.**

Figure 11: Process Level Secondary Analysis Chart - Scenario 6



Based on the results presented in **Table 22** and **Figure 11**, there are seven combinations that show there is no correlation when α=0.01, and two combinations when α=0.05. The commonality between all the combinations are Process Level factor 4, Level of Dependency to other ITIL processes. Also, none of the combinations include factor 3. From this analysis, the researchers concluded that the 4th factor of the process level score provides a negative influence over the Process Selection model.

5.4.2 Information Distribution Secondary Sensitivity Analysis

The researchers conducted a secondary analysis on the Information Distribution variable. To start, they only considered *Required Outputs* and omitted *Optional Outputs.* The researchers re-ordered the list from greatest to least and calculated a new rank for each process. They used the new rank order for the Information Distribution variable in the Process Selection model along with the original rank order lists from the other two variables.

5.4.2.1 Comparison Analysis of Old Ranks with New Ranks

The researchers conducted a spearman rank order correlation analysis between the old rank order list from the Information Distribution variable and the new rank order list using *Required Outputs* only. The analysis using the one tailed test and α = 0.01 yielded

a value of 0.89. The researchers concluded that the two lists had a statistically significant positive correlation with each other. While the two lists have a high positive correlation, there were some significant differences observed.

1. IM dropped from 9.5 to 18.5
2. KM dropped from 17 to 12
3. PM dropped from 6.5 to 12

The researchers conducted a Spearman Rank correlation analysis against the new process list generated by the Process Selection model and the list generated by expert opinion. The researchers concluded from that analysis that there was still a statistically significant rank order correlation ($\rho = 0.60$ with $\alpha = 0.01$). They conducted a secondary analysis on the Information distribution variable using the three scenarios detailed in **Table 23.**

Table 23: Information Distribution Secondary Analysis - Sensitivity Analysis Scenarios

Scenario Ref ID	Criteria
2	Evaluate the Process Selection Model omitting the Process Level variable and only using the Information Distribution and Process Centrality variables.
3	Evaluate the Process Selection Model only using the Information Distribution variable.
6	Evaluate the Process Selection Model omitting the Process Centrality variable and only using the Process Level and Information Distribution variables.

5.4.2.2 Information Distribution Secondary Analysis – Scenario 2

The researchers began the secondary sensitivity analysis for the Information Distribution variable with evaluating scenario 2. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Information Distribution variable) and the list generated by expert opinion, based on the parameters dictated in scenario 2. **Table 24** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 24: Information Distribution Secondary Analysis – Scenario 2

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.59	0.53

The researchers concluded there is a statistically significant positive correlation between the two lists even though ρ decreased by 10.5% between the first and second sensitivity analysis.

5.4.2.3 Information Distribution Secondary Analysis – Scenario 3

The researchers continued the analysis with evaluating scenario 3. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Information Distribution variable) and the list generated by expert opinion, based on the parameters dictated in scenario 3. **Table 25** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 25: Information Distribution Secondary Analysis – Scenario 3

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.56	0.47

The researchers concluded that there is a statistically significant positive correlation between the two lists even though ρ decreased by 14.9% between the first and second sensitivity analysis. However, there is an overall decline in ρ.

5.4.2.4 Information Distribution Secondary Analysis – Scenario 6

The researchers completed the secondary sensitivity analysis on the Information Distribution variable with evaluating scenario 6. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Information Distribution variable) and the list generated by expert opinion, based on the parameters dictated in

scenario 6. **Table 26** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 26: Information Distribution Secondary Analysis – Scenario 6

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.62	0.56

The researchers concluded that there is a statistically significant positive correlation between the two lists even though ρ decreased by 10% between the first and second sensitivity analysis. Based on the three secondary sensitivity analysis, the author concludes that omitting the *Optional Outputs* from the Information Distribution variable results in little to no impact on the Process Selection model.

5.4.3 Process Centrality Secondary Sensitivity Analysis

The researchers conducted a secondary analysis on the Process Centrality variable. To start, they only considered *Required Outputs* and omitted *Optional Outputs* and then performed a bidirectional network node analysis and calculated the eigenvector centrality. The researchers re-ordered the list from greatest to least and calculated a new rank for each process. The researchers used the new rank order for the Process Centrality variable in the Process Selection model along with the original rank order lists from the other two variables.

5.4.3.1 Comparison Analysis of Old Ranks with New Ranks

The researchers conducted a spearman rank order correlation analysis between the old rank order list from the Process Centrality variable and the new rank order list using the new EVC. The analysis using the one tailed test and $\alpha = 0.01$ yielded a value of 0.66. The author concludes that the two list had a statistically significant positive correlation with each other. While the two lists have a high positive correlation, there were some significant differences that they observed.

1. CM dropped from 1 to 17.

2. AvailM dropped from 2 to 14.
3. RDM dropped from 6 to 18.
4. FM rose from 11 to 3.
5. SupM rose from 16 to 2.

The researchers conducted a Spearman Rank correlation analysis against the new process list generated by the Process Selection model and the list generated by expert opinion. They concluded from that analysis that there was still a statistically significant rank order correlation ($\rho = 0.65$ with $\alpha = 0.01$). They conducted a secondary analysis on the Process Centrality variable using the three scenarios detailed in **Table 27.**

Table 27: Process Centrality Secondary Analysis - Sensitivity Analysis Scenarios

Scenario Ref ID	Criteria
2	Evaluate the Process Selection Model omitting the Process Level variable and only using the Information Distribution and Process Centrality variables.
4	Evaluate the Process Selection Model omitting the Information Distribution variable and only using the Process Level and Process Centrality variables.
5	Evaluate the Process Selection Model only using the Process Centrality variable.

5.4.3.2 Process Centrality Secondary Analysis – Scenario 2

The researchers began the secondary sensitivity analysis for the Process Centrality variable with evaluating scenario 2. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Process Centrality variable) and the list generated by expert opinion, based on the parameters dictated in scenario 2. **Table 28** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 28: Information Distribution Secondary Analysis – Scenario 2

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.59	0.55

The researchers concluded that there is a statistically significant positive correlation between the two lists even though ρ decreased by 5.4% between the first and second sensitivity analysis.

5.4.3.3 Process Centrality Secondary Analysis – Scenario 4

The author continued the analysis with evaluating scenario 4. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Process Centrality variable) and the list generated by expert opinion, based on the parameters dictated in scenario 4. **Table 29** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 29: Process Centrality Secondary Analysis – Scenario 4

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.41	0.28

The researchers concluded that there is no statistically significant positive correlation between the two lists. The value of ρ decreased by 31.8% between the first and second sensitivity analysis.

5.4.3.4 Process Centrality Secondary Analysis – Scenario 5

The researchers completed the secondary sensitivity analysis on the Process Centrality variable with evaluating scenario 5. The main objective of this analysis was to determine if there would still be a statistically significant positive correlation between the Process Selection model generated list (with a modified Process Centrality variable) and the list generated by expert opinion, based on the parameters dictated in scenario 5. **Table 30** captures the results of ρ from the original analysis, the first sensitivity analysis, and the secondary sensitivity analysis.

Table 30: Process Centrality Secondary Analysis – Scenario 5

Original ρ	First Sensitivity Analysis ρ	Second Sensitivity Analysis ρ
0.65	0.38	0.12

The researchers concluded show that there is no statistically significant positive correlation between the two lists. The value of ρ decreased by 69.6% between the first and second sensitivity analysis. Based on the three secondary sensitivity analysis, they concluded that the new EVC for the Process Centrality variable negatively impacted the Process Selection model and the correlation of the end results.

5.5 Potential Future Work

This model presented in this praxis should be validated through a case study to evaluate the overall approach, its application, and validity in a real IT organization; thereby providing a foundational platform that could be leveraged for variations of ITIL v3 implementations, including but not limited to ITIL Lite, Green ITIL Methodologies, and ITIL Outsourcing Models. Additionally, this model could be expanded to consider other selection variables than the ones that were utilized in this praxis.

References

[1] M. W. Johnson, A. Hately, B. A. Miller and R. Orr, "Evolving Standards for IT Service Management," *IBM Systems Journal,* vol. 46, no. 3, pp. 583 - 597, 2007.

[2] M. Marrone and L. M. Kolbe, "Uncovering ITIL Claims, IT Executives' Perception on Benefits and Business-IT Alignment," *Information System E-Business Management,* vol. 9, no. 3, pp. 164 - 175, 2011.

[3] A. Miller, E. Campos-Nanez, P. Fomin and J. Wasek, "An IT Infrastructure Library (ITIL) Maturity Strategy for Private Cloud Sourcing Models: A Literature Review and Research Methodology Formation," in *Information Systems International Conference (ISICO),* Bali, Indonesia, 2013.

[4] W.-g. Tan, A. C. Steel and M. Toleman, "Implementing IT Service Management: A Case Study Focussing on Critical Success Factors," *Journal of Computer Information Systems,* vol. 50, no. 2, pp. 1 - 9, 2009.

[5] A. Hochstein and W. Brenner, "Implementation of Service-Oriented IT Management: an Empirical Study on Swiss IT Organizations," in *2006 International Conference on Service Systems and Service Management*, Troyes, 2006.

[6] S. D. Galup, R. Dattero, J. J. Quan and S. Conger, "An Overview of IT Service Management," *Communications of the ACM,* vol. 52, no. 5, pp. 124 - 127, 2009.

[7] C. Pollard and A. Cater-Steel, "Justification, Strategies, and Critical Success Factors in Successful ITIL Implementation in U.S. and Australian Companies: An Exploratory Study," *Information Systems Management,* vol. 26, no. 2, pp. 164 - 175, April 2009.

[8] M. Marrone and L. M. Kolbe, "Impact of IT Service Management Frameworks on the IT Organization An Empirical Study on Benefits, Challenges, and Processes," *Business & Information Systems Engineering*, vol. 3, no. 1, pp. 5-18, 2011.

[9] L. Lema, J.-A. Calvo-Manzano, R. Colomo-Palacios and M. Arcilla, "ITIL in small to medium-sized enterprises software companies: towards an implementation sequence," *Software: Evoluion and Process*, pp. 528-538, 2015.

[10] M. Nicho and B. Mourad, "Sucess Factors for Integrated ITIL Deployment: An IT Governance Classification," *Journal of Information Technology Case and Application Research*, vol. 14, no. 1, pp. 25 - 53, 2012.

[11] D. Cannon, L. Hunnebeck, V. Llyod, A. Orr, S. Rance, C. Rudd and R. Steinberg, ITIL Service Strategy, London: TSO (The Stationery Office), 2011.

[12] L. Hunnebeck, D. Cannon, V. Lloyd, A. Orr, S. Rance, R. Steinberg and D. Wheeldon, ITIL Service Design, London: TSO (The Stationery Office), 2011.

[13] V. Lloyd, D. Cannon, L. Lunnebeck, A. Orr, S. Rance, C. Rudd and R. Steinberg, ITIL Continual Service Improvement, London: TSO (The Stationery Office), 2011.

[14] S. Rance, D. Cannon, V. Llyod, A. Orr, R. Steinbrg and D. Wheeldon, ITIL Service Transition, London: TSO (The Stationery Office), 2011.

[15] R. Steinberg, D. Cannon, L. Hunnebeck, V. Lloyd, A. Orr, S. Rance and D. Wheeldon, ITL Service Operation, London: TSO (The Stationery Office), 2011.

[16] A. Moura, J. Sauve and C. Bartolini, "Research Challenges of Business - Driven IT Management," in *2nd IEEE/IFIP International Workshop on Business-Driven IT Management*, Munich, May 2007.

[17] J. Iden and L. Langelan, "Setting the Stage for a Successful ITIL Adoption: A Delphi Study of IT Experts in the Norwegian Armed Forces," *Information Systems Management,* vol. 27, no. 2, pp. 103 - 112, 2010.

[18] F. Gacenga, A. Cater-Steel and M. Toleman, "An International Analysis of IT Service Management Benefits and Performance Measurement," *Journal of Global Information Technology Management,* vol. 13, no. 4, pp. 28-63, 2010.

[19] K. Peffers, T. Tuunanen, M. A. Rotherberger and S. Chatterjee, "A Design Science Research Methodology for Information Systems Research," *Journal of Management Information Systems,* vol. 24, no. 3, pp. 45 - 77, 2008.

[20] C. Okoli and K. Schabram, "A Guide to Conducting a Systematic Literature Review of Information Systems Research," *Sprouts: Working Papers on Information Systems,* vol. 10, no. 26, pp. 1-49, 2010.

[21] Y. Levy and T. J. Ellis, "A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research," *Informing Science: International Journal of an Emerging Transdiscipline,* vol. 9, no. 1, pp. 181-212, 2006.

[22] J. Iden and T. R. Eikebrokk, "Implementing IT Service Management: A Systematic Literature Review," *International Journal of Information Management,* vol. 33, no. 3, pp. 512-523, 2013.

[23] M. W. Johnson, A. Hately, B. A. Miller and R. Orr, "Evolving Standards for IT Service Management," *IBM Systems Journal,* vol. 46, no. 3, pp. 583 - 597, July 2007.

