THE EVOLUTION OF SOCIOLOGY OF SOFTWARE ARCHITECTURE

H. A. KASSIR

Ph.D.

2019

THE EVOLUTION OF SOCIOLOGY OF SOFTWARE ARCHITECTURE

HASSAN ABBAS KASSIR

A thesis submitted in partial fulfilment of the requirements of the University of East London for the degree of Doctor of Philosophy

July 2019

Abstract

The dialectical interplay of technology and sociological development goes back to the early days of human development, starting with stone tools and fire, and coming through the scientific and industrial revolutions; but it has never been as intense or as rapid as in the modern information age of software development and accelerating knowledge society (Mansell and Wehn, 1988; and Nico, 1994, p. 1602-1604). Software development causes social change, and social challenges demand software solutions. In turn, software solutions demand software application architecture. Software architecture ("SA") (Fielding and Taylor, 2000) is a process for "defining a structural solution that meets all the technical and operations requirements..." (Microsoft, 2009, Chapter I). In the SA process, there is neither much emphasis on the sociological requirements of all social stakeholders nor on the society in which these stakeholders use, operate, group, manage, transact, dispute, and resolve social conflicts. For problems of society demanding sociological as well as software solutions, this study redefines software application architecture as "the process of defining a structured solution that meets all of the sociological, technical, and operational requirements…"

This investigation aims to lay the groundwork for, evolve, and develop an innovative and novel sub-branch of scientific study we name the "Sociology of Software Architecture" (hereinafter referred to as "SSA"). SSA is an interdisciplinary and comparative study integrating, synthesizing, and combining elements of the disciplines of sociology, sociology of technology, history of technology, sociology of knowledge society, epistemology, science methodology (philosophy of science), and software architecture. Sociology and technology have a strong, dynamic, and dialectical relationship and interplay, especially in software development. This thesis investigates and answers important and relevant questions, evolves and develops new scientific knowledge, proposes solutions, demonstrates and validates its

benefits, shares its case studies and experiences, and advocates, promotes, and helps the future and further development of this novel method of science.

Table of Contents

List of Tables

List of Figures

Acronyms

ANT	Actor Network Theory
BAPCPA	Bankruptcy Abuse Prevention and Consumer Protection Act
CAGR	Compound Annual Growth Rate
CCDM	Credit Card Debt Market
CDIA	Credit Data Industry Association
CFPB	Consumer Finance Protection Bureau
CIRT	Center for Innovation in Research and Teaching
CoPs	Communities of Practice
CSG	Complex Socio-Genetic Model
DRCS	Debt Resolution Case Study
FCRA	Fair Credit Reporting Act
FDCPA	Fair Debt Collection Practices Act
FTC	Federal Trade Commission
G&Os	Goals and Objectives
IKT	Information, Knowledge, and Technology
IT	Information Technology
KS	Knowledge Society
MSDN	Microsoft Developer Network
QARCC	Quality Attribute Risk and Conflict Consultant
RIOTU	Regulator, Influencer, Owner Technologist, User

SA	Software Architecture
SCC	Synthesized Concurrent Checklist
SCOT	Social Construction of Technology Theory
SDRs	SSA Developer Requirements
SEPYN	Social Epistemology Network Development of Knowledge
SETT	The Sociogenetic Evolution of Technology Development
SGT	The Sociogenesis of Technology
SKS	Sociology of Knowledge Society
SPSS	Statistical Package for Social Sciences
SRs	Sociological Requirements
SSA	Sociology of Software Architecture
SSC	Step by Step Checklist
SSH	Simple Socio-hierarchical Model
ST	Sociology of Technology
TOR	Technical and Operational Requirements
UTAS	University of Tasmania

Acknowledgement

This research study and work is the culmination of over thirty years in graduate study and research in sociology, with an emphasis on the “Sociology of Technology in American Culture,” as well as over twenty-five years working at the heart of the PC, internet, and mobile revolutions on software architecture development projects. It also reflects a life of passion, fascination, intellectual development, academic study, and entrepreneurial market experience (including stock market and mortgage finance brokerships and multiple startups) with financial and other internet and mobile products, services, markets and economics.

Several people deserve my acknowledgement for their thoughtful and valuable contribution to my passion and interdisciplinary study of sociology of technology and the development of this thesis. I begin with the most profound leadership, mentoring, and guidance contributions received from my PhD director and thesis advisor Dr. Rabih Bashroush. He deserves my deepest and most profound gratitude for his engaging, interactive, and critical thinking style and methods. He always challenged me to think outside the box in innovative and creative ways. He showed me how to ask challenging questions, research and conjecture with a critical and academic mind, and develop my plan for answers. Most importantly, Dr. Rabih is pleasant to work with, patient, persistent, and challenging. He exemplifies good leadership, mentoring, and excellence in academic research and new knowledge development. Dr. Rabih has been a great role model scientist and researcher.

My acknowledgement, thanks, and gratitude is also due to my thesis advisory team: Dr. Dr. Syed Islam and Fahimeh Jafar. Dr. Syed Islam gave me great guidance, advice, leadership, and mentoring in the initial development of my thesis. Dr. Fahimeh Jafari mentored and advised me and reviewed my work through the final stage of my thesis. Her review and feedback were invaluable. She was patient, professional, specific, challenging, clear, and very helpful. She was generous with her time and responsive. Her sharp mind and critical thinking challenged me to improve my thesis and crystalize my ideas.

I also want to express my deepest feelings and gratitude for my initial graduate mentor and passed away advisor Dr. Joseph Jorgensen at the University of California, Irvine. He inspired me and ignited my passion for the interdisciplinary study of sociology of technology.

I also want to give gratitude to Dr. James Flink at the University of California, Irvine. He was a pioneer in the study of sociology of technology with a focus on the automobile. He inspired me to do the same but with a focus on the personal computer and later the internet. Dr. Flink was an exemplary model to emulate in the study of sociology of technology.

I would also like to express my thankfulness to the School of Architecture, Computing and Engineering (ACE) and Graduate School at the University of East London (UEL) for their support in my research.

I would like to express my deepest and most profound gratitude and love to my passed away parents who founded in me the love of education, knowledge, confidence, and the "to do your best" and "to never quit" attitude.

I would also like to express my admiration, recognition, respect, and warmest love for my wife who always inspires me with her endless energy, love, and dedication to the entire family and education for herself and our seven children. She lifts us all up makes us proud.

I would like to express my deep deep love, pride, and recognition to our most inspiring and supportive children. They have all been models of excellence in academia, society, careers, ethics, and friendship. They are the pride of our lives.

Last but not least, my love, recognition, and acknowledgement is due to my angel and playful grandchildren who keep the smile on my face and the hope in my life.

Dedication

I would like to dedicate this doctoral dissertation to my entire family including my parents, wife, siblings, children, and grandchildren. I could not have done it without them.

I also want to dedicate this to the many giants of history that inspire me to do my best to make a valuable, positive, and beneficial contribution to all of humanity. They inspired me to not live on the margins of history. We must all continue to be conscious and toil hard to improve the lives of billions of people who need social, educational, and economic help.

PART I: INTRODUCTION

Chapter One

Introduction

Pioneering a New Field of Interdisciplinary Study

1.1. Preface

After the 2008 debt market crisis and with the right combination of academia, market experience, enthusiasm, intellectual curiosity, and passion to apply them, we aimed to find a solution to resolving non-performing debt, especially the non-performing US credit card debt market. It had become clear that the market (and society at large) needed a software solution to recycle "toxic financial assets" on a regular basis so that they don't build up to the point of market crisis or collapse, "Great Recession," or "Great Depression." While stepping up to the challenge, this academic experience and market research and development process produced five rewarding outcomes: (1) a patent grant (#8489480 Method and system for restructuring debt) (Kassir, 2013), (2) the development of a digital mediation software solution, (3) a fintech business startup opportunity, (4) the synthesis, development, and evolution of a novel method, namely "The Sociology of Software Architecture," and (5) the opportunity to return to academia and complete a PhD at the University of East London ("UEL"). UEL offered the opportunity, pleasure, and luck of a "Direct PhD" program and great supervision and help from distinguished supervisors.

The complexity of social issues related to the financial markets makes the non-performing U.S. credit card debt market a good and model case study for the development of "sociological requirements" for Software Architecture. Hence, this market and academic research, development, and experimentation to resolve the non-performing U.S. credit card market evolved into components of the “Sociology of Software Architecture.” A healthy consumer credit card market extends easy and beneficial access to the financial markets to over 250 million Americans and billions of people worldwide. When the credit card market (along with other financial markets) suffers a debt crisis, non-performing credit card debt rises sharply (over 100%), millions of consumers lose access to credit worthiness and good financial markets, financing costs increase, and consumer spending dives.This could cause market recessions and/or depressions. The social pain and suffering from debt crisis is mammoth measured in the hundreds of billions of dollars in losses and tens of millions of people suffering financial stress and pain. The 2008 crisis is a good example. Resolving the U.S. non-performing credit card debt market crisis can become a model and template for other financial markets and internationally. The stakes and stakeholders are many; the interests, interactions, and social forces are complex, and the benefits and rewards can be promising and numerous. Novel and innovative SSA knowledge and science development promises to produce a solution for financial and market problems, promoting efficiency, productivity, optimization, social cohesion, economic development, and human progress.

To summarize above, SSA (or the “Sociology of Software Architecture”) is our new terminology to name this proposed novel interdisciplinary and comparative sub-branch of science. Hence, to lay the groundwork for SSA evolution and development, this thesis presents a literature review of the related interdisciplinary science fields of sociology, sociology of technology, history of technology, knowledge society, epistemology, scientific methodology (philosophy of science), and software architecture. This literature review shall cover the elements, parts, and components related to and helpful for SSA development. This includes introductions, definitions, theories, axioms, and principles in the first chapter, and methods, approaches, models, and techniques in subsequent chapters. What is the difference between “methods,” “approaches,” “models,” and “techniques”? This thesis will explain the difference and dedicate a chapter to each. These will be followed by a chapter on assessment (validation, verification, and evaluation). Then these methods, approaches, models, and techniques as well as assessment will be assembled in a toolbox for application with a “how to” instruction manual and examples. Furthermore, they will be applied to the case study of “how to repair the non-performing US credit card debt market.” Finally, we will have a brief conclusion chapter.

1.2. Motivation

Technology is a product of collective human behavior, interaction, innovation, development, and application. It is a product of social behavior and influences social behavior. It is impossible to make meaning of technology outside of the social environment. The best methods for studying social behavior in a social environment are sociological methods. Hence the interdisciplinary study of sociology of technology benefits in the understanding of the interactive and dialectical behavior and relationship between society and technology. Software architecture is the development framework for all software applications; and software development is the engine of all cutting edge technology development worldwide. Therefore, it is natural, beneficial, and necessary to evolve the sociology of software architecture as a specific application of the sociology of technology.

Software architects design software applications for stakeholder groups. These groups have different stakes and requirements. Software architects have traditionally been focused on the development of technical and operations requirements within the software system and environment. Additionally, there is SA development emphasis to incorporate business and economic requirements. But there is little or no emphasis, literature, or training on the development of sociological requirements. Sociological requirements are developed using sociological science methodology applied to software architecture development. Every stakeholder group is a social group with unique sociological attributes, behavior patterns, and social structure. It is therefore necessary and beneficial to study and understand stakeholder groups in terms of their sociological attributes, behavior, and structure. This is crucial for the development of SA sociological requirements applicable in software development and the marketplace. We call them SSA requirements.