[24] M. Winniford, S. Conger and L. Erickson-Harris, "Confusion in the Ranks: IT Service Management Practice and Terminology," *Information Systems Management*, vol. 26, no. 2, pp. 153 - 163, April 2009.

[25] C. G. Lynch, "Management Report - Most Companies Adopting ITIL Practices," *CIO Magazine*, 1 March 2006.

[26] A. Hochstein, G. Tamm and W. Brenner, "Service Oriented IT Management: Benefit, Cost and Success Factors," in *European Conference on Information Systems (ECIS) Proceedings 2005*, Regensburg, 2005.

[27] A. Hochstein, R. Zarnekow and W. Brenner, "Evaluation of service-oriented IT management in practice," in *Proceedings of the International Conference on Services Systems and Services Management*, 2005.

[28] R. Esteves and P. Alves, "Implementation of an Information Technology Infrastructure Library Process – the Resistance to Change," *Procedia Technology*, vol. 9, pp. 505 - 510, 2013.

[29] N. Ahmad and Z. M. Shamsudin, "Systematic Approach to Successful Implementation of ITIL," *Procedia Computer Science*, vol. 17, p. 237–244, 2013.

[30] A. Cater-Steel, M. Toleman and W. -. G. Tan, "Transforming IT Service Management - the ITIL Impact," in *17th Australasian Conference on Information Systems*, Adelaide, 2006.

[31] W.-G. Tan, A. Cater-Steel and T. Mark, "Implementing Centalised IT Service Management: Drawing Lessons from the Public Sector," in *Australasian Conference on Information Systems*, Toowoomba, 2007.

[32] W.-g. Tan, A. C. Steel and M. Toleman, "Implementing IT Service Management: A Case Study Focussing on Critical Success Factors," *Journal of Computer Information Systems,* vol. 50, no. 2, pp. 1 - 9, December 2009.

[33] J. Iden and L. Langelan, "Setting the Stage for a Successful ITIL Adoption: A Delphi Study of IT Experts in the Norwegian Armed Forces," *Information Systems Management,* vol. 27, no. 2, pp. 103 - 112, March 2010.

[34] J. Iden and T. Eikebrokk, "Using the ITIL Process Reference Model for Realizing IT Goverance: An Empirical Investigation," *Information Systems Management,* vol. 31, no. 1, pp. 37-58, 2014.

[35] M. Marrone and L. M. Kolbe, "Uncovering ITIL Claims, IT Executives' Perception on Benefits and Business-IT Alignment," *Information System E-Business Management,* vol. 9, no. 3, pp. 164 - 175, September 2011.

[36] P. Yamakawa, C. O. Noriega, A. N. Linares and W. V. Ramirez, "Improving ITIL Compliance Using Change Management Practices: A Finance Sector Case Study," *Business Process Management Journal,* vol. 18, no. 6, pp. 1020-1035, 2012.

[37] M. Marrone, F. Gagenga, A. Cater-Steel and L. Kolbe, "IT Service Management: A Cross-national Study of ITIL Adoption," *Communications of the Association for Information Systems,* vol. 34, no. Article 49, 2014.

[38] N. Ahmad, N. T. Amer, F. Qutaifan and A. Alhilali, "Technology adoption model and a road map to successful implementation of ITIL," *Journal of Enterprise Information Management,* vol. 26, no. 5, pp. 553 - 576, 2013.

[39] H. M. Alfaraj and S. Qin, "Operationalising CMMI: Integrating CMMI and CoBIT Prespective," *Journal of Engineering, Design and Technology,* vol. 9, no. 3, pp. 323 - 335, 2011.

[40] R. d. S. Pereira and M. M. d. Silva, "A Maturity Model for Implementing ITIL v3," in *2010 6th World Congress on Services (SERVICES-1)*, Miami, Florida, USA, July 2010.

[41] R. d. S. Pereira and M. M. d. Silva, "A Maturity Model for Implementing ITIL v3 in Practice," in *2011 15th IEEE International Enterprise Distributed Object Computing Conference Workshops (EDOCW)*, Helsinki, Finland, August 2011.

[42] B. McNaughton, P. Ray and L. Lewis, "Designing an Evaluation Framework for IT Service Management," *Information & Management*, vol. 47, no. 4, pp. 219-225, 2010.

[43] M. Alojail and B. Corbitt, "ITIL maturity model of IT outsourcing: Evidence from a “leading user," in *2014 9th Iberian Conference on Information Systems and Technologies (CISTI)*, Barcelona, 2014.

[44] A. Shrestha, A. Cater-Steel, M. Toleman and W.-G. Tan, "A Method to Select IT Service Management Processes for Improvement," *Journal of Information Technology Theroy and Application*, vol. 15, no. 3, pp. 31 - 56, 2014.

[45] R. G. Lee and B. G. Dale, "Business process management: a review and evaluation," *Business Process Management Journal*, vol. 4, no. 3, pp. 214-225, 1998.

[46] P. Harmon, "The Scope and Evolution of Business Process Management," in *Handbook on Business Process Management 1 - Introction, Methods, and Information Systems (2nd Edition)*, Heidelberg, Springer, 2015, pp. 37 - 80.

[47] H. Tschirky, "Bringing Technology into Management: The Call of Reality Going Beyond Industrial Management at the ETH," in *Innovation in Technology Management - The Key to Global Leadership. PICMET '97: Portland International Conference on Management and Technology*, Portland, Oregon, 1997.

[48] M. Tarafdar and S. Qrunfleh, "IT - Business Alignment: A Two - Level Analysis," *Information Systems Management,* vol. 26, no. 4, pp. 338 - 349, 2009.

[49] B. Henriksen and B. Andersen, "Is There a Tactical Level of Business Process?," *The TQM Journal,* vol. 22, no. 5, pp. 516 - 528, 2009.

[50] O. Holschke, J. Rake and O. Levina, "Granularity as a Cognitive Factor in the Effectiveness of Business Process Model Reuse," in *Business Process Management Lecture Notes in Computer Science*, Berlin, Springer - Verlag, 2009, pp. 245 - 260.

[51] N. Berente, B. Vandenbosch and B. Aubert, "Information Flows and Business Process Integration," *Business Process Management Journal,* vol. 15, no. 1, pp. 119 - 141, 2009.

[52] J. Antony, S. B. Anmol, M. Kumar, K. Mendibil and D. Montgomery, "Application of six sigma DMAIC methodology in a transactional environment," *The International Journal of Quality & Reliability Management* , pp. 31 - 53, 2015.

[53] M. Weske, Business Process Management: Concepts, Languages, Architectures, Heidelberg: Springer, 2007.

[54] P. Bonacich, "Some unique properties of eigenvector centraility," *Socila Networks,* pp. 555 - 564, 2007.

[55] H. P. Young, "Condorcet's Theory of Voting," *The American Political Science Review,* vol. 82, no. 4, pp. 1231 - 1244, 1988.

[56] J. S. M. Coleman, "Spearman Rank Order Correlation," in *Encyclopedia of Research Design*, Thousand Oaks, SAGE Publications, Inc., 2010, pp. 1405-1408.

[57] K. D. Multon and J. S. M. Coleman, "Ordinal Scale," in *Encyclopedia of Research Design*, Thousand Oaks, SAGE Publications, Inc., 2010, pp. 976-978.

[58] M. Nicho and B. Mourad, "Success Factors for Integrated ITIL Deployment: An IT Governance Classification," *Journal of Information Technology Case and Application Research*, vol. 14, no. 1, pp. 25 - 53, 2012.

[59] D. Dubie, "ITIL Adoption Increases in U.S., Proficiency Still Lacking," *Network World*, 29 February 2008.

[60] A. Cater-Steel, W. -. G. Tan and M. Toleman, "Using Institutionalism as a Lens to Examine ITIL Adoption and Diffusion," in *20th Australasian Conference of Information Systems*, Melbourne, December 2009.

[61] A. Cater-Steel, W. -. G. Tan and M. Toleman, "itSMF Australia 2011 Conference: Summary Report of ITSM Standards and Frameworks Survey," USQ & itSMF Australia, Toowoomba, 2011.

[62] CMMI Product Team, "CMMI for Development, Version 1.3," Software Engineering Institue, Pittsburgh, 2010.

Appendix A – Variable 1 Detailed Analysis

Table 31: Factor 1 Analysis of ITIL Processes

Process	Scale Value	Rationale
7Step	HIGH	Below are a list of tasks to establish the 7 Step improvement process: • Determine the appropriate methodologies to use as the foundation of the program • Identify industry standards to model • Perform an initial analysis of all processes • Conduct a gap analysis based on the first three bullets • Design an improvement strategy for each process • Determine the return on investment for each strategy and prioritize the projects.
AM	LOW	To establish this process, the process owner needs to work with IT Security Management to determine the appropriate levels of access that should be granted. This criteria is determined by IT security and passed down to the AM for execution. Additionally, there are several off the shelf products that can administer this process. Therefore, initiating this process can be done with little difficulty.
AvailM	HIGH	Availability Management process involves interfacing with the customers (Business Relationship Management), understanding the requirements, and determining the appropriate thresholds (Service Level Management). All that information is then given as inputs to the system design and managed throughout the life cycle of a service. Establishing this process requires having a resource with a high level of knowledge and understanding in not only the discipline of availability measurement and management, but how this can be executed for each service in the portfolio.
BRM	HIGH	It takes a significant period of time for the Business Relationship Management process to be fully established. It requires an understanding of the customer, their requirements, and their needs.
CapM	HIGH	Laying out the various levels of capacity planning requires an individual that has experience in capacity planning and understands the business needs and technical architecture. Specific areas of knowledge include: • Business Capacity Management • Service Capacity Management • Component Capacity Management Establishing this process requires having a resource with a high level of knowledge and understanding in not only the discipline of availability measurement and management, but how this can be executed for each service in the portfolio.
CE	HIGH	Establishing the criteria for evaluating changes is situational based on the needs of the organization, the types of changes they perform, and the type of technology that is used. Making the defining the data that is collected and determining the level at which it is evaluated requires a resource with a strong foundation in the technology as well change management practice and principles.

Process	Scale Value	Rationale
CM	LOW	The information that is documented and captured for each change is driven by the criteria established by Change Evaluation. The Change Management process can mature over time as the Change Evaluation process matures. To establish the initial process, the Change Management process owner only needs to document whatever information is available about a given change. The base documentation that can be captured is found in the ITIL literature.
DC	MEDIUM	Design coordination involves establishing the communication protocol, data transmission criteria, and resource responsibility matrix for each particular service. This process interfaces with several other processes and requires for those process to be established in order to be fully executed.
DM	HIGH	The Demand Management process involves interfacing with the customers (Business Relationship Management), understanding the environment and market, and being able to predict the need for a particular service. All that information is then given as inputs to several demand management tools that are administrated by individuals with a high degree of knowledge in the domain.
EM	MEDIUM	Event management is monitoring the system, determining the appropriate implementation tool sets, filtering process, alert mechanisms, and event detection process. This requires mid- level knowledge to set up and establish.
FM	HIGH	Setting up all the financial systems and cost approach takes a high level of knowledge and skill to perform.
IM	MEDIUM	Determining the initial criteria for documentation does not take a high level operational management competence to determine. However, developing the library of standard operating procedures and appropriate escalation protocol would require a mid-level degree of knowledge as well as a significant amount of time to establish.
ISM	HIGH	Several elements need to be established when this process is initiated. • Security Framework • Security Policy • Security Management System This would require a resource that has a high level of knowledge of security standards and practices as well as a strong understanding of how to execute a security program across an enterprise.
ITSCM	HIGH	IT Service Continuity Management has to be embedded in the development and design lifecycle phases of a service. In order to establish this process, a resource with a high level of knowledge in service and technologies must be used to establish and maintain this process.
KM	HIGH	Establishing a Knowledge Management system requires an understanding of all the data and information that is being captured and stored across a service and enterprise. Identifying, organizing, and storing that information in a relevant reference model for an enterprise requires a high level of knowledge and know how to execute.
PM	HIGH	Defining the process to handle, correlate, prioritize, and manage a system and operational problems requires an individual with a high level of knowledge in this area, both from a technical perspective as well as a business perspective.

Process	Scale Value	Rationale
RDM	HIGH	Determining the acceptance criteria and laying out the framework for this process will need to be done by those that have a high level of understanding on testing approaches and methodologies. Additionally, setting up the initial interfaces between all the various processes will require a large amount of time and effort to ensure transparency throughout the lifecycle.
RF	LOW	Clearly identifying the scope and criteria for activities that are handled within the process will require low-level of knowledge. Most information to establish this process can found in the ITIL literature.
SACM	HIGH	Creating an asset database that is capturing all information of an asset throughout the lifecycle and ensuring that it is scalable will take a high aptitude of knowledge in this area. An expert in the field will be needed to ensure that the database design meets the needs of the organization. Most out of the box solutions still require an expert in the field to launch the process.
SCM	MEDIUM	Determining the information that should be captured within the Service Catalogue would require a mid to senior level experience to develop. The ITIL literature provides an initial list of data that should be collected for each service. Depending on the enterprise, additional information may need to be captured.
SLM	HIGH	Determining the appropriate Service Level Agreement (SLA) framework that should be used for the entire portfolio of services or each individual of service requires high level of knowledge and understanding of the overall strategy of IT.
SM	HIGH	Determining a strategy for an enterprise is conducted at the higher levels of organizational management. There are several approaches conducted but typically require a high level of understanding as well as years of industry experience to facilitate.
SPM	HIGH	This process must strategically define and analyze approaches to services that meet the business needs in a cost effective way that brings value to the business. This initial setup and continued on-going execution requires a high level of aptitude for understanding changes to the IT landscape and service delivery models.
SupM	HIGH	Setting up the initial contracts to ensure that they are aligned with the service level agreements and requirements established requires a resource with a high level of knowledge. Additionally, this process has to determine the appropriate supplier management model that will be used across the enterprise.
SVT	MEDIUM	Determining the appropriate testing strategy and application of governing policies would require a resource with a knowledge base on testing practices and strategies.
TPS	HIGH	Below are a list of tasks to establish the Transition Planning and Support process: • Establish release policy by determining scope requirements for major, minor, and emergency releases • Determine the delivery frequency of each release type • Determine naming convention for release packages This process leverages the principles and practices of Project Management and governs many of the other lower level processes.

Table 32: Factor 2 Analysis of ITIL Processes

Process	Scale Value	Rationale
7Step	HIGH	Starting a process improvement plan requires a resource that has a vast knowledge in quality and process improvement methodologies. This resource will be seasoned in industry best practices and experienced in implementations of those best practices across operational enterprises.
AM	LOW	Once the process has been established, executing the SOPs should be relatively simple. Entry to Junior level resources can execute this process.
AvailM	HIGH	The Availability Management process requires a resource with a senior or principle level resource to maintain and manage. As new or upgraded services go through the lifecycle, the availability requirements will constantly need to be fined tuned and may require modifications to requirements, or service level agreements.
BRM	HIGH	Resources with a strong understanding in customer relationship management and business management principles are best suited for the role as the process owner for Business Relationship Management. Those resources are senior in level with many years of experience in this domain.
CapM	HIGH	On-going management of the capacity needs and planning future demands requires senior level knowledge coupled with an understanding of the business needs and technical challenges.
CE	MEDIUM	A mid-level resource can manage this process once established. The criteria may change based on new or enhanced services however, the change evaluation criteria will naturally mature as the service matures within the catalogue.
CM	LOW	Once the process is initially established, junior level IT engineers can manage the process and document all changes to services that are going through the level cycle.
DC	MEDIUM	A mid-level resource can manage this process once established.
DM	HIGH	On-going management of the future demands requires senior level knowledge coupled with an understanding of the business needs and technical challenges.
EM	LOW	Since parts of this process can be automated, the level of competency required of resources to execute its task is low.
FM	HIGH	Individuals that maintain the financial management systems need to have a high level of education and experience in the financial domain.
IM	LOW	Once the process has been established, executing the SOPs should be relatively simple. Entry to Junior level resources can execute this process.
ISM	HIGH	Once the initial processes are setup, an senior level staff member can maintain it. Typically, individuals within these roles have security accreditations.
ITSCM	MEDIUM	Once the IT Service Continuity plan has been developed, the appropriate exercises and drills will be captured and well documented within the plan. Therefore, a mid – level professional with 5 to 15 years of experience in IT continuity can maintain operations.
KM	MEDIUM	Once the knowledge management system, a mid – level professional with 5 to 15 years of experience in knowledge management and organizational management and change can maintain the system and supporting processes.

Process	Scale Value	Rationale
PM	HIGH	There is a large amount of ongoing analysis performed throughout this process. A good understanding of the data and how to extrapolate information from the data is crucial for this process area to be affective. Senior technical subject matters experts should be engaged within this process and managing the documented problems.
RDM	LOW	Once the acceptance criteria has been determined, documenting if the release package meets the criteria requires minimal effort.
RF	LOW	To continually execute this process, junior to mid-level resources can be used.
SACM	LOW	Once the process and system are in place, it is very easy to input the data into the database and maintain the information as long as the proper channels of communication are present.
SCM	MEDIUM	Once the requirements have been established, maintaining the information within the catalogue should not be a challenge as long as SCM is well integrated within life cycle. However, it is important to understand that all services will not capture the same amount of information.
SLM	MEDIUM	Maintaining the service level agreements throughout the service lifecycle requires interfacing with the customer and technical team. Resources supporting this process area need to have a firm understanding of the customers' expectations as well as the limitations for a particular service.
SM	HIGH	IT strategy for an enterprise is conducted at the higher levels of organizational management. This is conducted on a continual basis with a three to five year projected outlook.
SPM	HIGH	This process must strategically define and analyze approaches to services that meet the business needs in a cost effective way that brings value to the business. This initial setup and continued on-going execution requires a high level of aptitude for understanding changes to the IT landscape and service delivery models.
SupM	MEDIUM	Once the contracts are in place, regular review to ensure the vendor is meeting their obligations will require some level of knowledge about supplier contract management.
SVT	LOW	Since all the acceptance criteria has been established prior to the start of testing, no decisions are truly made during the process. It simple documents whether or not the acceptance criteria has been met.
TPS	MEDIUM	Once the framework for management of releases has been established, there will be little deviation from those constraints. Because the resources and roles may change from release to release, there will be some continued management to ensure services/applications are being delivered under budget and on time. As part of the service transition plan for each service/application that is delivered, there is a schedule of milestones, staffing and resource requirements, and issues and risks.

Table 33: Factor 3 Analysis of ITIL Processes

Process	Scale Value	Rationale
7Step	MEDIUM	The primary individuals making decisions for this process area are management or individuals leading/.managing tiger teams.
AM	LOW	No decisions are made at this level. The criteria for permissions has been established and is maintained through IT Security Management.
AvailM	HIGH	Decisions to change the levels of availability are determined by project stakeholders and customers.
BRM	HIGH	Project executives and high level management are the individuals that typical engage with the customer and make the appropriate decisions that impact service delivery projects.
CapM	HIGH	Decisions to change the needs for capacity planning are determined by project stakeholders and customers.
CE	HIGH	Project level stakeholders determined any modifications or changes to the change evaluation criteria. It's impacts span across various aspects of the service lifecycle.
CM	LOW	No decisions are made at this level. Any modification to this process are made in the change evaluation criteria and Transition Planning and Support process.
DC	HIGH	Project executives and management determine any changes that need to be made to this process as well as decisions in the execution of the process.
DM	LOW	Decision to change the service demand requirements are determined at the customer and project stakeholder level.
EM	LOW	Since this process is purely a notification service, no major decisions are required in it facilitation.
FM	MEDIUM	There are not many decisions made as part of this process. Instead, many decisions are made based on information coming from outputs of this process.
IM	LOW	Most incidents can have an accompanying procedure developed to resolve the issue. The criteria is pre-defined and no major decisions are made within this process.
ISM	MEDIUM	Security professionals make decisions that pertain to security policies and execution. That documentation is managed by management level professionals.
ITSCM	MEDIUM	IT Continuity professionals make decisions that pertain to IT continuity policies and execution. That documentation is managed by management level professionals.
KM	LOW	No decisions are made at this level. Information is captured and distributed to other processes.
PM	MEDIUM	Problem management makes decisions in regards to what and how problems will be addressed. Additionally, information is fed into capacity, availability, and service level management processes. This is all performed at the management level.
RDM	MEDIUM	Decisions on new functionality being delivered to the customer are done at this stage. Because the acceptance criteria was already established through the SLA and Business Management process, it is not considered to be high. However, there are many regular management operational decisions that come from this process.
RF	LOW	The Request Fulfillment criteria is pre-defined and no major decisions are made within this process.
SACM	LOW	No decisions are made at this level. Any modification to this process are made in the change evaluation criteria and Transition Planning and Support process.

Process	Scale Value	Rationale
SCM	LOW	No decisions are made at this level. Any modification to this process are made in the change evaluation criteria and Transition Planning and Support process.
SLM	MEDIUM	Customers and management resources are in constant negotiations on appropriate service levels throughout the lifecycle process.
SM	HIGH	Executives make many high level and very impactful decisions as part of the strategy planning and execution process.
SPM	HIGH	SPM determines what services will be delivered and how they will progress through the lifecycle.
SupM	HIGH	Choosing suppliers and the vehicle by which they are accountable to IT has a high degree of decisions that will impact Its ability to meet the business needs.
SVT	LOW	Since all the acceptance criteria has been established prior to the start of testing, no decisions are truly made during the process. It simple documents whether or not the acceptance criteria has been met.
TPS	MEDIUM	Within this process, the transition planner can determine if milestone delivery dates can be met based on planned and completed activities. Additionally, if milestone dates can't be made, then reorganizing of priorities may need to be done.

Table 34: Required Processes Reference Table

Process	Processes that Provide Require Input	Total Input Processes
7Step	• Availability Management • Capacity Management • Problem Management • Service Level Management	4
AM	• Change Management • Information Security Management • Request Fulfillment • Service Level Management	4
AvailM	• Demand Management • Financial Management • Service Level Management	3
BRM		0
CapM	• Change Management • Demand Management • Financial Management • Service Level Management	4
CE	• Transition Planning and Support	1
CM	• Change Evaluation • Knowledge Management • Problem Management • Service Asset & Configuration Management • Transition Planning and Support	5
DC	• Service Validation & Testing	1
DM	• Business Relationship Management • Strategy Management	2
EM	• Availability Management • Capacity Management • Change Management • Information Security Management • Service Asset & Configuration Management • Service Level Management	6
FM	• Capacity Management • Demand Management • Information Security Management • Release & Deployment Management • Service Asset & Configuration Management • Service Portfolio Management • Supplier Management	7
IM	• Change Management • Event Management • Knowledge Management • Release & Deployment Management • Service Level Management	5
ISM	• IT Service Continuity Management • Service Catalogue Management • Service Level Management • Service Portfolio Management	4

Process	Processes that Provide Require Input	Total Input Processes
ITSCM	• Availability Management • Capacity Management • Change Evaluation • Change Management • Incident Management • Information Security Management • Problem Management • Service Asset & Configuration Management • Service Level Management	9
KM	• Release & Deployment Management	1
PM	• Event Management • Incident Management • Knowledge Management	3
RDM	• Availability Management • Business Relationship Management • Service Asset & Configuration Management • Transition Planning & Support	4
RF	• Service Level Management	1
SACM	• Change Management • Knowledge Management • Problem Management • Release & Deployment Management • Service Validation & Testing	5
SCM	• Business Relationship Management • Change Management • Demand Management • Financial Management • Release & Deployment Management • Service Level Management • Service Portfolio Management	7
SLM	• Availability Management • Business Relationship Management • Capacity Management • Change Management • Release & Deployment Management • Supplier Management	6
SM	• Financial Management	1
SPM	• Business Relationship Management • Financial Management • Service Catalogue Management	3
SupM	• Financial Management • Information Security Management • IT Service Continuity Management • Service Level Management • Strategy Management • Service Portfolio Management	6

Process	Processes that Provide Require Input	Total Input Processes
SVT	• Availability Management • Capacity Management • Change Management • Release & Deployment Management • Service Asset & Configuration management • Service Level Management • Transition Planning & Support	7
TPS		0

Based on the information captured in **Table 34,** the average number of input processes is 3.8 and the standard deviation is 2.4. **Figure 12** depicts a bar chart to summarize the data in **Table 34.** Based on the bar chart, the researchers categorized the data into three groups. **Table 35** shows the alignment between the scale definition and the number of input processes.