Hence, necessity, benefits, and the passion of new knowledge development drive the motivation for the development of “The Evolution of Sociology of Software Architecture.” This novel interdisciplinary study aims to answer challenging questions below, propose meaningful answers and solutions, and develop SSA methods, approaches, and techniques that are applicable, useful, and beneficial. Furthermore, it presents the CCDM case study as a model to emulate, provides extensive references and bibliography, and promotes the further and future development of this independent interdisciplinary study of science.

1.3. Problem Statement: Research Questions

The goal of this thesis is to answer the following research questions:

Q1: *How does software development influence, impact, and mold social change?*

Q2: *How does it respond to social challenges?*

Q3: *How does it develop solutions to social problems and social development bottlenecks?*

Q4: *Does it encourage social division or cohesion?*

Q5: *How can sociology, software development, and related disciplines team up to develop a novel method of science to promote more optimization, efficiency, productivity, economic development, social cohesion, and progress?*

Q6: *If software development is the solution for social problems, then what are the sociological requirements for optimal software architecture development?*

Q7: *What are the methods, approaches, models, and techniques for developing sociological requirements?*

Q8: *How do you develop and integrate sociological requirements with technical and operational requirements?*

Q9: *How do you assess them with validation, verification, and evaluation tests? And,*

Q10: *What are some of the leading applications demanding a powerful "Sociology of Software Architecture" methodology?*

1.4. Contributions

The primary contribution of this interdisciplinary study and investigation is a novel methodology for the development of sociological requirements for software architecture. It is a synthesis of the two scientific disciplines, sociology and software architecture. It is also guided by the studies of sociology of technology, knowledge society, epistemology, scientific methodology, and related fields of study. The contributions of this thesis are as follows:

- **A comprehensive review of knowledge development in the fields of software architecture, sociology, sociology of technology, knowledge society, epistemology, scientific methodology, and related fields:** There are many useful and guiding interdisciplinary studies of sociology, technology, and related fields. This thesis uses these exciting and beneficial new knowledge studies and applies them specifically to the development of sociological requirements for software architecture.
- **A research methodology and synthesis of the above knowledge to produce a novel, promising, and interdisciplinary branch of science:** This study regresses both, the sociology and software architecture methods, to their common and parallel rail tracks of scientific methodology. It creates a process with five stations: discovery, conjecture, planning and design, operations, and reporting. This process mirrors the methodologies of sociology and software architecture, and synthesizes and integrates them in a clear step by step process.
- **The development of SSA methodology tools: approaches, models, and techniques:** These represent the SSA toolbox development. Choosing a scientific method gives the researcher a framework, structure, and macro steps to develop

planning and operations. But the researcher also needs tools with micro steps to build system components and parts, to run tests, to collect and analyze data, and to validate, verify, and evaluate planning, operations, and results. Our toolbox includes approaches, models, and techniques.

- **The development of an SSA application process:.** This SSA process proposes two application methods: concurrent and sequential application. Concurrent application calls for the concurrent and parallel development of sociological requirements with technical and operational requirements. Sequential application calls for the development of sociological requirements after the completion of technical and operational requirements or for existing applications.
- **The development of SSA assessment tools:** Assessment tools include validation, verification, and evaluation. Validation is determining that we are doing the right thing. Verification is determining that we are doing it the right way. And evaluation is measuring the value it contributes to achieving the project's goals and objectives. Choosing a scientific method gives the researcher a framework, structure, and macro steps to develop planning and operations. But the researcher also needs tools with micro steps to build system components and parts, to run tests, to collect and analyze data, and to validate, verify, and evaluate planning, operations, and results. Our toolbox includes approaches, models, techniques, and assessment tools including validation, verification, and evaluation.
- **The presentation of CCDM case study as a model to emulate:** Several case studies were used for the development of sociology of software architecture. This thesis shares some of them briefly but focusses and reports on the most important and beneficial of them extensively. This CCDM (Credit Card Debt Market) case study is a good model to emulate for new development.
- **The production of extensive references and bibliography sections, the call for action, and the promotion of further development of this sociology of software architecture:** This thesis produces extensive references and

bibliography sections. These are intended to help SSA practitioners, researchers, and developers.

1.5. Organisation of Thesis

Below is an overview of the thesis structure and content of each of its chapters:

1.5.1. Part I: Introduction

Chapter one introduces the thesis with five sections: preface, motivation, problem statement / research questions, contributions, and organisation of thesis.

Chapter Two lays the groundwork for this novel study development with literature review, synthesis, and knowledge development. It includes research backgrounds, introductions, definitions, theories, principles, and axioms of science from the contributing interdisciplinary studies of sociology, sociology of technology, history of technology, knowledge society, epistemology, scientific methodology (philosophy of science), and software architecture. The emerging, proposed, and developed SSA knowledge gives the framework for developing the following chapters on methods, models, approaches, techniques, and assessment (validation, verification, and evaluation). In the following chapters, more specific literature reviews, syntheses, and knowledge development will be included in the study of methods, models, approaches, techniques, and assessment. The opposite ends of the spectrum of contributing interdisciplinary studies are software architecture on the one end and sociology on the other. These two disciplines are very different in their development and experience. Software development is the child of branches of the physical sciences such as mathematics, statistics, electronics, and quantum physics development; this is an inanimate world with rigid inanimate behavior laws, empirical data, and systematic predictive modeling. The social sciences, including sociology, examine and study the animate world of human social organizations, tolerant human behavior with foundations in the humanities, philosophy, and language, complexity of known and unknown (such as intent) variables, more qualitative than quantitative data, and challenging predictive modeling. A physicist can predict star behavior with great confidence across time and distance A sociologist cannot predict social behavior with great confidence even in the present time and place. Synthesising these two disciplines is very challenging. Since most SSA development is likely to happen in a software development environment, and since software developers are taught the empirical and experimental disciplines of the physical sciences, the introduction of sociological elements or components can be confusing. In our synthesis, we focus on the options and/or choices in sociology closest to software development. In the following chapters, we place an emphasis on quantitative methodologies versus qualitative methodologies. Another way to help bridge the gap is to rebuild on common scientific method and epistemological grounds. We can also learn from the development of sociology of technology and knowledge society, as they are the forerunners to the sociology of software architecture.

Chapter Three discusses research methodology, in reference to scientific methods. The scientific method and epistemology are the common thread between all sciences. We utilize the scientific method as the common denominator of sociology and software architecture. Then we synthesize and develop SSA methods as parallel methods using the scientific method as their joint methodology. A scientific method is "a method of procedure that has characterized natural science... consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses" (LEXICO, 2019) It is the step by step science recipe for the entire scientific process, from research, to hypothesis, to experimentation and testing, data collection and analysis, to conclusion,to write up, and publication of results. Since software architecture and sociology have developed radically different methods of science, we reach down deep to common scientific methodology and epistemology roots to synthesize and develop a common foundation from compatible, coadjuvant, correlative, and complemental sociological and software architecture methods. We review and synthesize scientific methods from above contributing interdisciplinary branches of science and apply our SSA methodology to an MSDN SA example. Choosing a scientific method gives the SSA developer a plan and steps for research, application, and operation. In the SSA plan, the SSA developer may have many choices and/or options every step of the way. We then integrate and synthesize new knowledge and application methods (thereafter called “SSA methods”). Our goal is to increase software development optimization, produce additional value and benefits, promote social solution and cohesion, and encourage SSA’s future research. The aim of this methodology is to make the synthesis look like a seamless integration into the SA development process. This can be applied to any traditional SA methodology.

1.5.2. Part II: SSA Development, Application, and Assessment

Chapters Four, Five, and Six build an interdisciplinary toolbox consisting of approaches, models, and techniques. In these chapters we investigate approaches, models, and techniques adaptable to SSA development.

Chapter Four develops SSA approaches. To “approach” is a “to come near or nearer to” (Dictionary.com, 2019) to “start to deal with (a situation or problem) in a certain way” (LEXICO, 2019) or “to take preliminary steps toward accomplishment or full knowledge or experience of” (MWD, 2019) SA architects and developers are familiar with different approaches to SA development such as styles, patterns, software language, framework, and viewpoints. Sociological approaches are very different. We discuss three main and important sociological approaches: theoretical framework, worldview, and empirical data approach.

Chapter Five develops SSA models and techniques. The “model” is “a thing used as an example to follow or imitate” (LEXICO, 2019) or “an example for imitation or emulation” (MWD, 2019). It refers to structural graphics or templates available or invented to map out or envision the systematic solution. “Models” are very useful for planning and architecture. SA developers are used to models. This chapter capitalizes on SA developers’ familiarity with models to introduce two types of models: social structure and data models--especially qualitative and quantitative models. A sociological model is a form (menu, table, figure, flowchart, or schematic) representation of the different social groups and how they relate to and interact with each other. We will evolve some sociological models as well as develop new ones.

“Technique” refer to a clear scientific procedure (i.e. mathematics, statistics, data science, data methods--i.e. data collection and/or transformation, algorithms, programs, applications, computer tools, functions, experimentation, surveys, interviews, etc.) or an artistic way with step-by-step tasks and instructions to execute, perform, and accomplish the desired socio-technical solution. They are “the manner in which technical details are treated” (MWD, 2019), or “a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure” (LEXICO, 2019) They are the technical tools in a tool box of utility solutions, set of programs, or functions accessible and used to make the components, parts, and/or the elements of a systematic solution.

Chapter Six develops a plan and process for the application of SSA methodology. The instruction manual is a step by step process that uses an SSA toolbox of methods, approaches, models, and techniques tools (chapters III) for the development of SSA requirements and their proper application. These five types of tools can be beneficial, even empowering, if understood and applied properly. This is why we separated them into five different chapters, so as not to confuse them. Our tools come in different forms: menus (sequential steps and substeps), tables, figures, flowcharts, and schematics. In this chapter, we get to combine different forms of tools in a coordinated and systematic process.

Chapters Seven develops tools and instructions on assessment and the application of validation, verification, and evaluation tests.Assessment is about tests for the purpose of validation, verification, and evaluation of sociological requirements. Validation is about testing and assessing if we are building the right product. Verification is about testing and assessing if we are building the product right. Evaluation is about testing and assessing if we are on the right track to achieving or exceeding our metrics, goals, and objectives, or failing them. Assessment is about assessing all three: validation, verification, and evaluation. SA architects and developers are trained to assess and test SA technical and operational requirements. In this chapter, we discuss how to assess and develop tests for SSA sociological requirements. This includes meeting compliance with all the sociological laws (such as consumer protection), adopt industry best practices, and respond to the hopes, demands, and concerns of sociological stakeholder advocates, such as social, political, academic, economic, business, and religious groups.

1.5.3. Part III: SSA Case Studies

Chapter Eight discusses SSA Case studies that were used in the development of this novel interdisciplinary study. It also suggests candidate SSA models and applications. There were three primary SSA case studies: Education Technology, Local Search, and debt restructuring for Credit Card Debt Market ("CCDM"). The CCDM case study will be explored in detail in five chapters (Eleven through Fifteen).

Chapters Nine, Ten, Eleven, and Twelve explore a case study on how to repair a non-performing US credit card debt market.