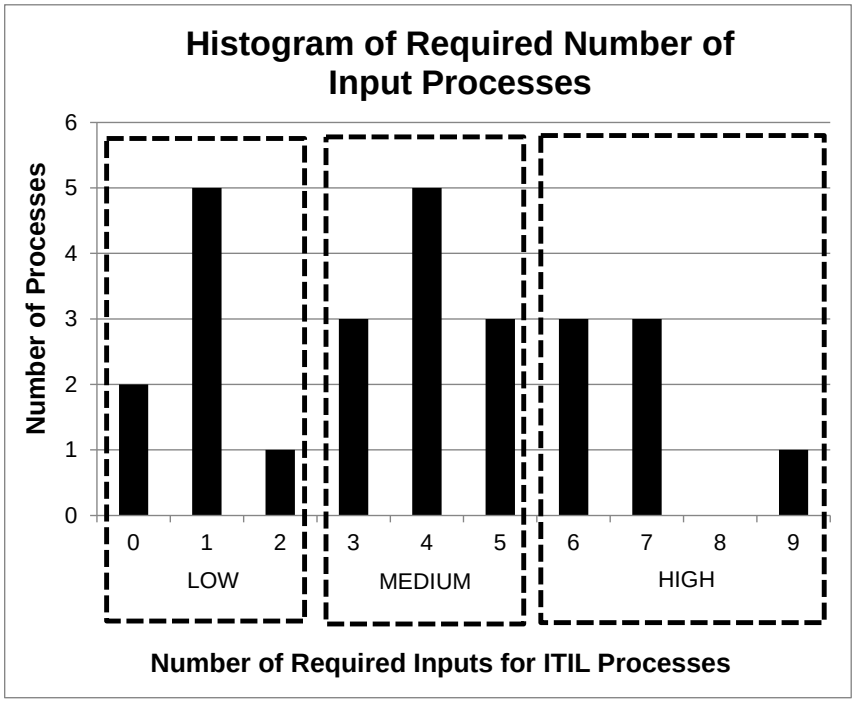


Figure 12: Required Process Input Histogram

Table 35: Factor 4 Analysis of ITIL Processes

Process	Scale Value
7Step	MEDIUM
AM	MEDIUM
AvailM	MEDIUM
BRM	LOW
CapM	MEDIUM
CE	LOW
CM	MEDIUM
DC	LOW
DM	LOW
EM	HIGH
FM	HIGH
IM	MEDIUM
ISM	MEDIUM
ITSCM	HIGH
KM	LOW
PM	MEDIUM
RDM	MEDIUM
RF	LOW
SACM	MEDIUM
SCM	HIGH
SLM	HIGH
SM	LOW
SPM	MEDIUM
SupM	HIGH
SVT	HIGH
TPS	LOW

Table 36: Factor 5 Analysis of ITIL Processes

Process	Justification	Factor Scale Value
7Step	The Seven Step Improvement process provides value to the business by continually monitoring, assessing, and analyzing the delivery of services to identify opportunities to improve customer service [13].	MEDIUM
AM	Access Management • Ensures the right level of access to systems and services to employees that follows the security provisioning policies and compliance, and • Provides capabilities to monitor abuse and revoke privileges as needed [15].	LOW
AvailM	Availability Management ensures that the availability and reliability requirements of the service and associated system are met as the service evolves with changing business needs. This directly impacts customer satisfaction and the continued growth of IT and the business [12].	HIGH
BRM	Business Relationship Management provides a forum for IT to communicate with their customers in order to understand their needs for various IT services [11]. This communication is used as the conduit for other ITIL processes.	MEDIUM
CapM	Capacity Management ensures that the capacity and performance requirements of the service and associated system are met as the service evolves with changing business needs. This directly impacts customer satisfaction and the continued growth of IT and the business [12].	HIGH
CE	Change Evaluation provides value to the business be evaluating changes in terms of delivery benefit, and providing improvements in performance for changes to services [14].	MEDIUM
CM	Change Management provides value to the business by • Tracking changes and assessing risks through the service lifecycle, • Providing auditable evidence on changes to various services, and • Providing improvements to service delivery processes [14].	LOW
DC	Design Coordination ensures that through the design phase, IT services • Achieve the intended business value with the accepted risks and cost constraints • Control rework and unplanned labor costs associated with poor service design, and • Ensure that all services comply with the service architecture framework utilized by the IT organization [12].	MEDIUM
DM	Demand Management defines the levels at which resources and capabilities interact to deliver IT services to achieve the desired business outcomes [11].	HIGH
EM	Event Management provides a means for early detection of incidents. It brings value to the business by allowing the capability for automated monitoring which can remove the need for expensive resources, and allow for events to be escalated and addressed prior to service disruptions [15].	MEDIUM

Process	Justification	Factor Scale Value
FM	Financial Management provides inputs into strategic decisions by • Providing regulatory and legislative compliance • Providing forecasting for accurate budget planning • Providing analysis on the cost for IT services to ensure costs are recovered. [11].	MEDIUM
IM	Incident Management is the most visible process to the business to demonstrate value. This process reduces the number of unplanned service outages and disruptions to the business [15].	MEDIUM
ISM	Information Security Management enforces security controls in all areas of IT, and manages IT risk to ensure compliance with government regulations [12].	HIGH
ITSCM	IT Service Continuity Management is driven by business risks. It provides awareness on continuity requirements to ensure recovery of services and reduce potential adverse impacts to the business [12].	HIGH
KM	Knowledge Management provides value to the business across all phases of the service lifecycle by controlling and managing data that is vital to delivering quality services to the customer [14].	MEDIUM
PM	Problem Management works with other processes to improve service availability and quality while reducing the number of unplanned service disruptions [15].	MEDIUM
RDM	Release and Deployment Management improves the delivery of changes by optimizing costs, minimizing risk, and ensuring services align with business goals [14].	MEDIUM
RF	Request Fulfillment provides value to the business by providing quick and effective access to procedures for standard services that can be accessed directly by the customer [15].	LOW
SACM	Service Asset and Configuration Management provides value to the business by • Providing traceability of service assets and assessing risks through the service lifecycle, • Providing information used for forecasting and planning future changes, and • Managing and delivering service warranties [14].	MEDIUM
SCM	Service Catalogue Management is a central source of information on services provided by IT the improves efficiency, effectiveness, and alignment of business objectives [12].	LOW
SLM	Service Level Management provides an interface to the business for • Determining service level targets, • Discussing all service level related issues, and • Addressing all breaches in service delivery [12].	HIGH
SM	Strategy Management ensures that the appropriate level of funding is allocated for IT investments by: • Ensuring expenditures are matched to validated business objectives • Managing investment priorities, and • Balancing resources and capabilities across all IT investments [11].	HIGH
SPM	Service Portfolio Management evaluates if IT should invest in various projects through business case justification and return on investment analysis. This can shift funding dramatically across the IT portfolio [11].	HIGH

Process	Justification	Factor Scale Value
SupM	Supplier Management ensures • Seamless end to end delivery of quality IT services across all suppliers • Optimized supplier agreements that align with the core business needs, and • The management of all supplier contracts and agreements that meet the agreed SLAs [12].	MEDIUM
SVT	Service Transition and Planning provides value to the business by ensuring a level of confidence that the services delivered meet business requirements and expectations [14].	MEDIUM
TPS	Transition Planning and Support ensures all implementations of changes to services are completed in an efficient and effect manner [14].	MEDIUM

Appendix B – Variable 2 Detailed Analysis

Table 37: Variable 2 Analysis – Seven Step Improvement Process

Process	Input/Output	Required/Optional
FM	Output	OPTIONAL
SCM	Output	OPTIONAL
SPM	Output	OPTIONAL

Table 38: Variable 2 Analysis – Access Management Process

Process	Input/Output	Required/Optional
ISM	Input	Required
RF	Input	Required
CM	Input	Required
SLM	Input	Required
SACM	Input	Optional

Table 39: Variable 2 Analysis – Availability Management Process

Process	Input/Output	Required/Optional
BRM	Input	OPTIONAL
DM	Input	REQUIRED
SPM	Input	OPTIONAL
SCM	Input	OPTIONAL
SLM	Input	REQUIRED
FM	Input	REQUIRED
CM	Input	OPTIONAL
RDM	Input	OPTIONAL
SACM	Input	OPTIONAL
CM	Output	OPTIONAL
RDM	Output	REQUIRED
7Step	Output	REQUIRED
SLM	Output	REQUIRED
ITSCM	Output	OPTIONAL
EM	Output	REQUIRED

Table 40: Variable 2 Analysis – Business Relationship Management Process

Process	Input/Output	Required/Optional
SPM	Input	OPTIONAL
7Step	Output	OPTIONAL
CM	Output	OPTIONAL
RDM	Output	REQUIRED
SCM	Output	REQUIRED
SLM	Output	REQUIRED
SPM	Output	REQUIRED

Table 41: Variable 2 Analysis – Capacity Management Process

Process	Input/Output	Required/Optional
BRM	Input	OPTIONAL
DM	Input	REQUIRED
SM	Input	OPTIONAL
IM	Input	OPTIONAL
PM	Input	OPTIONAL
SLM	Input	REQUIRED
FM	Input	REQUIRED
CM	Input	REQUIRED
SLM	Output	REQUIRED
FM	Output	REQUIRED
EM	Output	REQUIRED

Table 42: Variable 2 Analysis – Change Evaluation Process

Process	Input/Output	Required/Optional
TPS	Input	REQUIRED
CM	Output	REQUIRED

Table 43: Variable 2 Analysis – Change Management Process

Process	Input/Output	Required/Optional
SCM	Input	OPTIONAL
RDM	Input	OPTIONAL
SLM	Input	OPTIONAL
FM	Input	OPTIONAL
SACM	Input	REQUIRED
TPS	Input	OPTIONAL
BRM	Input	OPTIONAL
SVT	Input	OPTIONAL
PM	Input	REQUIRED
ISM	Input	OPTIONAL
CapM	Input	OPTIONAL
DM	Input	OPTIONAL
ITSCM	Output	STRONG

Table 44: Variable 2 Analysis – Design Coordination Process

Process	Input/Output	Required/Optional
SVT	Input	REQUIRED
CM	Output	OPTIONAL
PM	Output	OPTIONAL

Table 45: Variable 2 Analysis – Demand Management Process

Process	Input/Output	Required/Optional
BRM	Input	REQUIRED
SM	Input	REQUIRED
7Step	Output	OPTIONAL
AvailM	Output	REQUIRED
CapM	Output	REQUIRED
CM	Output	OPTIONAL
FM	Output	REQUIRED
ITSCM	Output	OPTIONAL
SCM	Output	REQUIRED
SLM	Output	OPTIONAL
TPS	Output	OPTIONAL

Table 46: Variable 2 Analysis – Event Management Process

Process	Input/Output	Required/Optional
CapM	Input	REQUIRED
AvailM	Input	REQUIRED
SACM	Input	REQUIRED
ISM	Input	REQUIRED
SLM	Input	REQUIRED
IM	Output	REQUIRED
PM	Output	REQUIRED

Table 47: Variable 2 Analysis – Financial Management Process

Process	Input/Output	Required/Optional
SACM	Input	REQUIRED
DM	Input	REQUIRED
SPM	Input	REQUIRED
SupM	Input	REQUIRED
CapM	Input	REQUIRED
SPM	Output	REQUIRED
SupM	Output	REQUIRED
SM	Output	REQUIRED

Table 48: Variable 2 Analysis – Incident Management Process

Process	Input/Output	Required/Optional
EM	Input	REQUIRED
CM	Output	OPTIONAL
PM	Output	REQUIRED
AvailM	Output	OPTIONAL
CapM	Output	OPTIONAL
SACM	Output	OPTIONAL
SLM	Output	REQUIRED

Table 49: Variable 2 Analysis – Information Security Management Process

Process	Input/Output	Required/Optional
SCM	Input	REQUIRED
SPM	Input	REQUIRED
SLM	Input	REQUIRED
ITSCM	Input	REQUIRED
IM	Input	OPTIONAL
PM	Input	OPTIONAL
CM	Input	OPTIONAL
SACM	Input	OPTIONAL
EM	Input	OPTIONAL
IM	Output	OPTIONAL
PM	Output	OPTIONAL
FM	Output	REQUIRED
SupM	Output	REQUIRED
CapM	Output	OPTIONAL
Avail	Output	OPTIONAL

Table 50: Variable 2 Analysis – IT Service Continuity Management Process

Process	Input/Output	Required/Optional
CM	Input	REQUIRED
SLM	Input	REQUIRED
IM	Input	REQUIRED
DM	Input	OPTIONAL
CE	Input	OPTIONAL
SM	Input	OPTIONAL
PM	Input	REQUIRED
AvailM	Input	REQUIRED
CapM	Input	REQUIRED
SACM	Input	REQUIRED
ISM	Input	REQUIRED
FM	Input	OPTIONAL

Table 51: Variable 2 Analysis – Knowledge Management Process

Process	Input/Output	Required/Optional
IM	Output	REQUIRED
PM	Output	REQUIRED
RDM	Output	OPTIONAL
SACM	Output	REQUIRED

Table 52: Variable 2 Analysis – Problem Management Process

Process	Input/Output	Required/Optional
IM	Input	REQUIRED
EM	Input	REQUIRED
CM	Output	REQUIRED
SACM	Output	REQUIRED
RDM	Output	OPTIONAL
AvailM	Output	OPTIONAL
CapM	Output	OPTIONAL
ITSCM	Output	OPTIONAL
SLM	Output	OPTIONAL
FM	Output	OPTIONAL

Table 53: Variable 2 Analysis –Release & Deployment Management Process

Process	Input/Output	Required/Optional
CM	Input	OPTIONAL
SVT	Input	OPTIONAL
SACM	Input	REQUIRED
KM	Input	OPTIONAL
SLM	Input	OPTIONAL
BRM	Input	REQUIRED
ITSCM	Input	OPTIONAL
TPS	Input	REQUIRED
IM	Output	REQUIRED
SACM	Output	REQUIRED
ITSCM	Output	OPTIONAL
SCM	Output	REQUIRED
SLM	Output	REQUIRED
KM	Output	REQUIRED
FM	Output	REQUIRED

Table 54: Variable 2 Analysis – Request Fulfillment Process

Process	Input/Output	Required/Optional
RDM	Input	OPTIONAL
SACM	Input	OPTIONAL
IM	Input	OPTIONAL

Table 55: Variable 2 Analysis – Service Asset & Configuration Management Process

Process	Input/Output	Required/Optional
CapM	Input	OPTIONAL
CM	Input	REQUIRED
FM	Output	REQUIRED
ITSCM	Output	OPTIONAL
IM	Output	OPTIONAL
PM	Output	OPTIONAL
AvailM	Output	OPTIONAL
RDM	Output	REQUIRED
CM	Output	REQUIRED

Table 56: Variable 2 Analysis –Service Catalogue Management Process

Process	Input/Output	Required/Optional
BRM	Input	REQUIRED
FM	Input	REQUIRED
SPM	Input	REQUIRED
DM	Input	REQUIRED
CM	Input	REQUIRED
SLM	Input	REQUIRED
SPM	Output	REQUIRED

Table 57: Variable 2 Analysis – Service Level Management Process

Process	Input/Output	Required/Optional
SM	Input	OPTIONAL
DM	Input	OPTIONAL
SPM	Input	OPTIONAL
SCM	Input	OPTIONAL
CM	Input	REQUIRED
BRM	Input	REQUIRED
IM	Input	OPTIONAL
CapM	Input	OPTIONAL
AvailM	Input	OPTIONAL
7Step	Output	REQUIRED

Table 58: Variable 2 Analysis – Service Portfolio Management Process

Process	Input/Output	Required/Optional
BRM	Input	REQUIRED
FM	Input	REQUIRED
SM	Input	OPTIONAL
BRM	Output	OPTIONAL
SCM	Output	OPTIONAL

Table 59: Variable 2 Analysis – Supplier Management Process

Process	Input/Output	Required/Optional
FM	Input	REQUIRED
SLM	Input	REQUIRED
SM	Input	REQUIRED
ISM	Input	REQUIRED
ITSCM	Input	REQUIRED
SPM	Input	REQUIRED
SPM	Output	OPTIONAL
SLM	Output	REQUIRED

Table 60: Variable 2 Analysis – Service Validation & Testing Process

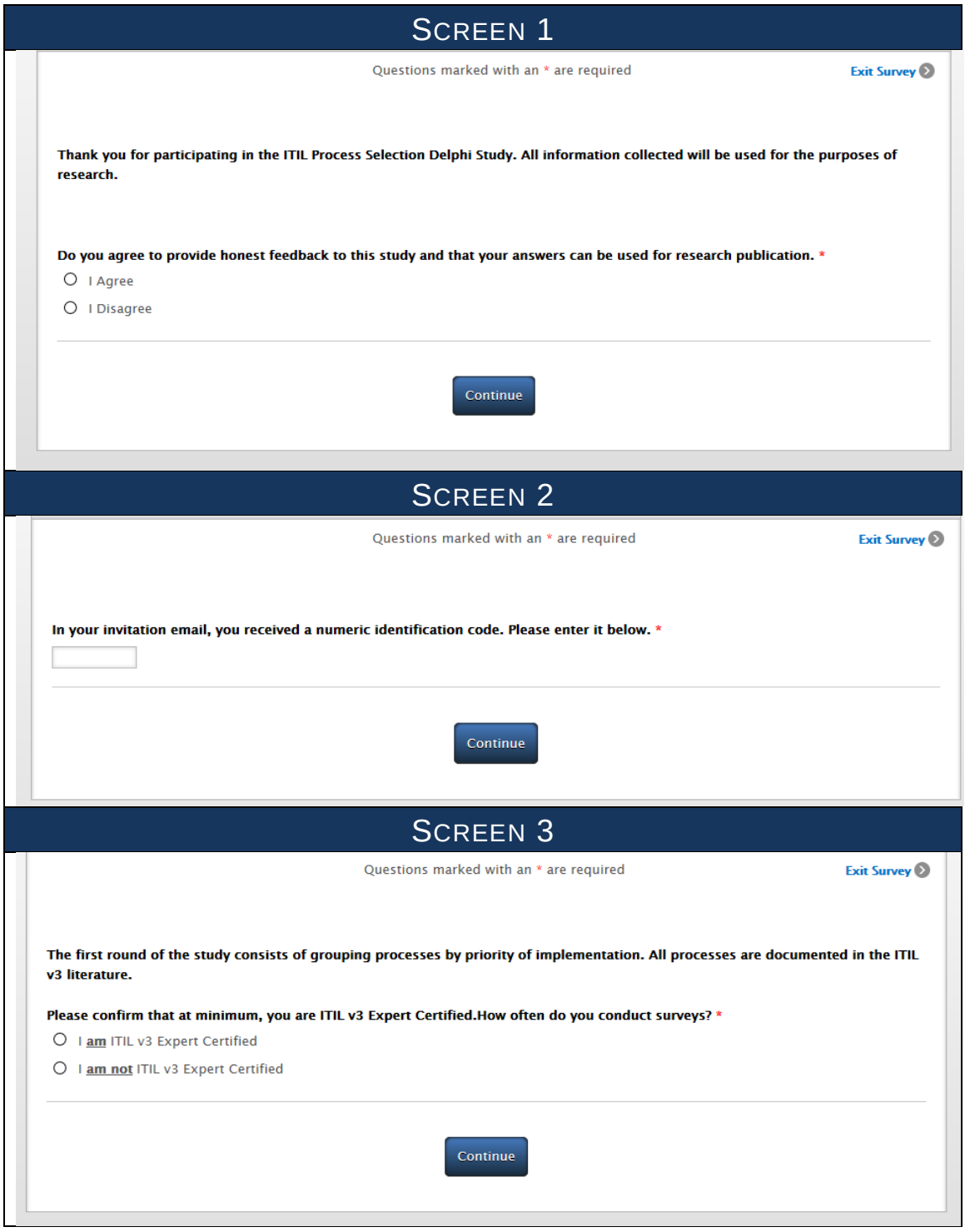
Process	Input/Output	Required/Optional
SACM	Input	REQUIRED
CM	Input	REQUIRED
CapM	Input	REQUIRED
AvailM	Input	REQUIRED
SLM	Input	REQUIRED
RDM	Input	REQUIRED
TPS	Input	REQUIRED
SACM	Output	REQUIRED
DC	Output	REQUIRED

Table 61: Variable 2 Analysis – Transition Planning & Support Process

Process	Input/Output	Required/Optional
CM	Input	OPTIONAL
DM	Input	OPTIONAL
SPM	Input	OPTIONAL
BRM	Input	OPTIONAL
RDM	Output	OPTIONAL
SVT	Output	OPTIONAL
SACM	Output	OPTIONAL
CM	Output	OPTIONAL
CE	Output	OPTIONAL
KM	Output	OPTIONAL

Appendix C – Delphi Study Questionnaire

C.1 Round One Questions



SCREEN 4

Questions marked with an * are required

Exit Survey

Choose five (5) V3 ITIL processes that you consider are critical for implementation in any IT organization. *

- ☐ Financial Management for IT Services
- ☐ Service Portfolio Management
- ☐ Demand Management
- ☐ Strategy Management for IT Services
- ☐ Business Relationship Management
- ☐ Service Catalogue Management
- ☐ IT Service Continuity Management
- ☐ Information Security Management
- ☐ Availability Management
- ☐ Capacity Management
- ☐ Design Coordination
- ☐ Supplier Management
- ☐ Service Level Management
- ☐ Service Asset and Configuration Management
- ☐ Change Management
- ☐ Change Evaluation
- ☐ Transition Planning and Support
- ☐ Release and Deployment Management
- ☐ Service Validation and Testing
- ☐ Knowledge Management
- ☐ Incident Management
- ☐ Request Fulfillment
- ☐ Access and Identity Management
- ☐ Event Management
- ☐ Problem Management
- ☐ Seven Step Improvement Process

Continue

SCREEN 5

(**PROCESSES SELECTED IN SCREEN 4 WILL NOT APPEAR IN SCREEN 5)

Questions marked with an * are required

Exit Survey

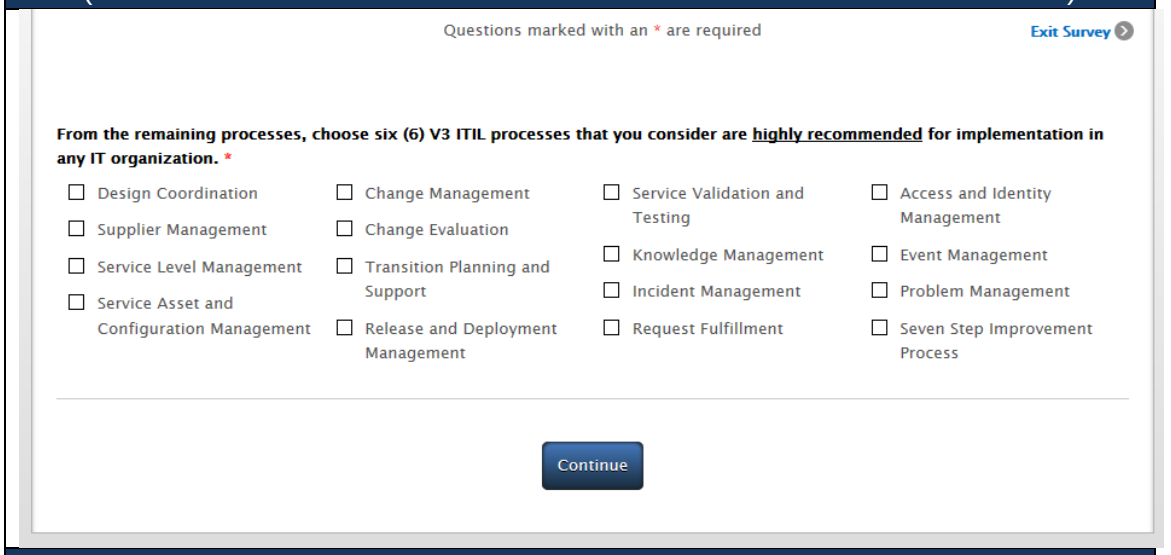
From the remaining processes, choose five (5) V3 ITIL processes that you consider are important for implementation in any IT organization. *

- ☐ Service Catalogue Management
- ☐ IT Service Continuity Management
- ☐ Information Security Management
- ☐ Availability Management
- ☐ Capacity Management
- ☐ Design Coordination
- ☐ Supplier Management
- ☐ Service Level Management
- ☐ Service Asset and Configuration Management
- ☐ Change Management
- ☐ Change Evaluation
- ☐ Transition Planning and Support
- ☐ Release and Deployment Management
- ☐ Service Validation and Testing
- ☐ Knowledge Management
- ☐ Incident Management
- ☐ Request Fulfillment
- ☐ Access and Identity Management
- ☐ Event Management
- ☐ Problem Management
- ☐ Seven Step Improvement Process