Chapter Nine develops two ways to apply the SSA methodology: concurrent and sequential ways. Concurrent application calls for a parallel and mirrored development on the SA and SSA requirements. Sequential application is better suited for existing projects or for different teams. Additionally, this chapter applies the step by step processes to "Discovery" and "Conjecture." Chapters Ten, Eleven, and Twelve are applications of the process for "Planning and Design," "Operations," and "Reporting."

This CCDM case study was not the result of applying the final SSA methodology explained and discussed in the above discussed chapters. Rather, it was a lengthy and gradual experiment that was used to develop this more innovative and efficient scientific SSA methodology. In researching the non-performing US credit card debt market, we observed the failure of many market and technology solutions due to the complexity of the sociological environment and resistance of competing stakeholders. We also watched further deterioration of the market during the Great Recession of 2008. We then asked ourselves: How do we research, study, and analyze the issues and/or conditions of the complex sociological environment and develop them into a checklist of easily understandable “sociological requirements”? How do we turn them into scientific methodology for architects and developers to add, integrate, and synthesize with their traditional SA technical and operational requirements?

We did not start with an SSA development process. We started addressing the sociological issues one at a time. We then proceeded to produce a methodology and process for multiple sociological solutions related to the same project, and to apply partial successes from preceding projects on the ones to follow. We then called them sociological requirements and synthesized them with SA technical and operational requirements using the MSDN SA development model. It was a rolling experiment (trial, error, and discovery) over many years with a sociological mindset. It also utilized several successful preliminary partial experiments from preceding projects (testing smaller and simpler concepts and parts and components of case studies). Coming from a passionate “Sociology of Technology” background, developing SSA methodology was exciting, challenging, and rewarding. In this research, development, and experimental, we were granted US patent # 8489480 titled “Method and system for restructuring debt” (Kassir, 2013). This section’s goal is to show how we would conduct this case study if we already had the SSA development methodology at hand and had to do it all over again in a more methodical, efficient, productive, cost effective, and timely manner. We want to share this experience and novel knowledge development and advocate its adoption, evolution, and further and future development.

1.5.4. Part IV: Conclusion

Chapter Thirteen is a brief thesis conclusion chapter. In it, we evaluate the shortcomings and limitations, as well as successes, new research frontiers, and further challenges. We conduct a discussion, make assessments, ask questions, evaluate answers, and formulate conclusions. We re-evaluate research goals and objectives, assess achievement, and ponder improvement. We ask and answer the following and similar questions: What do we do once we have read and understood the sociology of software architecture? What is it that we want to build, and why? What real impact will this have on an architect or developer? What did we set out to achieve? How do we validate the work? How will we test that we have achieved? How do measure performance? What new knowledge development did we generate? What are the new research frontiers? How do we develop them? What kind of new knowledge development is needed? How to best advance new frontier through research advocacy? What do we envision is the future and further development of this field of study? What questions does this research layout for future research and development? What applications and markets does this research highlight for SSA development? What are the solution's scope and value proposition? What are the social impacts of SSA development? Does SSA development accelerate market and social disruption? What are the costs and benefits? Is this good or bad for technology and economic development, and social progress?

This thesis is a first step towards laying the groundwork and building the foundation for the evolution and development of the sociology of software architecture. The ingredients, building materials, tools, and knowhow come from the surrounding, interdisciplinary, and comparative fields of sociology, sociology of technology, sociology of knowledge society, scientific methodology (philosophy of science), epistemology, history of technology, and software architecture. Additionally, gaps should be filled, bridges should be built, bottlenecks should be resolved, and new knowledge should be developed. This research methodology includes literature review, survey, history of technology, discovery, definition, a collection of useful and fitting elements, parts, tools, and components, comparative analysis, synthesis, integration, the development of new knowledge to bridge the gaps and innovate solutions to bottlenecks, publishing, and the promotion of further and future growth and development of this novel and innovative sub-branch of science. On top of the groundwork and foundation, this thesis builds layers of necessary, constructive, and helpful tools from methods, approaches, models, techniques, and validation tests. Then it combines them into a "how to" toolbox and instruction manual with examples of applications that benefit the most from adding sociological requirements to the SA development process (combining them into the SSA development process). This instruction manual is followed by a case study application (how to repair the non-performing US credit card debt market). This case study is an example and a model to study, follow, and emulate for the application of SSA development; it shows how SSA development is done, validates its methodology, and demonstrates its benefits. The goal benefits from SSA development are increased optimization, efficiency, and productivity, advanced technology, added value and benefits, accelerated growth, social cohesion and problem solution, increased market activity, economic growth, and human progress.

2. Chapter Two

Literature Review

Laying the Groundwork: Introduction, Theories, Principles, Axioms, and Definitions

---

2.1. Introduction

The sociology of software architecture (“SSA”) is our proposed name for the development of a synthesized, novel, innovative, and promising sub-branch of science. It is a sub-branch of the sociology of technology (“ST”) and sociology of knowledge society (“SKS”). SSA aims to advance the science of software architecture through the introduction of sociological methods into SA development. SSA is a synthesis of sociology, sociology of technology, history of technology, sociology of knowledge society, scientific methods (philosophy of science), epistemology, and software architecture (hereinafter referred to as “SSA root sciences”). We conduct the synthesis by looking at, borrowing from, enhancing, reinventing, and adding new parts, components, and tools envisioned and derived from the above SSA root sciences. We also innovate and introduce novel ideas and knowledge, fill the gaps, bridge disconnectivity, remove bottlenecks, and expand science. Our goal is the promise of added optimization, efficiency, productivity, value, and benefits. Our ultimate goal is consumer empowerment, accelerated interaction, business growth, economic development, social cohesion and resolution, and human progress.

This study faces many challenges:

The first challenge is the novelty of a new science. We have to lay the grounds and build the foundation from SSA root sciences. We synthesize knowledge from comparatively very different branches of science. And we have to fit and modify methods, approaches, models, and techniques that were originally designed for different purposes.

The second challenge is the deep scientific divide between the schools of social sciences and physical sciences. The "social" is an attribute of human subjects: they are animate, intelligent, conscious, social, and knowledge driven. The "physical" is an attribute of lifeless subjects: they are inanimate, lack intelligence, unconscious, static and defunct. A software developer can best understand the vastness of difference and complexity of the challenges by trying to build software algorithms that predict the behavior of "social" versus "physical" subjects. Animate intelligent behavior is very tolerant, permissive, varied, learning/knowledge driven, voluntary and unpredictable. Social reactions undergo complex and collective sensory and intelligence processes. Time to react can vary from immediate to eternal. And knowledge can produce complexity involving vast numbers of known and unknown variables. Inanimate behavior is very rigid, stringent, contained, unintelligent, and predictable. Its reactions are governed by strict universal laws of matter, energy, and motion. Its governing laws are involuntary, self-propelling, and automatic. Hence, the social sciences have to find solutions for studying and analyzing animate behavior. They have to deal with much more complex subjects with infinitely more unknowns and relatively limited knowledge. Sociologists have been innovative and creative in finding solutions. Although the field of sociology is very different from software architecture, every software developer is naturally an educated social human being with social experiences that allow him/her to deal naturally with many sociological concepts. This is an advantage that should be exploited. The reverse is not true: not every sociologist is naturally a software developer. Hence, the software developer's advantage should be turned into a great opportunity.

The third challenge is in dealing with sociological data. Social behavior data is more qualitative than quantitative. Sociologists have innovated many solutions to deal with data challenges; but most sociologists struggle with data management, science, and analysis. It is easier to teach a software developer the sociologists' data solutions than to teach a sociologist the software developers' data solutions. Furthermore, software developers, especially if they are familiar with data management and science methods and techniques, can synthesize their data management knowledge, training, and experience with sociological methods and techniques that advance more value and benefits.

On the other hand, sciences have common grounds in the scientific method, epistemology, and computerization. These, together, have approaches, models, and techniques that give us much to appreciate and utilize for the benefit of mankind. The synergies between sociology and software architecture are profound. The advantages of software developers to lead SSA development are numerous. The need for novel and innovative ideas and solutions is mammoth. And the promises of optimization, efficiency, productivity, cost effectiveness, added value and benefits, social cohesion, economic development, business growth, and social progress are very desirable and often acutely demanded. This is why we call upon all SA architects and developers to learn and understand SSA development, apply it for the benefit of all, and contribute to its evolution and advancement.

In this Introduction, we aim to research, study, discuss, synthesize, develop, and re-define "Software Architecture" ("SA"), "Sociology of Technology" ("ST"), and "Sociology of Knowledge Society" ("SKS"). Then we will use this research to synthesize and develop a novel definition, as well as proposed hypothesis/theories, assumptions, qualities, and attributes for the "Sociology of Software Architecture" ("SSA"). This novel study field aims to optimize SA development. SKS is a subset of ST; and SSA is a synthesis of SA and SKS.

To achieve this goal, we survey and discuss traditional literature, definitions, assumptions, qualities, attributes, theories, and hypotheses. We synthesize and integrate some ideas and concepts. We hypothesize, theorize, clarify our assumptions, and argue for change. We \ also develop their qualities and attributes (i.e. SA, ST, SKS, and SSA), lay the ground for building methods, approaches, models, techniques, and discuss applications for this novel

SSA scientific method. Our objective is to have a clear definition of SSA based on a synthesis of our re-definitions of SA, SKS, and ST. We establish a clear theory of SSA with clear definitions, attributes, and qualities. These will give us the foundation upon which we can develop sociological requirements and build a toolbox for the integration and implementation alongside traditional SA technical and operational requirements. The ultimate goal is to answer the questions stated in the abstract. We want to develop and apply a new SSA practice that will optimize the development of software technology and maximize benefits, usefulness, and the betterment of people's lives. We also want to guide future research and knowledge development in this novel SSA field of study. The below Figure 1. shows how we proceed in this research:

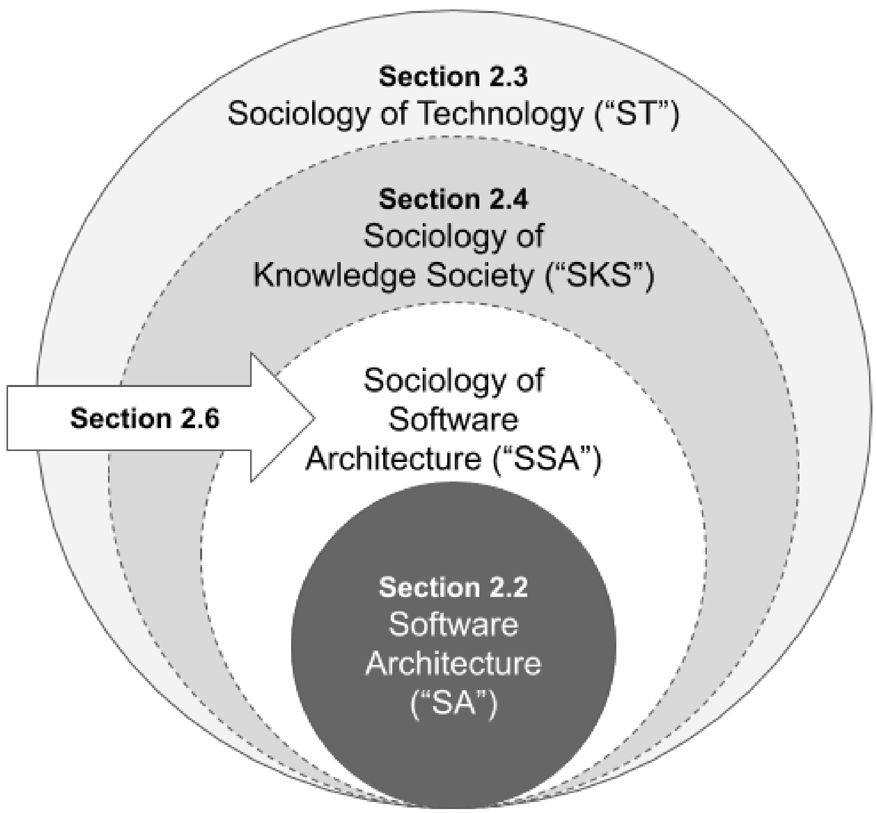

Figure 1: Method for Developing Sociology of Software Architecture

In this chapter, we present several theories and methods that formalize the principles, assumptions, axioms, and steps to follow when an SSA architect wants to develop sociological requirements and understand the impact of SA development on society.