Continue

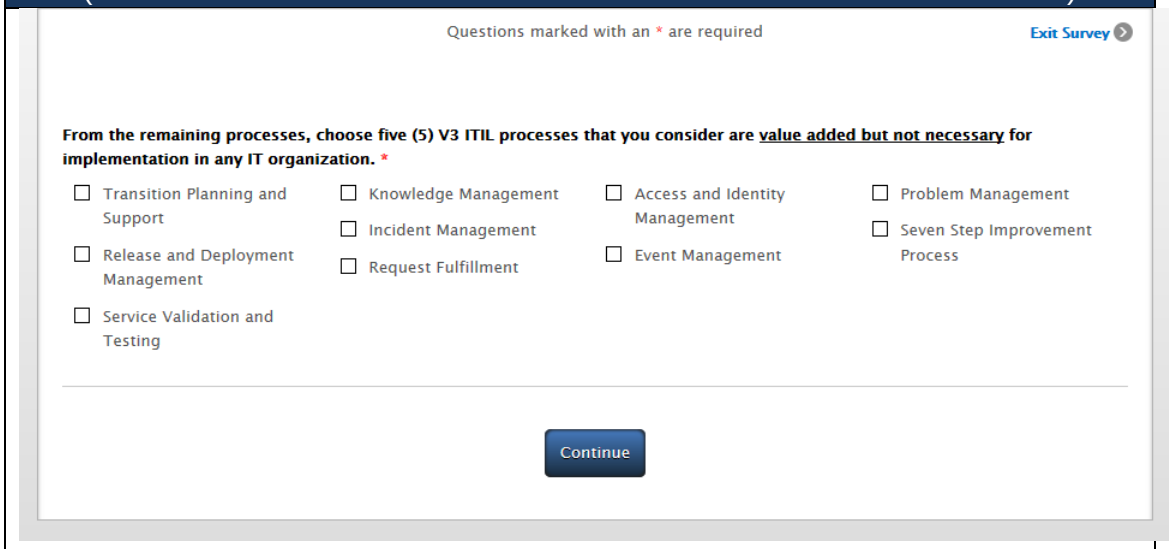
SCREEN 6

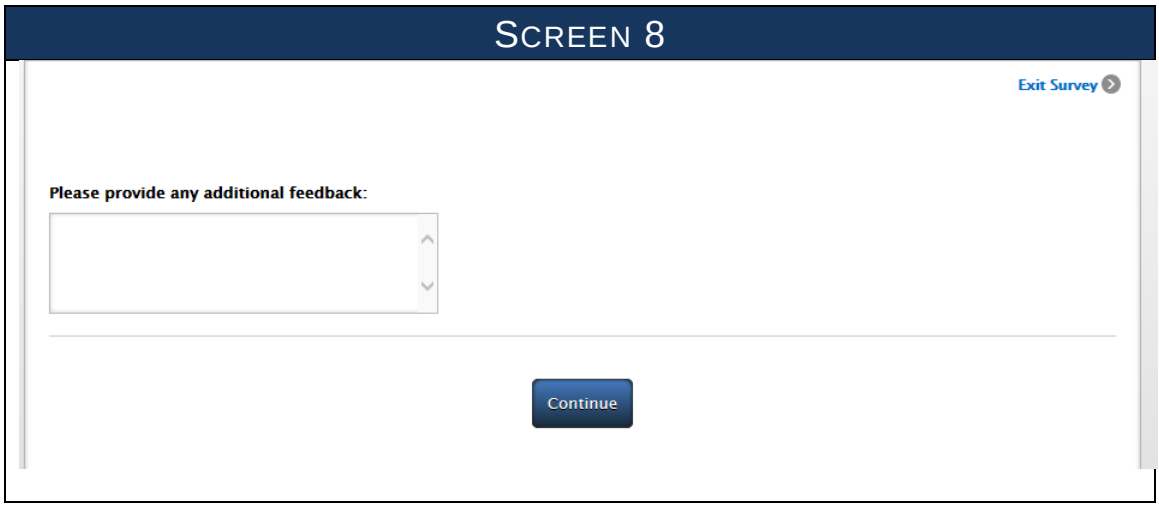
(**PROCESSES SELECTED IN SCREEN 5 WILL NOT APPEAR IN SCREEN 6)



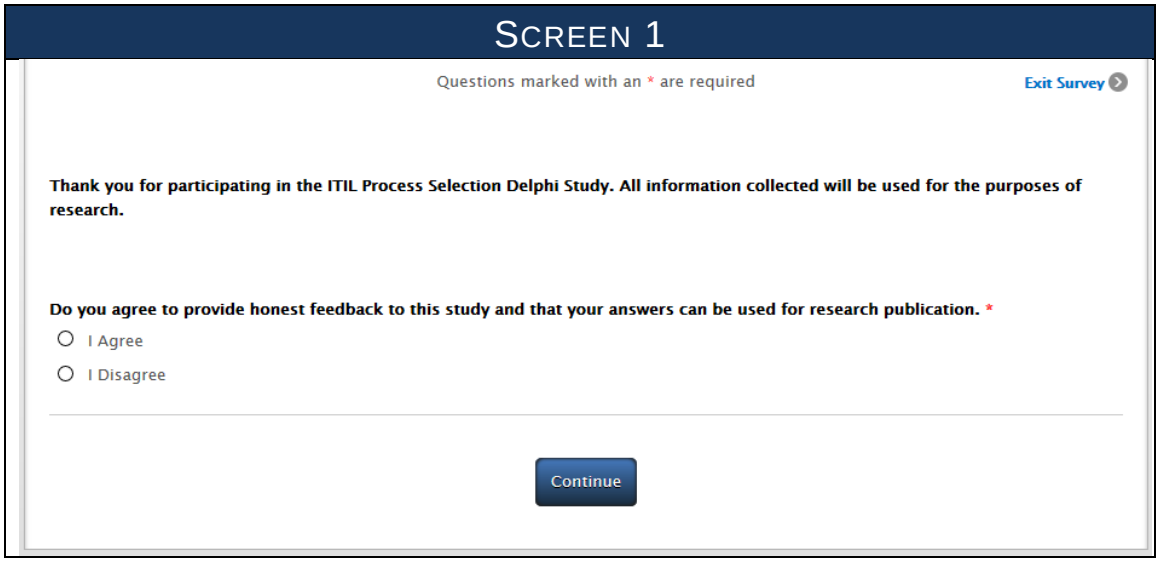
SCREEN 7

(**PROCESSES SELECTED IN SCREEN 6 WILL NOT APPEAR IN SCREEN 7)

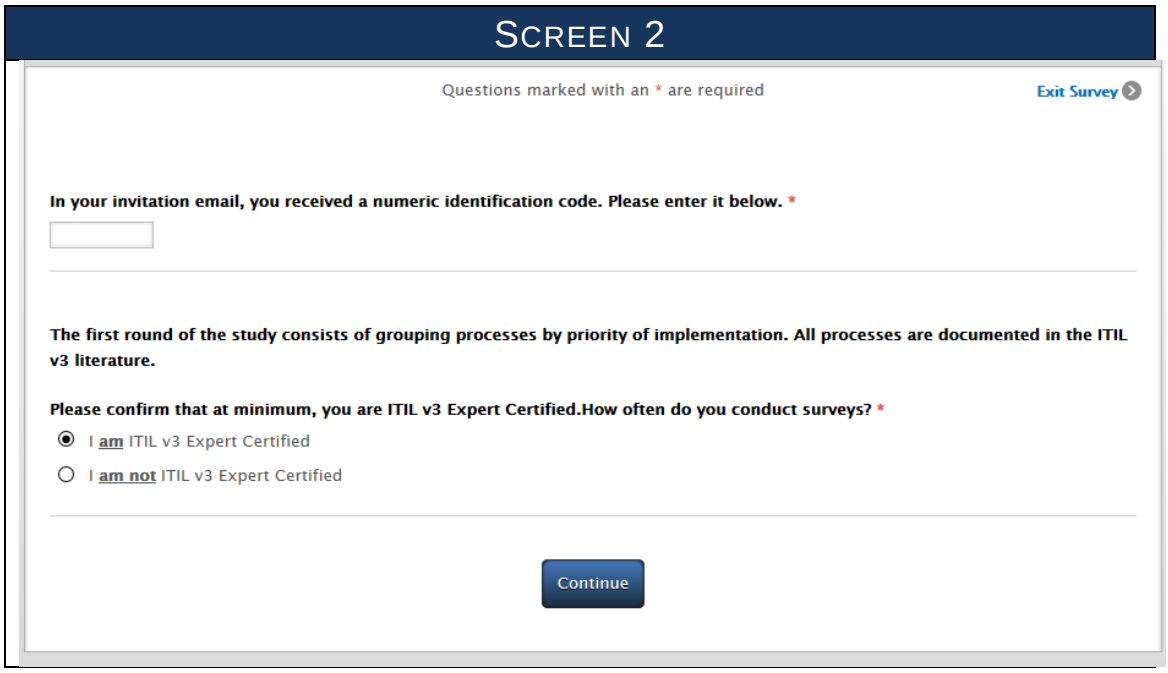




C2. Round Two Questions

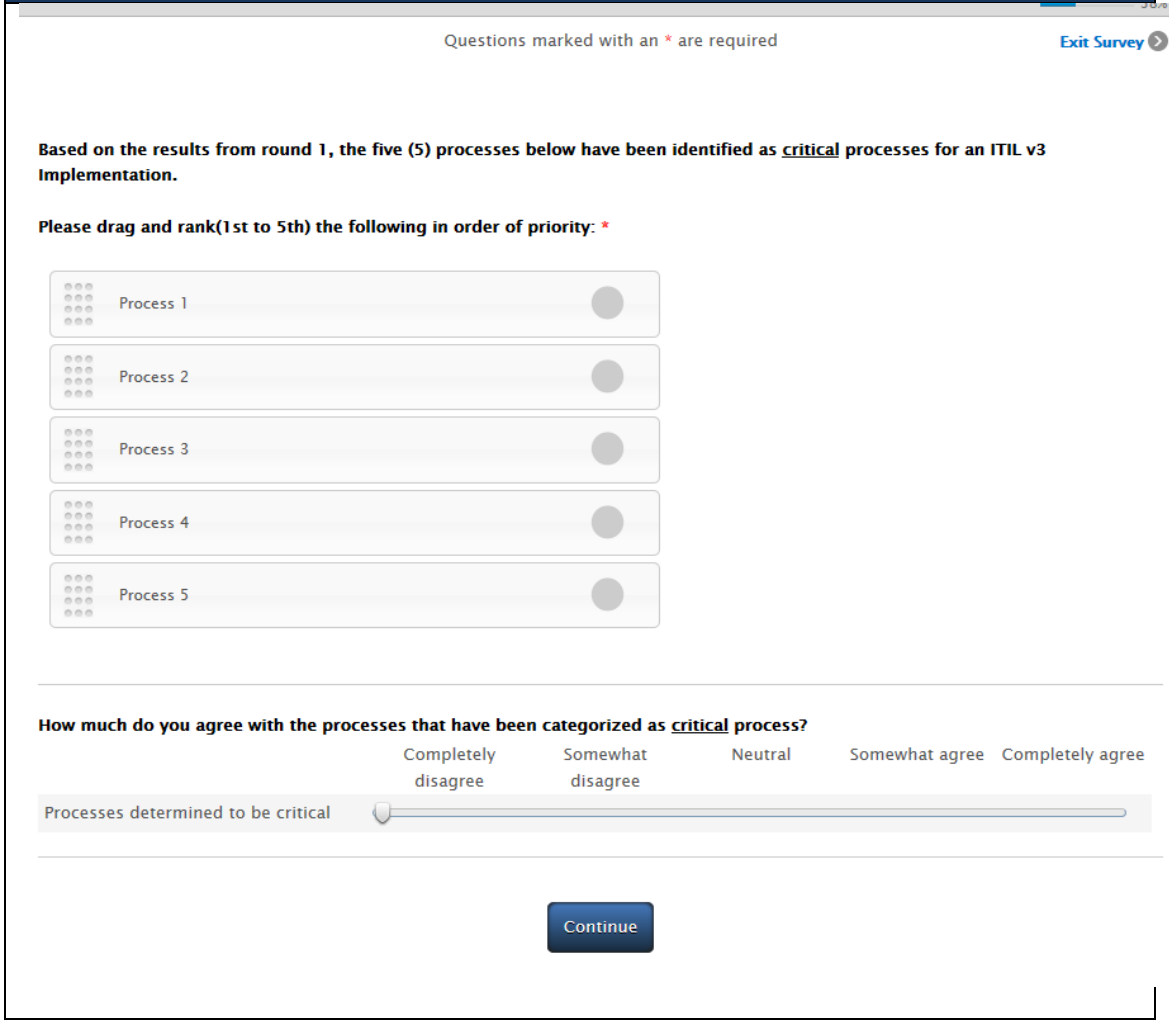


SCREEN 2


Questions marked with an * are required
Exit Survey
In your invitation email, you received a numeric identification code. Please enter it below. *
The first round of the study consists of grouping processes by priority of implementation. All processes are documented in the ITIL v3 literature.
Please confirm that at minimum, you are ITIL v3 Expert Certified.How often do you conduct surveys? *
I am ITIL v3 Expert Certified
I am not ITIL v3 Expert Certified
Continue

SCREEN 3

(PROCESS CHOICES WILL BE BASED ON FEEDBACK FROM SURVEY 1)



SCREEN 4

(PROCESS CHOICES WILL BE BASED ON FEEDBACK FROM SURVEY 1)

Questions marked with an * are required

Exit Survey

Based on the results from round 1, the five (5) processes below have been identified as important but not critical processes for an ITIL v3 Implementation.

Please drag and rank(1st to 5th) the following in order of priority: *

- Process 1
- Process 2
- Process 3
- Process 4
- Process 5

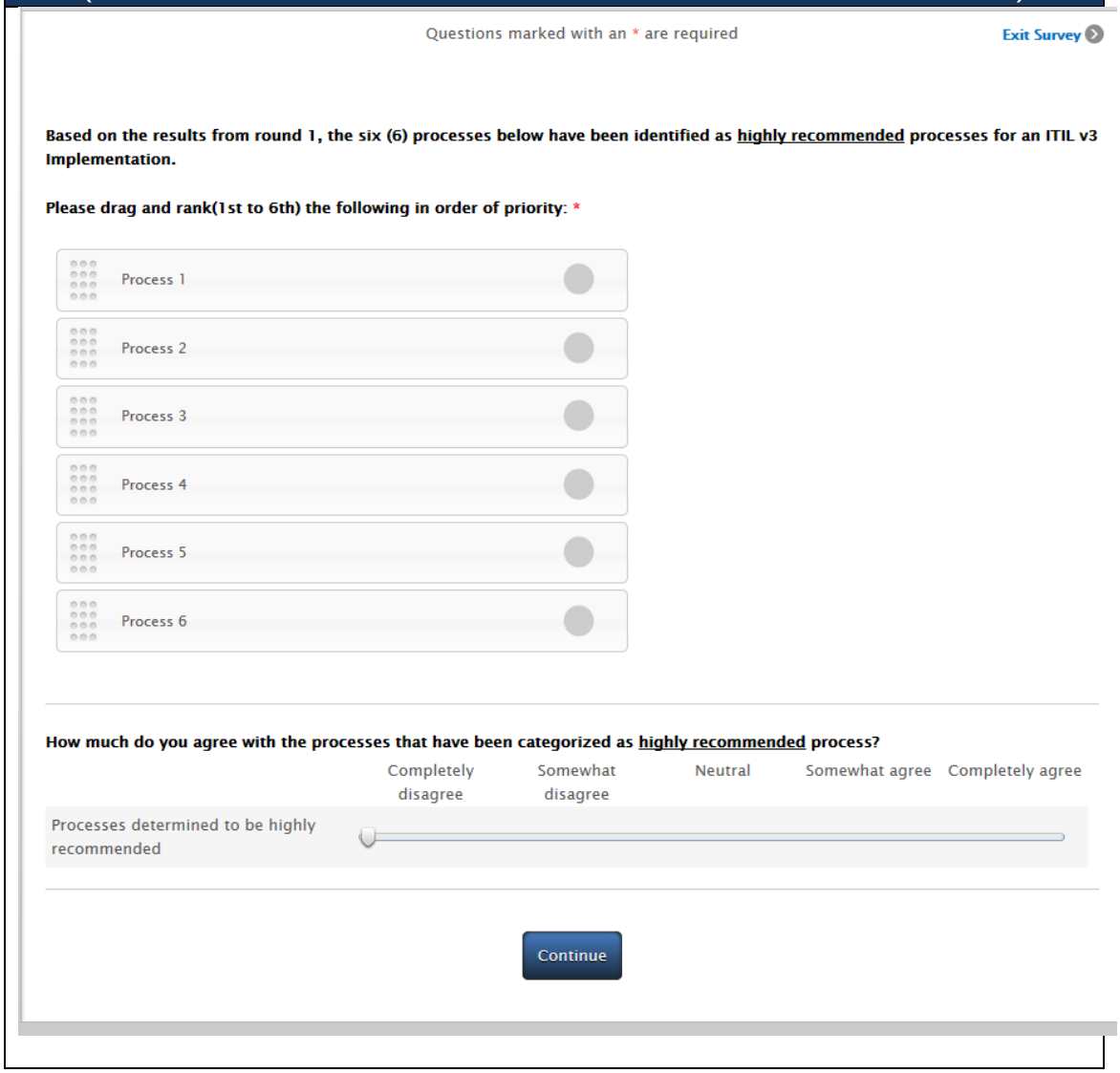
How much do you agree with the processes that have been categorized as important but not critical process?

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
Processes determined to be important but not critical					

Continue

SCREEN 5

(PROCESS CHOICES WILL BE BASED ON FEEDBACK FROM SURVEY 1)



SCREEN 6

(PROCESS CHOICES WILL BE BASED ON FEEDBACK FROM SURVEY 1)

Questions marked with an * are required

Exit Survey

Based on the results from round 1, the five (5) processes below have been identified as value added but not necessary processes for an ITIL v3 Implementation.

Please drag and rank(1st to 5th) the following in order of priority: *

- Process 1
- Process 2
- Process 3
- Process 4
- Process 5

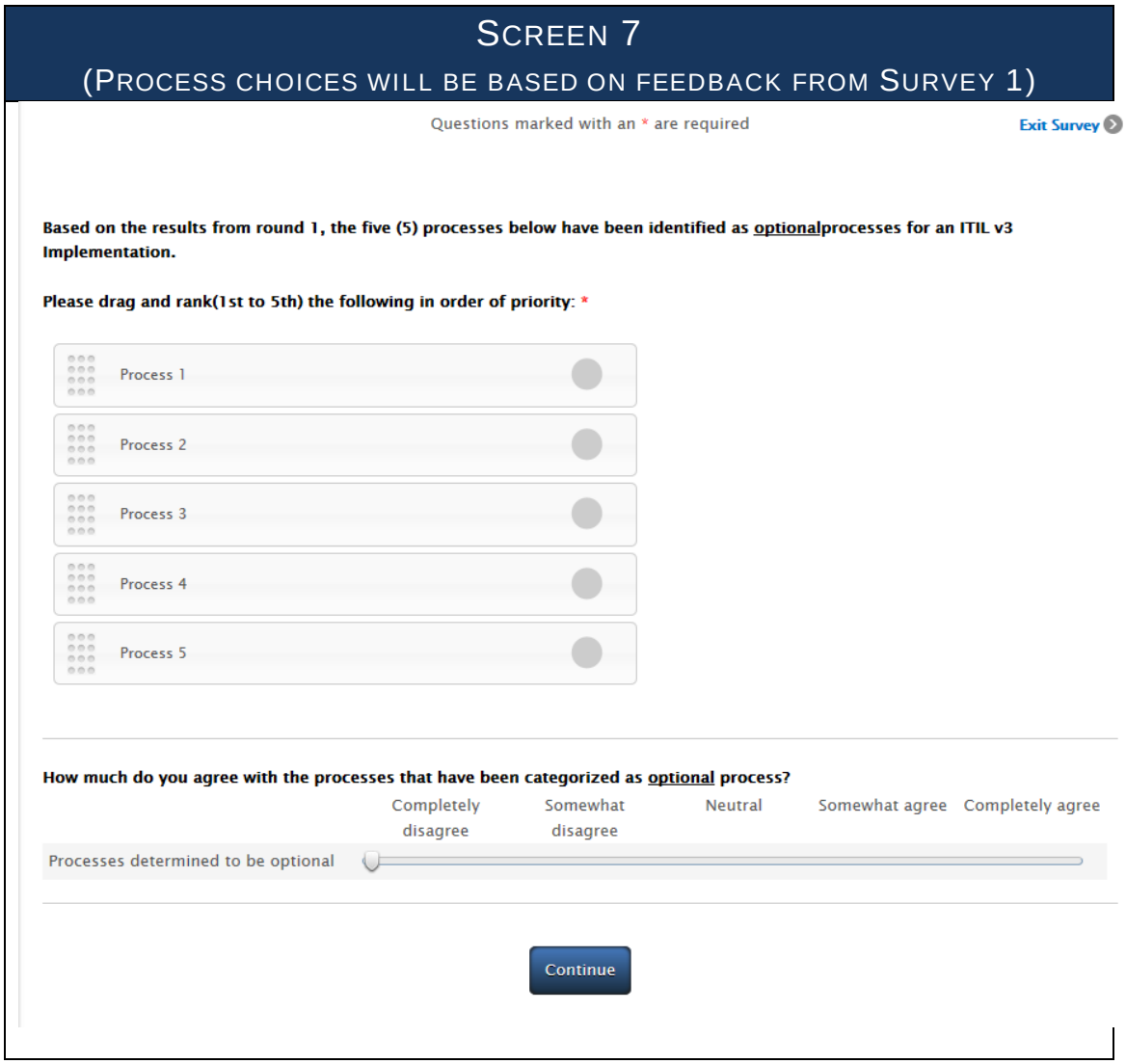
How much do you agree with the processes that have been categorized as value added but not necessary process?

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
Processes determined to be value added but not necessary					

Continue

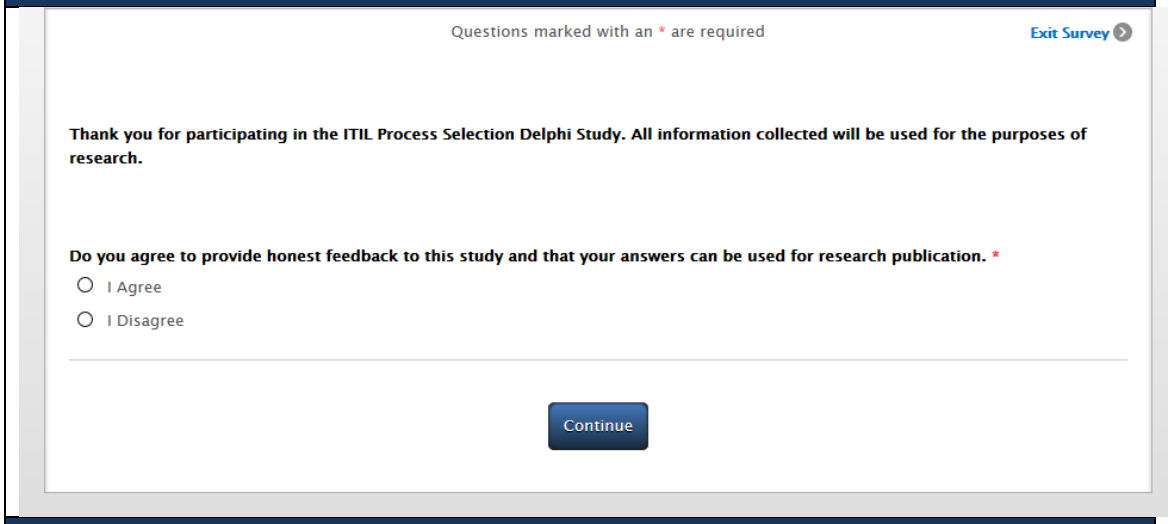
SCREEN 7

(PROCESS CHOICES WILL BE BASED ON FEEDBACK FROM SURVEY 1)

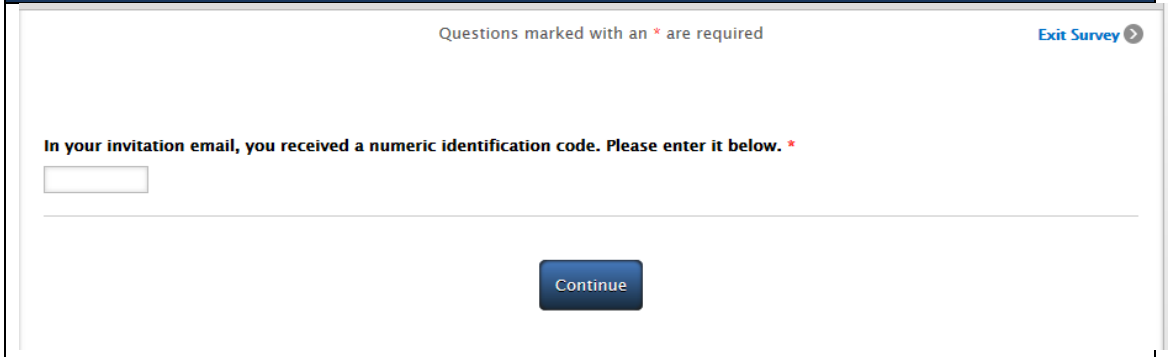


C.3 Round Three Questions

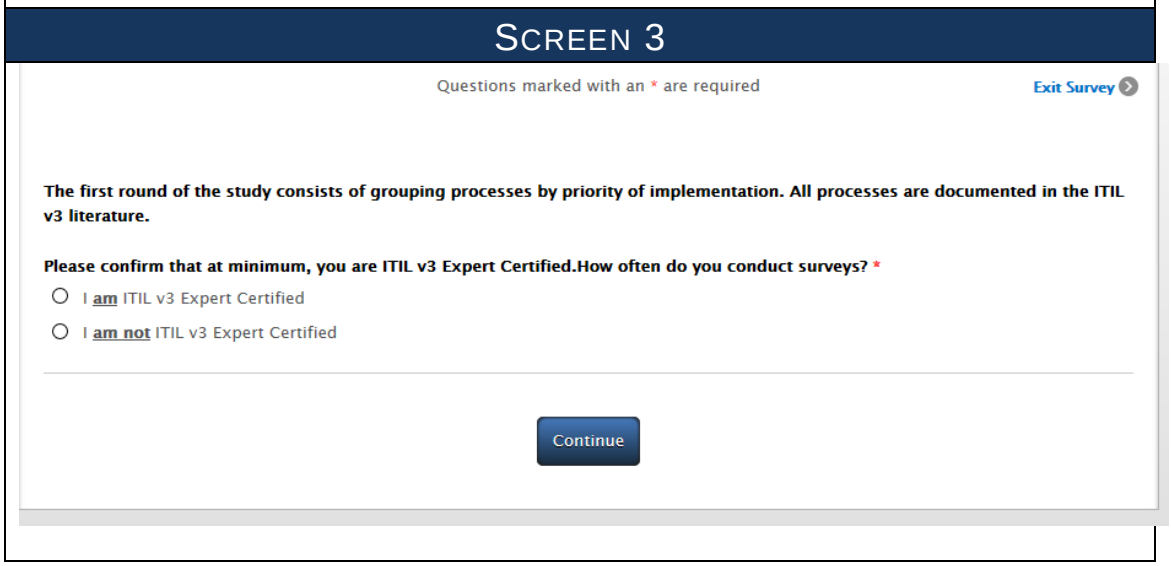
SCREEN 1



SCREEN 2



SCREEN 3



SCREEN 4 (PRIORITY LIST BASED ON FEEDBACK FROM SURVEY 2)

Questions marked with an * are required

Exit Survey

ITIL Implementaiton Priority List

	Completely disagree	Somewhat disagree	Neutral	Somewhat agree	Completely agree
Based on the resulting list, is this close to what you were expecting for a process selection priority list? *					

If you *Completely Disagreed* or *Somewhat Disagreed*, please provide feedback.