2.2. What is Software Architecture?

"Software architecture typically plays a key role as a bridge between requirements and implementation (see Figure 2)" (Garlan, 2000, p. 2).

Earlier definitions, such as Garlan and Shaw's paper "An Introduction to Software Architecture" (Garlan and Shaw, 1993) do not use a formal definition for SA.Instead, finding software application development increasing in complexity, they integrate many software development methods and models into a more cohesive SA (with focus on planning design). Other definitions that follow tend to focus on "technical and operational" definitions. Here are some examples:

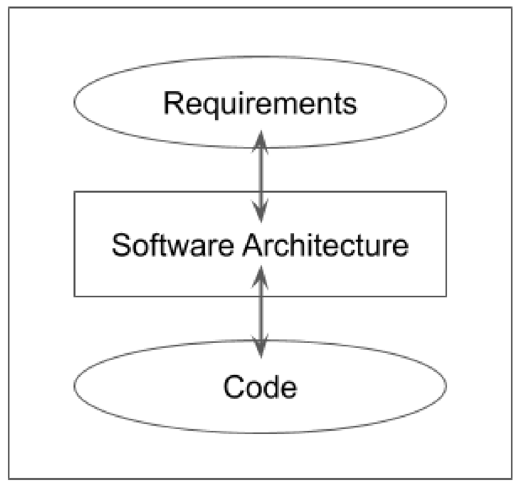

Figure 2: Software Architecture as a Bridge

Perry and Wolf's model (Perry and Wolf, 1992): Software Architecture = {Elements, Form, Rationale}

That is, a software architecture is a set of architectural (or, if you will, planning and design) elements that have a particular form. We distinguish three different classes of architectural elements: processing elements; data elements; and connecting elements. In Patterns of Enterprise Application Architecture (Fowler, 2002), Martin Fowler outlines some common recurring themes when explaining architecture. He identifies these themes as: "The highest-level breakdown of a system into its parts; the decisions that are hard to change; there are multiple architectures in a system; what is architecturally significant can change over a system's lifetime; and, in the end, architecture boils down to whatever the important stuff is." Bass, Clements, and Kazman define it as "the software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible qualities of those elements, and the relationships among them" (Bass, Clements, and Kazman, 2003, p. 4) Woods and Rozanski define it as "the set of system design decisions that dictate the fundamental structure and properties of a system" (Woods and Rozanski, 2005, p. 6).

Above are examples of SA technical and operational definitions. In defining "Software Architecture", we will use more modern, evolved, and expanded industrial (Microsoft and IBM) and academic textbooks and published paper definitions. Microsoft's MSDN defines it as:

> the process of defining a structured solution that meets all of the technical and operational requirements, while optimizing common quality attributes such as performance, security, and manageability. It involves a series of decisions based on a wide range of factors, and each of these decisions can have considerable impact on the quality, performance, maintainability, and overall success of the application (Microsoft, 2009, Chapter I).

The key words in the definition above are: process, structure, and technical and operational requirements. The rest of the definition goes deeper into defining "technical and operational" attributes of the process. In the Abstract above, this researcher has adopted this MSDN definition as a foundation and added "sociological requirements." It is important to elaborate on "process" and "structure." The Oxford dictionary defines "process" as "a series of actions taken in order to achieve a particular end" (LEXICO, 2019). It also defines "method" as "A particular procedure for accomplishing or approaching something, especially a systematic or established one" (LEXICO, 2019). A method is a more "systematic" way to apply science, hence the scientific method. In our approach to define a more "scientific" way to developing “sociological requirements” for the Sociology of Software Architecture, we focus on developing methods (which may include one or more processes).

“Structure” is defined as “the arrangement of and relations between the parts or elements of something complex” (LEXICO, 2019) whereas “system” is defined as “A set of things working together as parts of a mechanism or an interconnecting network; a complex whole.” A “system” has structure, components, elements, interconnectivity, and etc. SA evolved as a solution to the complexity of software development. Hence, when SA is applied, a systematic method is often the better method to apply. Adding “sociological requirements” to develop the Sociology of Software Architecture will definitely be advanced by applying methodical and systematic solutions.

Hence, this research modifies SA definition to the following: “the method of defining a systematic solution that meets all of the sociological, technical, and operational requirements,...” we added “sociological” before “technical, and operational” not because it precedes in importance but rather because it precedes in sequence. Peter Eeles (Eeles, 2004) of IBM defines software architecture as “the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution” [IEEE 1471]. Eeles also says that architecture “defines behavior,” “focuses on significant elements,” “balances stakeholder needs,” “embodies decisions based on rationale,” is “influenced by its environment,” “influences team structure,” is“present in every system,” and “has a particular scope.” When Eeles speaks of defining behavior or balancing stakeholder needs, Eeles is still focused on the “technical and operational requirements” in the development of the architecture and the software.

Eeles’ definition uses “system;” this is more in line with our definition above. What is more interesting about Eeles’ definition is his focus on “behavior,” “stakeholders,” “environment,” and “team.” Although Eeles remains on the “technical and operational” definition of these terms, he, nonetheless is touching on sociological elements. This research will expand on Eeles’ concepts of “stakeholders,” “environment,” “team,” and “behavior.”

In a whitepaper by Rozanski, Nick, and Woods, they define SA requirement as “a concern about an architecture is a requirement, an objective, an intention, or an aspiration a stakeholder has for that architecture” (Rozanski and Woods, 2005) Eeles defines a “stakeholder” as “an individual, team, or organization with an interest in, or concerns relative to, a system. [IEEE 1471]” (Eeles, 2004). This research expands on the definition of “stakeholder”; it goes beyond the traditional SA definition of stakeholders to have direct and material relationship with the project. This will be further expanded after we define the sociology of Software Architecture. In sum, we will look for and discover sociological stakeholders that are not traditionally incorporated in SA development; they are the equivalent of “sociological elephants in the room.” To best identify the “relevant” sociological stakeholders, we will focus on studying the “sociological environment” in which the system will be deployed and the possible disruptions to social groups beyond the direct involvement in the software development. For example, competitors may be disrupted and severely affected by the software development; if we think of competitors as stakeholders, and possibly have team members play the role, we can see how this might influence the SA project.

We also look at expanding the SA development team to include people occupied with the development of “sociological requirements.” This can be done either through trained SA engineers or through consultants or sociology practitioners.

Last, but not least, we will be very interested in sociological behavior of all stakeholders in our sociological environment. SA engineers may focus primarily on software system behavior. This research will equally demonstrate that negative and positive sociological behavior around the SA development can have a great impact on the sustainability and successful evolution of a software solution.

Conclusively, the modified SSA definition becomes: the method of defining a systematic solution that meets all of the sociological (with a special focus on social environment, sociological stakeholders, behavior, and sociological team specialization), technical, and operational requirements ...

In Software Architecture in Practice (2nd edition), Bass, Clements, and Kazman define architecture as follows:

> The software architecture of a program or computing system is the structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them. Architecture is concerned with the public side of interfaces; private details of elements—details having to do solely with internal implementation—are not architectural (Bass, Clements, and Kazman, 2003, p. 4).

This definition expresses SA's necessity with software system complexity. However, what is most interesting to us is that it is "concerned with the public side of the interfaces." This seems to be referring to the public users of the software and how they interface with the software. "Interface" is a very important "sociological requirement" that is already widely recognized in SA development. User interface and the user experience have proven to be critical elements for the success of software application development. This research will build on the "interface" issue to sociological groups that may not be directly interfacing with the software. For example, developing electronic medical records systems affects the patient directly, without a direct patient interface. Easier and lower cost electronic filing of lawsuits increased lawsuits against debt defaulters, significantly causing court jams.

Hence, this modified SSA definition becomes: the method of defining a systematic solution that meets all of the sociological (with a special focus on social environment, sociological stakeholders, interface, behavior, and sociological team specialization), technical, and operational requirements ...Philippe Kruchten, Grady Booch, Kurt Bittner, and Rich Reitman derived and refined a definition of architecture based on work by Mary Shaw and David Garlan. Their definition is:

> Software architecture encompasses the set of significant decisions about the organization of a software system including the selection of the structural elements and their interfaces by which the system is composed; behavior as

> specified in collaboration among those elements; composition of these structural and behavioral elements into larger subsystems; and an architectural style that guides this organization. Software architecture also involves functionality, usability, resilience, performance, reuse, comprehensibility, economic and technology constraints, tradeoffs and aesthetic concerns (Shaw and Garlan, 1996).

From this definition, we see a better focus on technical and operational requirements; we also like to highlight "interface" which has been integrated above. More importantly, we like to focus on involving "functionality, usability, resilience, performance, reuse, comprehensibility, economic and technology constraints, trade offs, and aesthetic concerns." All these attributes have sociological implications in light of expanding our "special focus on social environment, sociological stakeholders, interface, behavior, and sociological team specialization."

2.2.1. Redefining Software Architecture with Sociological Requirements

This research re-develops SSA definition as: the method of defining a systematic solution that meets all of the sociological (with a special focus on social environment, sociological stakeholders, interface, behavior, and sociological team specialization), technical, and operational requirements, [… elaboration on technical and operational details is not the subject of this research.] Software architecture also involves functionality, usability, resilience, performance, comprehensibility, reuse, economic and technology constraints, tradeoffs and aesthetic concerns.

This is an important note to add on "technical and operational" requirements: focusing this research on the sociological requirements of SA neither diminishes the primary importance of "technical and operational requirements" nor ignores the integration of SA views (functional, information, concurrency, and development views--this research recommends adding a "sociological view(s)"), nor SA elements (middleware, hardware, component types, connectors, information flows, processes, etc.) nor components (modules, connectors, functions, nodes, technologies, data stores, constraints), or quality attributes such as performance, security, and manageability, nor quality properties (performance, security, scalability, availability, sustainability, etc.) (Woods and Rozanski, 2005). More importantly, this research encourages the methodical integration of machine learning into SA development. There are many useful technical, operational, and sociological applications for machine learning in SA development; however, our focus in this research is on the sociological usefulness of machine learning for understanding, developing, and evolving sociological requirements, the qualitative and quantitative development of methods and processes to define and measure sociological metrics, and the continued evolution and tweaking of the software application to optimize and monetize sociological value and benefits, increase compliance and user satisfaction, and minimize liability and costs.