Based on the resulting list, are there any anomalies that you believe are present?

Are there any additional comments that you would like to make in regards to the results from this study?

Continue

Appendix D – Delphi Study Details

A Delphi study of six ITIL experts was conducted. The study consisted of three rounds of surveys. The surveys were administrated electronically by a cloud-based service provider called QuestionPro, Inc. The Delphi study was approved by the George Washington University (GWU) Institutional Review Board (IRB) on September 18, 2015 (IRB# 081536).

D.1 Design & Sampling

The Delphi study collected data from certified ITIL experts. The experts were solicited through LinkedIn professional groups. The initial selection pool was chosen from the three groups below:

- The ITIL Group
- ITL & ITSM Certified Experts
- ITSM (ITIL) Professionals

From those groups, sixty experts were randomly chosen based on the criteria below:

- Verifiable expert certification
- Contribution to the ITIL body of knowledge
- Currently practicing ITIL in the industry

Each expert was sent a private message requesting their participation in the Delphi study. As part of the request, all potential risks and precautions were outlined. With the acceptance to participate in the study, the participants agreed to have their input anonymously published. From the sixty experts solicited, twenty-one candidates agreed to participate. The twenty-one candidates were assigned a 5-digit unique identifier. Taking this measure increased the integrity of the data collected. From the twenty-one candidates who showed interest in participating in the Delphi Study, six filled out the

surveys for round 1 and 2, and four filled out the survey for round 3. Round 3 was an optional round for the participants to provide feedback.

D.2 Delphi Study Round 1

The first round started on Monday, September 21, 2015 and concluded on Friday, October 2, 2015. The survey was comprised of seven (7) closed-ended questions and one (1) open-ended question. The respondents were given a complete list of ITIL processes and asked to group them in clusters of five or six based on priority starting with the most "critical." Below are the four categorizations that were given to the respondents that could be used to classify each ITIL process. The fifth category, "optional," was used for any process that was not chosen in the other four categories.

- Critical
- Important
- Highly Recommended
- Value Added But Not Necessary
- Optional

Appendix C has a complete set of questions provided in the first round.

Each category was given a numeric value (Reference **Table 13**).

Table 62: Category Numeric Value Table

Process	Numeric Value
Critical	1
Important	2
Highly Recommended	3
Value Add	4
Optional	5

Based on those values, the average value for each process was calculated. The results from the first round of the Delphi study are present in **Table 63.**

Table 63: Round 1 Delphi Study Results on ITIL Process Importance

Process	Critical Category	Import Category	Highly Recommended Category	Value Add Category	Optional Category	Average	SDT DEV	STD Error
7Step	2	1	0	1	2	3	1.8973666	0.7745967
AM	1	0	1	1	3	3.83	1.6020861	0.6540489
AvailM	0	1	2	1	2	3.67	1.2110656	0.4944155
BRM	1	1	0	4	0	3.17	1.3291652	0.5426294
CapM	1	1	1	2	1	3.17	1.4719647	0.6009271
CE	0	0	2	2	2	4	0.8944272	0.3651484
CM	5	1	0	0	0	1.17	0.4082646	0.1666733
DC	0	0	2	2	2	4	0.8944272	0.3651484
DM	0	0	3	1	2	3.83	0.9831989	0.4013893
EV	0	2	1	2	1	3.33	1.2110656	0.4944155
FM	1	0	3	0	2	3.33	1.5055497	0.6146381
IM	4	1	1	0	0	1.5	0.83666	0.341565
ISM	0	4	1	0	1	2.67	1.2110656	0.4944155
ITSCM	0	1	3	0	2	3.5	1.2247449	0.5
KM	1	2	3	0	0	2.33	0.8165047	0.3333367
PM	3	2	0	0	1	2	1.5491933	0.6324555
RDM	1	3	1	1	0	2.33	1.032802	0.4216397
RF	1	2	1	2	0	2.67	1.2110656	0.4944155
SACM	3	2	1	0	0	1.67	0.8165047	0.3333367
SCM	2	1	2	0	1	2.5	1.5165751	0.6191392
SLM	2	2	2	0	0	2	0.8944272	0.3651484
SM	1	0	0	2	3	4	1.5491933	0.6324555
SPM	1	2	2	1	0	2.5	1.0488088	0.4281744
SupM	0	1	1	3	1	3.67	1.032802	0.4216397
SVT	0	0	2	2	2	4	0.8944272	0.3651484
TPS	0	0	1	3	2	4.17	0.7527815	0.3073218

The values were sorted from least to greatest, and ranked using the methodology in **Section 3.4.2.2.** The processes were grouped in sets of 5 (and one set of 6) which correlated to the five categories. **Table 64** shows the final results from the first round.

Table 64: Round 2 Input Data for Delphi Study

Process	Average	Rank	Category
CM	1.17	1	Critical
IM	1.5	2	Critical
SACM	1.67	3	Critical
PM	2	4.5	Critical
SLM	2	4.5	Critical
KM	2.33	6.5	Important
RDM	2.33	6.5	Important
SCM	2.5	8.5	Important
SPM	2.5	8.5	Important
ISM	2.67	10.5	Important
RF	2.67	10.5	Important
7Step	3	12	Highly Recommended
BRM	3.17	13.5	Highly Recommended
CapM	3.17	13.5	Highly Recommended
EV	3.33	15.5	Highly Recommended
FM	3.33	15.5	Highly Recommended
ITSCM	3.5	17	Value Add
AvailM	3.67	18.5	Value Add
SupM	3.67	18.5	Value Add
AM	3.83	20.5	Value Add
DM	3.83	20.5	Value Add
CE	4	23.5	Optional
DC	4	23.5	Optional
SM	4	23.5	Optional
SVT	4	23.5	Optional
TPS	4.17	26	Optional

D.3 Delphi Study Round 2

The second round of the study began on Monday, October 5, 2015 and concluded on Friday, October 16, 2015. The experts were given the results from the first round and asked to rank the processes from most important to least important in each category. Additionally, the experts were asked to rate how much they agreed with the results from round 1 for each category. The survey consisted of 13 closed-ended questions. The complete set of questions asked in round 2 of the study is located in **Appendix C**. The results from round 2 of the Delphi study is presented in **Table 65**.

Table 65: Round 2 Delphi Study Results on ITIL Process Importance

Process	Expert #1	Expert #2	Expert #3	Expert #4	Expert #5	Expert #6
7Step	14	16	12	12	16	13
AM	21	20	21	21	21	21
AvailM	18	17	18	19	19	17
BRM	12	15	14	15	13	14
CapM	13	14	15	14	14	15
CE	25	26	26	25	26	23
CM	2	3	2	4	2	1
DC	24	25	23	26	23	25
DM	17	19	20	18	18	20
EM	16	12	16	13	15	12
FM	15	13	13	16	12	16
IM	1	1	5	3	1	2
ISM	7	11	10	11	8	10
ITSCM	20	18	19	17	17	18
KM	6	8	9	9	10	7
PM	5	2	4	5	4	5
RDM	9	7	8	7	6	6
RF	11	6	11	6	11	11
SACM	3	4	3	2	3	3
SCM	10	9	7	8	7	9
SLM	4	5	1	1	5	4
SM	22	22	22	22	22	22
SPM	8	10	6	10	9	8
SupM	19	21	17	20	20	19
SVT	26	23	24	23	25	24
TPS	23	24	25	24	24	26

Figure 13 shows the results of how much the experts agreed with the results from round 2.

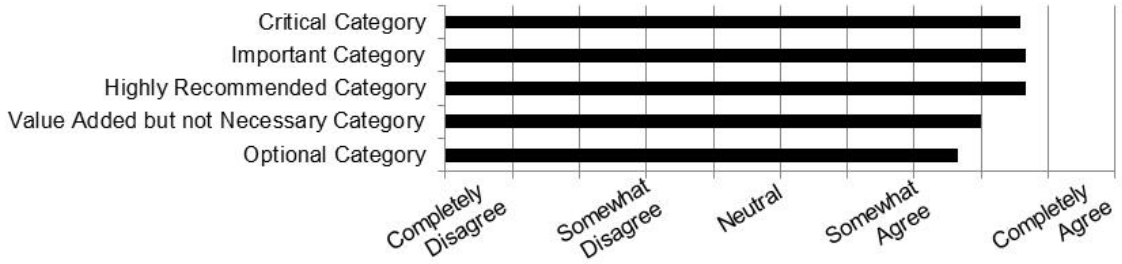


Figure 13: Delphi Study Round 2 Results – How much did the experts agree?

The authors examined the data with a paired comparison; those results are reflected in **Figure 14.** The researchers conducted a Borda score calculation, sorted the data from greatest to least, and ranked the values using the methodology from **Section 3.4.2.4**. The resulting priority list is captured in **Table 66.**

Prefer \ Over	7Step	AIM	AvailM	BRM	CapM	CE	CM	DC	DM	EM	FM	IM	ISM	ITSCM	KM	PM	RDM	RF	SACM	SCM	SLM	SM	SPM	SupM	SVT	TPS
7Step		6	6	3	3	6	0	6	6	3	4	0	0	6	0	0	0	0	0	0	0	6	0	6	6	6
AIM	0		0	0	0	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	6	6
AvailM	0	6		0	0	6	0	6	3	0	0	0	0	4	0	0	0	0	0	0	0	6	0	5	6	6
BRM	3	6	6		4	6	0	6	6	3	3	0	0	6	0	0	0	0	0	0	0	6	0	6	6	6
CapM	3	6	6	2		6	0	6	6	3	3	0	0	6	0	0	0	0	0	0	0	6	0	6	6	6
CE	0	0	0	0	0		0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
CM	6	6	6	6	6	6		6	6	6	6	2	6	6	6	5	6	6	5	6	4	6	6	6	6	6
DC	0	0	0	0	0	4	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
DM	0	6	3	0	0	6	0	6		0	0	0	0	1	0	0	0	0	0	0	0	6	0	4	6	6
EM	3	6	6	3	3	6	0	6	6		3	0	0	6	0	0	0	0	0	0	0	6	0	6	6	6
FM	2	6	6	3	3	6	0	6	6	3		0	0	6	0	0	0	0	0	0	0	6	0	6	6	6
IM	6	6	6	6	6	6	4	6	6	6	6		6	6	6	5	6	6	4	6	4	6	6	6	6	6
ISM	6	6	6	6	6	6	0	6	6	6	6	0		6	1	0	1	4	0	1	0	6	2	6	6	6
ITSCM	0	6	2	0	0	6	0	6	5	0	0	0	0		0	0	0	0	0	0	0	6	0	4	6	6
KM	6	6	6	6	6	6	0	6	6	6	6	0	5	6		0	1	4	0	3	0	6	4	6	6	6
PM	6	6	6	6	6	6	1	6	6	6	6	1	6	6	6		6	6	1	6	2	6	6	6	6	6
RDM	6	6	6	6	6	6	0	6	6	6	6	0	5	6	5	0		4	0	5	0	6	4	6	6	6
RF	6	6	6	6	6	6	0	6	6	6	6	0	2	6	2	0	2		0	2	0	6	2	6	6	6
SACM	6	6	6	6	6	6	1	6	6	6	6	2	6	6	6	5	6	6		6	4	6	6	6	6	6
SCM	6	6	6	6	6	6	0	6	6	6	6	0	5	6	3	0	1	4	0		0	6	3	6	6	6
SLM	6	6	6	6	6	6	2	6	6	6	6	2	6	6	6	4	6	6	2	6		6	6	6	6	6
SM	0	0	0	0	0	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	6	6
SPM	6	6	6	6	6	6	0	6	6	6	6	0	4	6	2	0	2	4	0	3	0	6		6	6	6
SupM	0	5	1	0	0	6	0	6	2	0	0	0	0	2	0	0	0	0	0	0	0	6	0		6	6
SVT	0	0	0	0	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		4
TPS	0	0	0	0	0	5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	

Figure 14: Paired Comparison Results from Round 2

Table 66: Round 3 Input Data for Delphi Study

Process	Borda Score	Rank
IM	143	1
CM	142	2
SACM	138	3
SLM	136	4
PM	131	5
RDM	113	6
KM	107	7
SCM	106	8
SPM	105	9
RF	100	10
ISM	99	11
7Step	73	12.5
BRM	73	12.5
EM	72	14
CapM	71	15.5
FM	71	15.5
AvailM	48	17
ITSCM	47	18
DM	44	19
SupM	40	20
AM	31	21
SM	24	22
SVT	11	23
DC	10	24.5
TPS	10	24.5
CE	5	26

D.4 Delphi Study Round 3

The third round of the study began on Monday, October 19, 2015 and concluded on Friday, October 30, 2015. The survey consisted of 10 questions, 3 open-ended questions, and 7 closed-ended questions. The experts were given the results from round 2 and asked if they agreed with the results or not.