2.3. What is The Sociology of Technology?

Sociology is the “scientific” study of social interaction and group behavior. Sociologists look for patterns, common attributes, social location, recurring characteristics, or events. A society is a group of people who share geography and culture. “To understand what sociology is all about, one has to look at oneself from a distance, to see oneself as one human being among others. For sociology is concerned with the problems of society” (Elias, 1978, p. 28). With the rise of the scientific revolution, we saw several major studies of society attempting to apply the scientific method, as better knowledge development tool than philosophy, to analyze, understand, and explain social interaction, group behavior, principal problems, and desired solutions. Karl Marx proclaimed his “historical materialism” as an application of science for the study of society. On the other side was social darwinism similarly developed by Herbert Spencer. Hence, sociology is a modern academic scientific discipline focused on the study of modern society starting with the scientific and industrial revolutions. In sum, sociology is the study of modernity.

Sociology approaches the study of society through macro (wider social context) and micro (particular social behavior). It also looks for the strange and the familiar. Some of the key concepts addressed in the study of sociology include: social location, marginalization, and power and inequality (economic, political, cultural, educational, etc.).

The word "science" (a keyword for defining sociology and technology) as we use it today means "empirical science." This modern meaning differs from the historical meaning of science as knowledge. What we call today "science" used to be called "natural philosophy." The change of meaning happened in the first half of the 19th century and coincided with the coining of the term "scientist." The term scientist was coined for the first time in 1834 by a Cambridge University historian and philosopher of science, William Whewell. This was in answer to an objection by a British philosopher to the use of the term "natural philosophy" (Snyder, 2010).

Sociology as a scientific academic discipline was born in the late 19th century as a "positive science of society." Among it pioneers are Henri de Saint-Simon, Auguste Comte, Emile Durkheim, William Graham Sumner, Frank Blackmar, Albion Small, and Max Weber.

2.3.1. History of the Sociology of Technology

The sociology and history of technology (Bijker, Hughes, and Pinch, eds., 1989) originated with the study of science, technology, and society (STS) (Bauchspies, 2006); this happened in the 1960s and 1970s following the burst of advanced technology development advanced with World War II (Boczkowski and Lievrou, 2008). On the other hand, we saw earlier in the twentieth century the development of the study of sociology of knowledge. In short, sociologists quickly recognized knowledge, science, and technology as important components of modernity the demand a special academic focus. This extended to studying the history of technology, history and philosophy of science, and science, engineering, and public policy studies.

Sociology of technology is the study of the dialectical relationship between sociology and technology development. "Need is the mother of invention" is a famous parable that has proven itself over time. The need to conquer and control nature drove inventions from stone tools to space travel through the solar system and beyond. Technology is a practical solution to overcome sociological development challenges and impediments; hence, it contributes to developmental progress which, in turn, can have ripples in sociological structure, attributes, and elements. And sociological developments, such as speech, logic, philosophy, education, knowledge, groups, organizations, wars, peace, etc. can lead to the discovery of or a newly developed need to invent novel technologies. Hence, the interplay between technology and sociological development are intertwined, dialectical, dynamic, and powerful. "Technological Determinism" (Marx, 1994) is an example of a sociological theoretical development attempting to explain this relationship.

Distributed technology (Sassen, 2002), allowing every individual to own, control, and use powerful technology tools (such as mobile devices) leads to the contribution of information and power throughout a highly networked society. Distributed technology is leading to a greater level of globalization and cross border interaction. This can be correlated with the recent political backlash against globalization and free trade. Distributed technology, this researcher believes, is leading to a higher form of capitalism; this, this researcher calls "Distributed Capitalism." Humanity is currently at an early stage of Distributed Capitalism. It could lead to dramatic transformations in the ownership and control of intellectual property, capital, labor, rent. We could see transformations from centralized banking economies to networked banking authority (like bitcoin) that may transfer the pillars of power from traditional state organizations to non-traditional social network groups. Awareness of distributed technology and its mammoth impact on sociological structures, attributes, and elements can't be ignored by the developers of software application architecture. This demands a strong need to add "sociological requirements" to the traditional "technical and operational requirements" of software development.

2.3.2. Synthesis of Sociology and Software Architecture

What is software architecture and how does it relate to sociological requirements?

Microsoft's Application Architecture Guide defines software architecture:

> Software architecture encompasses the set of significant decisions about the organization of a software system including the selection of the structural elements and their interfaces by which the system is composed; behavior as specified in the collaboration among those elements; composition of these structural and behavioral elements into larger subsystems; and an architectural style that guides this organization. Software architecture also involves functionality, usability, resilience, performance, reuse, comprehensibility, economic and technology constraints, tradeoffs and aesthetic concerns. (Microsoft, 2009, Chapter 1)

Hence, according to above definition, software architecture = structural elements + interface + behavioral specifications between elements + architectural style + functionality + usability + resilience + performance + reuse + comprehensibility + economic and technology constraints + tradeoffs + aesthetic concerns. If we remove "technical and operational requirements" (which are the two pillars of traditional software architecture), we are left with: sociological software architecture = interface (maybe UI/UX) + functionality (maybe) + usability (maybe) + economic constraints (yes). As you can see, SA is technical and operational centered with minor touches into possible sociological issues. In developing sociological requirements, interface (meaning UI/UX) would first define the target (most important) stakeholders. If it is the individual consumer, then we would start with their demographics and behavioral attributes. Addressing primarily male vs. female, younger vs. older, lower-middle, middle, upper middle, or higher income segment, educated vs. uneducated, academic vs. nonacademic, etc., can dramatically influence interface requirements. If the software architect determines that demographics are very important (cost/benefit analysis), then intelligent detection of the prospective stakeholder through dynamic third party databases and machine learning algorithms may become the optimal solution to offer each stakeholder an interface experience that is most conducive to engagement and conversion.

"Economic constraints" in this definition can be interpreted strictly through a business lens (budget, time, cost, ROI, etc). We cannot deny the software architect from ranking these economic considerations on top of other considerations. Nonetheless, there are many other economic considerations that can be evaluated and may contribute to a more optimal development of sociological requirements. For example, software solutions are valued on automation, scalability, efficiency, and disruption; they most often dramatically reduce the cost of transacting across a trade platform. The economic value disruption and redistribution can affect many third party stakeholders in many different ways while giving the developer similar economic results. The software architect should investigate the economics of all stakeholders and make conscious sociological decisions on how to redistribute the value generated by the software solution. Many software architects may not be familiar with trickle up (demand side) (Setterfield, 2002) and trickle down (supply side) economics (Felstein, 1986); however, a minimum level of familiarity, research, or inquiry about these issues can help software architects develop important sociological requirements. It may also give the architect a fresher look at the entire economics model and realize economic gains not visible without such analysis. It also allows software architects or decision makers to become aware of the sociological ramifications of their work.

There are many more sociological attributes and elements that should have weighed influence on software development. Software technologies and applications are notorious for sociological disruption; all disruptions have positive and negative effects and some disruptions can be managed. Software architects should look into managing disruptions based on sociological requirements. Some disruptions may happen too soon and too fast causing upheaval; others may be made softer (with a sociological gain) others may be accelerated, etc. we are not suggesting social engineering (Hadnagy, 2010); however, we are suggesting that the software architect should look into sociological requirements and look for optimization.

Hence, we synthesize and redefine sociological software application architecture as: the methodical process of qualifying (defining) and quantifying (measuring with clearly defined metrics) attributes (material or behavioral), elements (subcategory of attributes), and components (operating subsystems) of a systematic solution that optimizes structure, input to output process and flow, value generation, value redistribution, and development of relevant sociological, technical, and operational requirements.

By "methodical" we mean the identification and selection of a clearly defined methods that best mirror scientific methods and can be tested, applied, reapplied, and potentially improved by any qualified software architect based on a clearly defined recipe or process. Every method has at least one process in it, but different methods have different processes.By "systematic" we mean a dynamic, operational, and productive structure with clearly defined input, output, flow process, components, and interactions between components.

ST Questions

The Sociology of Technology is the study of social interaction influencing or influenced by technology development. Sociologists seek answers and solutions to the following questions:

- *What is technology?*
- *Does technology development determine sociological development or the reverse?*
- *How do sociologists understand modernity, the industrial age, knowledge society, and post-industrial age in terms of technology?*
- *Is "knowledge society" or "information society" different from or similar to the industrial society?*
- *Does technology affect the development of capitalism and modernity?*
- *How can other disciplines use sociology as a science and utilize its methods to further understand and better develop their areas of study?*
- *How can we apply the study and methods of sociology for the betterment and advancement of SA development?*

There are many more questions one can ask relating sociology and technology (Kilminster, 2007). But we are specifically focused on the utility and benefit from sociology for the advancement of development of Software Application Architecture.

2.3.3. What is Technology?

The term technology first appeared in 1829 in a book written by botanist Jacob Bigelow and titled “Elements of Technology” Bigelow defined technology as “the principles, processes, and nomenclature of the more conspicuous arts, particularly those which involve applications of science, and which may be considered useful” (Bigelow, 1829, p. V). The Webster dictionary defines technology as “the use of science in industry, engineering, etc. … to invent useful things or to solve problems … a machine, piece of equipment, method, etc. that is created by technology.” It also defines technology as “the practical application of knowledge especially in a particular area” (MWD, 2019)

It is important here to note that both terms “technology” and “sociology” are derivatives of the modern meaning of science, empirical science (as in “scientist”). This explains why most of us do not tend to think of technology when we discuss the earliest human and “practical application of knowledge” to develop stone tools and fire. In conclusion, modern science is only a specific application of knowledge; we should look at technology in historical perspective as the byproduct of knowledge development of every society since the first speaking human.

Is technology a science or an art?

This was one of the main questions we had to answer and discuss during our advance to Ph.D. candidacy exams. The Greek origin of technology (technologica) meant “the systematic treatment of an art” (MWD, 2019) After studying and practicing art, science, and technology for over four decades, we have no doubt that technology is a mixed application of science and art. Technology is applying knowledge, especially science, with art, creativity, and inventiveness.

In our study, we will define technology as the “innovative and practical application of knowledge, especially modern science, for the advancement of social development.” Technology in-and-of-itself is meaningless without the social context of its development, production, deployment, and promotion including the intent, use, and benefit of its developers to enhance their economic, political, social, military, academic, etc. position. Studying technology as an independent actor or agent vis-a-vis society causing or shaping social change is missing the point.

2.3.4. Theories of Sociology of Technology

Theories and methods of sociology of technology are applications of sociological theories and methods on technology. These are the leading sociology theories: Social Constructionism, Actor-Network Theory, Positivism, Anti-Positivism, Post-Positivism, Marxism, Neo-Marxism, Division of Labor, Interactionism, Symbolic Interactionism, Globalization, Modern World-System, Critical Theory, Functionalism, Communication and Social Order, and etc. (Giddens, 1996). The leading methods of sociology are quantitative and qualitative methods, historical and comparative methods, mathematical, computational, and network analysis methods, ethnography, and ethnomethodology (Denzin, 1989).

The leading theory of sociology of technology, Social Construction of Technology (SCOT), applies social constructionism theory to explain technology. On the other end of the spectrum is the theory of technological determinism (MacKenzie and Wajcman, 1999) which applies historical determinism (OR, 2019) theory to explain technology. SCOT theory argues that human action leads the development of technology, not the other way around. SCOT differs slightly from our definition that technology is the “innovative and practical application of knowledge, especially modern science, for the advancement of social development.” It is not a question of which one shapes the other, human action or technology, but rather that society is the actor and technology is not an actor but an application or product of the actor. By defining society as the actor and technology as a product, the argument about which one shapes the other becomes mute.

Here are some key concepts of SCOT theory: “From the early history of the bicycle, Pinch and Bijker provide examples of closure and stabilization, social shaping, interpretive flexibility, and the influence of social groups” (Bijker, Hughes, and Pinch, eds., 1989, p. 7).

- **Closure and Stabilization:** “Closure in technology involves the stabilization of an artifact and the ‘disappearance’ of problems” (Bijker, Hughes, and Pinch, eds., 1989, p. 37). For the purpose of this research, we need to focus at the social meaning of the problem and develop technology to solve the problem.

- **Interpretive Flexibility**: “Technological artifacts are culturally constructed and interpreted; in other words, the interpretive flexibility of a technological artifact must be shown” (Bijker, Hughes, and Pinch, eds., 1989, p. 34). This researcher believes that cultural interpretation is an important dimension of the social interpretation; however, other social dimensions including economic, political, aesthetic ones should be equally interpreted.

- **Relevant Social Group**: “In Bijker’s model ‘the key element is the identification of a relevant social group is a shared meaning attribution’” (Bijker, Hughes, and Pinch, eds., 1989, p. 103). For this research purpose, we equate the social group with the sociological stakeholder in the development of the desired technology.

- **Social Shaping**: “With their emphasis on social shaping, Pinch and Bijker deny technological determinism” (Bijker, Hughes, and Pinch, eds., 1989, p. 6). Technological determinism argues that technology is a material development that shapes social development. In the following, this research will argue that social action is the only driver of technological development. The development of “sociological requirements” discussed above and below is a good example of the social shaping of technology. According to Robin A. Williams and David Edge (1996), "Central to SST is the concept that there are 'choices' (though not necessarily conscious choices) inherent in both the design of individual artefacts and systems, and in the direction or trajectory of innovation programmes” (Williams and Edge, 1996, p. 866).

What is SCOT?

It is an abbreviation of "Social Construction of Technology" (Williams and Edge, 1996). It applies the "constructivism" theory of sociology on technology. This theory says that people "construct" their own knowledge through experience, observation, and reflection, and that the success of technology comes from social adoption ("like") and usefulness (economic value), not merely from its own technological innovation merits. This is a classical application of sociological theory to develop the sociology of technology. To apply this further into SA development, we can see its implications in encouraging software architects to dig deep into and research theirs and other SA experience, gather sociological observations, and reflect on the interplay between sociology and technology. This research suggests expanding observations to relevant "sociological elephants in the room" stakeholders and adding "data analytics" to observation in the development of sociological requirements.

The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology ("SCOT") (Klein and Kleinman, 2002; and Bijker, Hughes, and Pinch, eds., 1989) a pioneering book first published in 1987, launched the new field of social studies of technology. In one of the papers presented in this book, "Society in the Making: The Study of Technology as a Tool for Sociological Analysis," Michel Callon discusses the concept of the "Engineer-Sociologist." Callon discusses a case study of the VEL project in France to "illustrate the capacity of engineers to act as sociologists (or historians or economists)." Callon's illustration supports this research's aim to train software architects to act as sociologists or to benefit from sociologists in their SA development. SCOT remains the leading theory of technological innovation in science and technology studies. The second in line is actor-network theory ("ANT"). ANT was developed by Bruno Latour and Michel Callon (Klein and Kleinman, 2002).

SCOT was introduced in 1984 by Bijker and Pinch (Bijker, Hughes, and Pinch, eds., 1989). But despite its wide criticism, it continues to be one of the most useful theories in the application and development of ST. There are two other theories that compete with SCOT: (1) structural social construction of technology (Structural SCOT) (Klein and Kleinman, 2002), (2) actor-network theory ("ANT"), and (3) technological determinism theory. Structural SCOT's fundamental premise of approach is that "the social world is constituted of historically established structures that at any given point in time confront actors as external and constraining." This theory's emphasis in the structure of relevant social groups can be beneficial for our study of the Sociology of Software Architecture since we promote the integration of relevant "elephants in the room" sociological groups and their sociological requirements.

Another sociological theory application into the sociology of technology is Actor-Network Theory (ANT). ANT (a "sociology of associations") focuses on the "material" and "semiotic" involved in the interplay of people and technology; "material" reflects the actual involvement of technological tools in the interaction while "semiotic" reflects the human interpretation of the interaction and its technological elements. In his famous Reassembling the Social book, Bruno Latour says: "the social cannot be substituted for the tiniest polypeptide, the smallest rock, the most innocuous electron, the tamest baboon. Objects of science may explain the social, not the other way around. No experience was more striking than what we saw with our own eyes: the social explanation had vanished into thin air" (Latour, 2006, p. 99). This theory was developed by Michel Callon and Bruno Latour (leading French ST scholars), John Law (a British sociologist), and others.

Technological determinism

Technological determinism (sometimes equated with the idea that machines are the masters of society), is a term coined by American sociologist Thorstein Veblen (1857-1929), and is closely associated with historical determinism. It is a "reductionist" theory of technology that believes technology determines social development and structure. Reductionism is a theoretical framework that reduces objects, phenomena, explanations, theories, and meanings to the most basic and simple forms. Technological determinism theorizes that technology is prime force shaping sociological changes. Marx applied technological determinism theory to explain how the development of productive technology determines the modes of production, economic hierarchy, and the history of social change, relationships, organizational structure. According to this theoretical framework, software applications are more than tools for users to accomplish certain tasks, they are social transformers that determine the new social organization and order. This theoretical camp has been divided into two groups: "hard (radical) determinism" and "soft (moderate) determinism" (MacKenzie and Wajcman, 1999).

Other theories include: Structuration Theory by Anthony Giddens (Giddens, 1991; DeSanctis and Poole, 1994; and Jones, 2008), Systems Theory (Boulding, 1956; Luhmann, Baecker, and Gilgen, 2013; Luhmann, 1995; Buckley, 1967; and Hughes, 1994), and Activity Theory (Nardi, 1996; and Engeström, Miettinen, and Punamäki, eds., 1999).

In 1986, Melvin Kranzberg, the founding editor of Technology and Culture, published a paper titled "Technology and History: 'Kranzberg's Laws'" Kranzberg's Laws promote a distinct sociological view of technology (Kranzberg, 1986):

> Technology is neither good nor bad; nor is it neutral...technology's interaction with the social ecology is such that technical developments frequently have environmental, social, and human consequences that go far beyond the immediate purposes of the technical devices and practices themselves (Kranzberg, 1986, p. 545).

Kranzberg's laws include the following: (1) Technology is neither good nor bad; nor is it neutral, (2) invention is the mother of necessity, (3) technology comes in packages, big and small, (4) although technology might be a prime element in our public issues, nontechnical factors take precedence in technology-policy decisions, (5) all history is relevant, but the history of technology is the most relevant, and (6) technology is a very human activity - and so is the history of technology.

2.4. What is The Sociology of Knowledge Society?

Before we research and study the “Sociology of Knowledge Society” (Stehr and Meja, eds., 1984), we like to examine “knowledge” and “Knowledge Society.”

The Oxford dictionary defines knowledge (Nassehi, von der Hagen-Demszky, and Mayr, 2007) as “facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject” (LEXICO, 2019) By comparison, information (as in “Information Society”) is defined as “facts provided or learned about something or someone.” Nico Stehr, a prominent “Knowledge Society” sociologist, defines knowledge as “represents a capacity to act” (Nico, 1994, p. 40). We redefine knowledge as “the uniquely social, human-innate, and intellectual capacity to recognize and/or learn facts, information, and skills, inter-communicate and recognize, discuss, and evaluate them through speech, pen, and tablet across languages, cultures, generations, time, and space, to stack-accumulate knowledge, and to intellectually generate new knowledge from existing knowledge.”

2.4.1. SEPYN: The Theory of Social Epistemology Network (“SEPYN”) Development of Knowledge

Novel Theory Development

SEPYN is our novel and proposed theory that defines knowledge development in terms of social epistemology. This theory hypothesizes that reasoning is a collective and evolutionary development over time integrating all human experience. A newly born human being connects with the surrounding human epistemological environment network to learn language, reasoning, and culture. The learned language, reasoning, and culture are the result of social and epistemological evolution since the beginning of humanity. Hence, by the time a human being becomes an adult, he/she would have already become a product of his/her own social epistemology environment. SEPYN states the following principles:

1st principle: “*We think, therefore I am*.” This challenges René Descartes’ famous statement “*I think, therefore I am*” (Cogito ergo sum) (Cottingham, 1996). A human being born in the wilderness and developing without any social interaction whatsoever cannot produce but very simple knowledge. Knowledge, as we know it in every society, is a cumulative collective social effort across time, space, languages, cultures, generations, etc.

2nd principle: Knowledge is made up of two components, recognition and learning. Recognition starts before birth with the development of our senses; learning comes from social sources (mother, family, culture, schools, the state, etc.), feeling, thinking, reasoning, and experience.

3rd principle: Knowledge is two types, universal knowledge and cultural knowledge. Universal knowledge (i.e. mathematics, physical sciences, logic, etc) is universally recognized and learned across time, space, languages, cultures, generations, etc. Cultural knowledge (language, art, cultural heritage, etc.) represents unique beliefs based on a society’s historical experience and belief system assumptions. In the modern Knowledge Society (especially as a consequence to IT, the internet, and globalization), is changing the dynamics between universal and cultural knowledge. Over the past century, universal knowledge, through the modern educational system, science, and technology (Böhme and Stehr, eds., 1986), has become the dominant knowledge center whereas non-dominant cultural knowledge is being challenged by dominant cultural knowledge (i.e. Western culture) as well as universal knowledge.

4th principle: Reasoning is a social network activity; the individual’s reasoning can only make sense in terms of the social knowledge (both universal and cultural).

5th principle: Experimental knowledge is superior to theoretical knowledge since it can validate itself through repeated experiments by multiple experimenters across human differentiations; empirical science experiments and observations are more powerful than thought experiments or philosophy.

6th principle: Knowledge development methodology establishes universal processes and steps to validate knowledge; the scientific method is a great example of how methodical scientific development change human development.

About “Knowledge Society”

Hence, knowledge, in essence, is a sociological phenomenon. “Knowledge Society” is a society where knowledge development is on the rise and represents one of the main pillars of the social system. In the IT knowledge society, knowledge and information represent “the” main pillar of the social system.

“Knowledge Society” (Longhurst, 1989), “Information Society,” “Information capitalism” (Fuchs, 2013), “Network Society” (Sociology of the Internet), “technical state” (Stehr, 2010), and/or “Post-Industrial Society” generally refer to the same era, a stage in modernity where the share of production of hard (tangible) industrial goods in the economy is declining while the share of production of soft (intangible) industrial goods production is increasing; IT, especially software, have taken center stage in the speed of development and proliferation in a way never witnessed before in history. Information and knowledge development and production have increased dramatically with IT. Hence, “Knowledge Society” refers to a unique subset of “Technology Society.” We have defined “Sociology of Technology” above; now we focus on defining “Sociology of Knowledge Society” as an important quality of the modern age, especially since the proliferation of computing and exponential development of IT.

Our choice of “Knowledge Society” vs. “Information Society” or other nomenclature is for the following four reasons:

- **Principles of Knowledge**: see above.

- **Software Architecture Analogy**: Knowledge to information is analogous with Knowledge Society (KS) to Software Architecture (SA). SA is static, descriptive, technical, and operational; KS is dynamic, interactive, productive, and meaningful. Unless you connect the two (SA to KS) through sociological requirements, SA cannot be optimized.

- **Lessons of History**: Many people think that the current "knowledge revolution" is the first experienced by humanity due to modernity and IT. The fact is that whenever a society experienced a "knowledge revolution," its sociological ramifications were deep, wide, and historic. "Ancient societies (Rome, China, the Aztec Empire), that gained and maintained power in part as a result of their superior knowledge and information technology, may be described as knowledge societies of sorts" (Nico, 1994, p. 40). Mesopotamia invented agriculture and irrigation, Cuneiform--first form of writing, urban civilization, mathematics, maps, astronomy and astrology, time tools, the plow, the sailboat, the wheel, and the chariot (Faiella, 2006). Egypt, China, India, and Greece all developed knowledge societies. It is also equally wise to look at the "Islamic Golden Age of Science" (Falagas, Zarkadoulia, and Samonis, 2006), the development and proliferation of the printing press technology "as an agent of change" (Eisenstein, 1980), the Renaissance, the modern scientific revolution, the development of the modern schools and universities (Dzisah and Etzkowitz, 2011), and the invention of radio and television. These are all examples of "knowledge technology revolutions" that changed the world. By looking at history we can better understand and appreciate the uniqueness of the current information and knowledge revolutions.

Greek society believed that our knowledge development and understanding of the world should rely on logic (thought experiments) rather that empirical science experiments. They utilized the power of mind and reason to observe and understand the world. Hence, Greek knowledge development was focused on logic and philosophy. In the Islamic golden age of science (8th - 12th century), muslims invented the "scientific method," believed that knowledge is good only if useful and beneficial, promoted empirical experimentation, and developed methodologies for knowledge development. As a result, muslims gave us mathematics (algebra, algorithm--logic of science) and experimental applied science. In the modern European Renaissance, Enlightenment, scientific revolution, and industrialism, Europeans benefited from both the Greek and Islamic knowledge developments. Today's Knowledge Society is standing on the shoulders of all civilizations and empowered by IT.

2.4.2. Synthesis of the Unique qualities of IT Development

We will use the term “Knowledge Society” to represent the sociological developments (Meja and Stehr, 2014); and we will use the term “Information Age” to represent the most unique attribute of this modern “Knowledge Society.” Hence, it is an information age knowledge society with IT development and proliferation as its soul and cause of exponential growth. IT is unique among other technologies, and SA is the lead developer of IT development. Hence, the sociology of knowledge society must address the uniqueness and qualities of such society and IT.

The following are our proposed synthesis of the unique qualities of IT:

1. IT delivers superior information

Audiovisual information targets all the senses: it is empowering. The power of audiovisual media, especially cinema, TV, and radio, has been socially transformative in the 20th century. IT's ability to digitize audiovisual media and integrate it into software applications and digital networks has been empowering especially to the IKT Cycle. For example, finding a YouTube video to learn almost anything, anytime, anywhere, and for free is very empowering globally across social organizations and social networks.

2. IT is actionable:

IT development has become the engine for knowledge development and IP proliferation. This unique global development is opening up opportunities to a significant percentage of mankind without precedent. IP development means value and economic development that can be produced by a poor individual living in a remote village in an underdeveloped country as well as large production organizations.

3. IT is extensible to intellectual behavior:

It is an adjunct to human intellectual activities and knowledge development. Information is the principal input and output of knowledge development, and, as stated above, “technology is a sociological phenomenon built on the unique social quality of human and intellectual knowledge development.” Hence, information technology becomes an engine of knowledge and information development and production serving as a tool for multiple purposes as well as an extension and empowerment of intellectual productivity. *Information technology is a way for technology to create more information and more knowledge, and hence more technology* (“IKT Cycle”).

4. IT is human networking and interaction:

We defined Sociology above as “the study of social interaction and group behavior.” IT allows for large social networks never experienced before with accelerated interaction across the globe. This makes “Sociology of Information Society” as “the study of rapid, massive, and intensive social interaction and social network and group behavior.”

5. IT is permeable across social barriers:

The time has arrived, especially with the internet and mobile smartphone technology, where, except for rare remote pockets of underdeveloped societies, almost no social group interacts without IT.

6. IT is software; it is soft power:

Although IT is grounded in hardware, it is the software quality that makes it so unique. Digital technology allows for the storage, transfer, and use of software across the globe at minimal costs.

7. IT is permeable throughout most other technologies:

Digital technology is transforming almost all other technologies or their production methods.

8. IT is distributed:

This is a most unique quality of IT; distribution of information and knowledge means distribution of technology development know-how and the empowerment of all users of IT at a distributed level (like mobile devices, etc.).

9. IT is exponentially fast:

IT's IKT Cycle can accelerate in ways never experienced by most other technologies. Faster and accelerating cycles mean faster and accelerating social change.

10. IT is disruptive:

IT is not the first disruptive technology; there are many technologies that have disrupted the world: electricity, telephony, assembly lines, automobiles, airplanes, medical discoveries, and etc. are but a few examples of technologies that have transformed the world. However, because of the above nine qualities, IT disruption is far more formidable than any other technology experienced before.

Because of above unique qualities of IT development, the Sociology of Information Society has become a hot and fascinating study for sociologists. However, they seem to have different names that share many similar sociological qualities and timelines. Almost all sociologists agree that there is a social evolution beyond the industrial society that started in the mid 19th century and continued until the latter part of the 20th century. Hence, in addition to being called the "Knowledge Society," some call it the "Information Society," “Informational Capitalism,” or the “Post-Industrial Society.” In the following, we will survey the literature and the main theories in this field.

The “Sociology of Knowledge” discipline studies how Knowledge affects social development whereas the “Sociology of Knowledge Societies” studies how societies, with knowledge being among or the main pillar of social system development, solve their social problems and accelerate development.

Our synthesis proposes that the “Sociology of Knowledge Society” should be studied in terms of:

(1) knowledge as a combination of information and action (with empowerment tools);

(2) the analogy between information and knowledge, and Software Architecture and Knowledge Society;

(3) the uniqueness of knowledge development to social development, the history of knowledge societies;

(4) the unique qualities of IT development; and

(5) differentiation between “universal knowledge” and “cultural knowledge.”

Furthermore, we hypothesize that the unique qualities of IT knowledge development that sets the sociology of contemporary and IT driven knowledge society apart from all previous knowledge society developments.

2.5. SETT: The Theory of Sociogenetic Evolution of Technology Development

Novel Theory Development

This research hypothesizes and proposes novel sociology of technology theory: we call it “The Sociogenetic Evolution of Technology Development” theory (or “SETT”).

“Sociogenesis” is “the evolution of societies or of a particular society, community, or social unit” (MWD, 2019). Hence, “the sociogenetic evolution of technology development” theory means that technology was developed as a result of social evolution and change. Technology is a human product; therefore, social change happens prior to and produces technology. Technology, in turn, influences social change. This dialectical interplay has been continuing and accelerating since the early human beings developed stone tools. Technology development acceleration has reached an exponential phase with information technology.

2.5.1. SETT Axioms:

- **Technology is a sociological phenomenon** built on the unique social quality of human and intellectual knowledge development. It is a manifestation of an innate intellectual ability evolved as a product of the social, speaking, and writing mind (including graphic artefacts and representations). Speech is a pillar of social interaction across a group. Writing is a pillar of social interaction across time, space, societies, languages, and disciplines. Artefacts are the material record of human technology. Animals produce little more than primitive technology. Only humans have produced advanced technology. It is a tool developed through observation, thinking, interaction, and, most importantly, through people’s ability to accumulate knowledge in written format.

- **The pen and tablet** (from the stone tablet to the book to the modern electronic tablet) are the two most important technologies ever. They allowed the accumulation of human knowledge across, geography, culture, language, and time.

- **The scientific method** became an accelerator, not the cause, of science and technology development. Information sciences (especially software) are exponential accelerators of technology and sociological development.

Technology is a mix of pure, raw, and innate human inventiveness, art, science, and intellectual and material development.

- **Society, not science, develops, produces, and uses technology**. Society does it with complex sociological interactions, dynamics, challenges, conflicts, opportunities, and competitiveness.
- **Society's innate drive to perfection** governs technology development and evolution. Even the most fascinating technology becomes obsolete in the future. All technology is imperfect. Society seeks perfection. Sociological conditions will forever drive innovation and development to an impossible-to-reach perfection.
- **Technology is shaped by social interaction**. The sociological application and use of technology, not the technology itself, shapes sociological development. Technology's influence is primarily the result of its developer and user perspectives. To study the influence of technology, the researcher must understand the structure of the social forces developing and using the technology as well as the social forces impacted by it.
- **Technology is a human tool, not an independent agent**. Technology being good or bad is a sociological viewpoint representing a specific view. In the absence of humans, it becomes neutral.
- **All history is relevant; the history of human development is the most relevant**. The history of technology is only relevant in relation to the history of human development.
- **The history of technology is the history of the sociology of technology**.

- **There are unintended consequences for technology on social change and development**. This is not due to technology itself but rather to the complex, undiscovered, and unseen laws of nature, especially sociological laws.

This research defines the "Sociology of Technology" as a sociological study of how society develops, and uses technology, and how it is affected by it. Since knowledge development is the most significant human quality, the Sociology of the IT driven knowledge society becomes the most important branch of sociology of technology in modernity.

2.6. What is The Sociology of Software Architecture ("SSA")?

In this section, we develop the Sociology of Software Architecture within the methodology outlined below (see next graphic image). We redefine "Software Architecture" (SA), then we define the "Sociology of Knowledge Society" (SKS) as a subset of "Sociology of Technology" (ST). Next we develop and build the "Sociology of Software Architecture" (SSA) as a subset of the "Sociology of Knowledge Society" applied to our unique sociological definition of "Software Architecture."

In Section 1.1 above ("What is Software Architecture?"), we concluded with the following unique SA sociological definition: the method of defining a systematic solution that meets all of the sociological (with a special focus on social environment, sociological stakeholders, interface, behavior, and sociological team specialization), technical, and operational requirements, [… elaboration on technical and operational details is not the subject of this research.] Software architecture also involves functionality, usability, resilience, performance, comprehensibility, reuse, economic and technology constraints, tradeoffs and aesthetic concerns.

In Section 1.2 above ("What is Sociology of Technology?"), we concluded with the following: this research hypothesize a different ST theory; we call it 'The Sociogenesis of Technology' (or "SGT") and it assumes ten different laws for the study of Sociology of

Technology.” This research also adopted the following ST definition: “The Sociology of Technology is the sociological study of what society does with technology, how it develops it, how it uses it, and how it is affected by it. Since knowledge development is the most significant human quality, then the Sociology of the IT driven Knowledge Society becomes becomes the most important branch of Sociology of Technology in modernity.

In Section 1.3 above (“What is Sociology of Knowledge Society?”), we concluded with: “The “Sociology of Knowledge Society” should be studied in terms of: (1) knowledge as a combination of information and action (with empowerment tools), (2) the analogy between information and knowledge, and Software Architecture and Knowledge Society, (3) the uniqueness of knowledge development to social development, the history of knowledge societies, and (4) differentiation between “universal knowledge” and “cultural knowledge.” Furthermore, we hypothesized the unique qualities of IT knowledge development that sets the Sociology of Contemporary and IT Driven Knowledge Society apart from all previous knowledge society developments.”

2.6.1. SSA Synthesis

Software Architecture aims to optimize the development of Knowledge Society with a thoughtful and deliberate method of decisioning, planning, and designing of an IT system that (1) delivers information, (2) empowers users with actionable tools (hence it is a knowledge developer), and (3) aims to qualify, quantify, and influence sociological change of behavior.

Sociology of Software Architecture aims to develop the social science (Sociology) and method to help and support SA apply best practices and achieve optimal and progressive social development; SSA aims to develop “sociological requirements.” SA projects applying SSA methodology and social requirements are called socio-technological solutions.

Sociological Requirements focus especially on sociological stakeholders ("social groups"), environment ("social situation"), interface ("social interaction"), and behavior ("social role" and action desired with SA's empowerment tools) (Nico, 1994, p. 40). Additionally, we develop a set of skill mix, team structuring, and sociological team specialization.

SSA Methods: SSA methodology is synthesized based on the common steps of the scientific method and the parallel steps of traditional SA development as outlined by MSDN (Microsoft, 2009) (as an example).

SSA Approaches are defined as developed ways, especially for first time SSA developers to qualify/define and quantify/measure the development of "sociological requirements."

SSA Models: are sociological models for defining social groups synthesized for SSA development.

SSA Techniques: we define them as clear scientific procedures or artistic approaches with step-by-step instructions and tasks to execute and perform in order to accomplish the desired socio-technological solution.

SSA Assessment: this includes developing tests for validation, verification, and evaluation of SSA development process and progress.

Alistair Cockburn, a pioneer in the agile software development movement says:

> Architects do not like being told that their clean designs are the result of accounting for social forces. Project managers do not get to use their knowledge of social issues to influence architecture. Yet it is clear that social issues affect the software architecture in ways that the good architect takes into account (Cockburn, 1996, p. 40).

Cockburn elaborates further that

> most software architects do not think of themselves accounting for social issues, but that is one of the characteristics of good architecture. Accounting for social issues gives designers an easier life, which gives the software a longer life.

The aim of this research is to make sociological methods a much more conscious, present, and contributing science to SA development.

2.7. What are Sociological Requirements?

When we speak of "sociological requirements," we are talking about sociological attributes and elements that are outside the software system but influence or are influenced by the software system. For example, if you automate the legal process of filing a summons, you save costs, reduce the price, save time, and promote efficiency. But more importantly, in some cases, as in the debt collection industry, you make it more cost effective for debt collectors to file thousands instead of hundreds of summons per portfolio and hence they can jam the court system and cause serious social stress by suing many more people (NCLC, 2010). When we speak of sociological requirements, we speak of the latter, the sociological ripple effect of software development.

Sociological Requirements focus especially on:

a. **Sociological stakeholders** ("social groups" or "SSA groups"): stakeholders, in most cases, refers to direct stakeholders in the development and use of a software solution. Sociological stakeholders refers to all, direct and indirect, stakeholders. In the above stated example (lawsuit automation), the court system is a significant indirect sociological stakeholder.

b. **Environment** ("social situation"),

c. **Interface** ("social interaction"), and

d. **Behavior** ("social role" and action desired). (Nico, 1994, p. 40)

Additionally, we develop a set of skill mix, team structuring, and sociological team specialization.

We divide sociological requirements into two types:

1. Sociological Requirements (“SRs”)
2. SSA Developer Requirements (“SDRs”)

2.7.1. SRs: Sociological Requirements

In the above definition, we are focused on the following SRs (Nico, 1994, p. 40):

1) Sociological stakeholders = “social groups”,
2) Sociological environment = “social situation”,
3) User interface = “social interaction”), and
4) User behavior = “social role” and action desired with SA’s empowerment tools

Now that we have paired SRs with their sociological counterparts, we will be able to look at sociological models (next section 2) and develop models for sociological stakeholders, environments, user interface, and user behavior.

2.7.2. STR: SSA Developer Requirements

What are the sociological requirements for the SSA Developer?

The SSA Developer can be a single architect, a team, or a company. Here are suggested requirements for an SSA Developer.

1. You can follow the methodology outlined in this investigation supported by extensive references.

2. You can hire a consultant with sociological credentials and experience to augment and help you with your project.

3. In larger teams, you have a team member and train her/him on SSA methods to help her/him fully participate in a team project (Fischer, 2004).

2.8. Summary

In this introductory chapter, we accomplished the following:

1. We redefined software architecture by adding sociological requirements to its technical and operational requirements.

2. We proposed a new theory of knowledge development, namely SEPYN. SEPYN hypothesizes that the social epistemology networking forms knowledge development including language, reasoning, and culture. Hence, reasoning and knowledge are a collective social activity.

3. We proposed our own synthesis of the unique qualities of IT development.

4. We proposed a new theory of technology development named SETT. SETT hypothesizes that technological development is the product of sociological interaction and evolution. Hence, to optimize technology development, we must integrate sociological requirements.

5. We proposed the development of a novel and promising sub-branch of science named SSA or the Sociology of Software Architecture.

6. We defined "sociological requirements" and broke it up into two types: SRs, or Sociological Requirements, and SDRs, or SSA Developer Requirements.

In the next five chapters, we will investigate, synthesize, and build a toolbox of methods, approaches, models, and techniques useful for SSA development. Next, we discuss "how to" apply what we have learned. e then develop assessment tools for validation, verification, and evaluation. In the following chapter, we present a case study of "how to repair the non-performing U.S. credit card debt market."

3. Chapter Three

Research Methodology

SSA Methodology: Synthesis of Methods of Sociology and Software Architecture

---

3.1. Introduction: The Scientific Method

The scientific method is the most important development in the history of academic knowledge. It is the demarcation line between science and non-science. The term “science” has changed meaning in the past two centuries. “Science” meant “knowledge” in Latin. Later, the term came to have a meaning associated with “Modern (restricted) sense of ‘body of regular or methodical observations or propositions concerning a particular subject or speculation’ is attested from 1725; in 17c.-18c.”. In 1832, William Whewell coined the term “scientist.” For the past couple of centuries, the term science has meant empirical methods that involve experiments and/or observations. But the modern Scientific method as we know it today was first documented in the early days of the Golden Age of Islamic Science. Muslim scientist called it “al-tajrobah,” “atajrubah,” or “attajrobah.”

The scientific method is unique because of its many attributes and proven contribution to scientific progress. Most important among these attributes are: empirical, a step by step process, replication, verification, testability, validity, reliability, accumulation of knowledge, multi-hypothesis testing, systematic observation, scrutiny, peer review, systematic, prediction, law formation, publication, academic cross pollination. Because of its rich and beneficial attributes, it has become the backbone of all “sciences.” However, it has proven itself to be more challenging to apply with the social sciences due to the qualitative nature of known and unknown human variables. The scientific method and epistemology are the common grounds on which we synthesize sociology and software architecture. In this chapter, we will use the scientific method as the common denominator of Sociology and Software Architecture. Then we will synthesize and develop SSA methods as parallel methods using the scientific method as their joint methodology. We will apply it using MSDN traditional SA steps. The aim of the SSA methodology is to make the synthesis look like a seamless integration into the SA development process. This can be applied to any other traditional SA methodology. we will focus on the overall plan (structure) of SSA research, but we will also introduce many sociological terms and concepts. In the following chapter, we will focus on SSA approaches, models, and techniques, and will have the opportunity to explain the main and most useful terms and concepts for SSA developers.

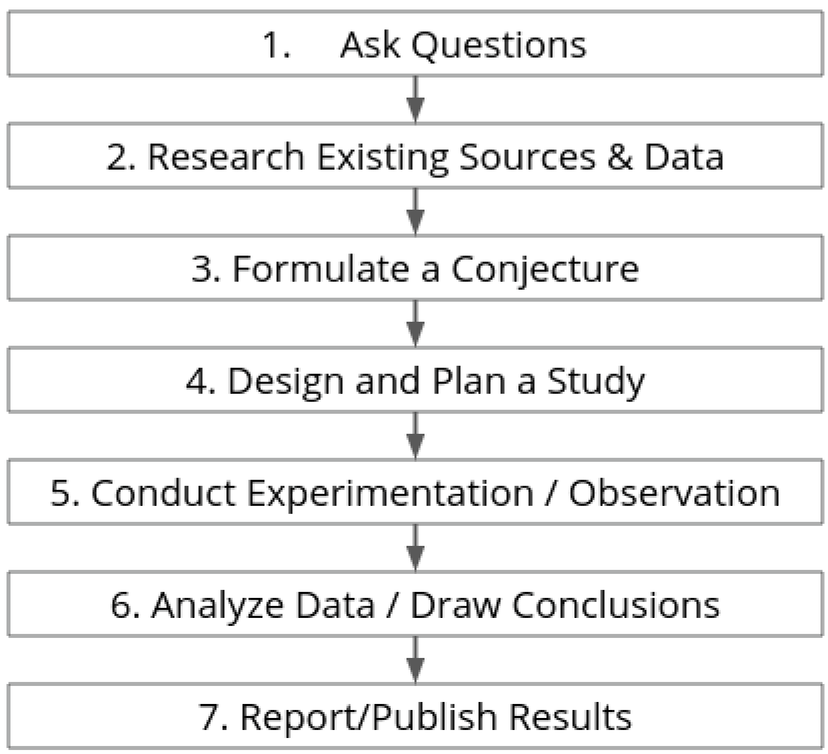

Figure 3 The Scientific Method

The scientific method is the demarcation line between modern “science” as in “scientist,” “research scientist,” or “empirical science,” and “science” as in the ancient Latin and general meaning of scholarly knowledge. The Merriam-Webster dictionary defines the scientific method as “principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses” (MWD, 2019) The scientific method is the most powerful knowledge development invention. It is a five to seven step process (Figure 2.1.1).

For the purpose of this study, we will use a five step process. We combine the first and second steps into one step and we call it “discovery.” This includes asking questions, literature review, formulation of problem, researching existing sources, looking at existing data, looking for similar case studies, exploring related science disciplines, thinking outside the box, exploring existing theories, axioms, assumptions, and much more. It’s aim is to make full discovery of all the issues of the study. The 2nd step is “conjecture.” We selected the term “conjecture” of the term “hypothesis” because it is a broader concept and more applicable to software architecture. Hypothesis is “a tentative assumption made in order to draw out and test its logical or empirical consequences” (MWD, 2019). The oxford dictionary defines conjecture as “an opinion or idea that is not based on definite knowledge and is formed by guessing” (OLD, 2019). The Merriam-Webster dictionary defines it as “inference formed without proof or sufficient evidence” and “a conclusion deduced by surmise or guesswork” (MWD, 2019) For this study, we define conjecture as “an explanation, opinion, idea, scenarios inferred or deduced by scientific research based surmise or guesswork, or a tentative assumption made in order to draw out and test its logical or empirical consequences.” This includes attempts to find correlations, patterns, relationships, governing laws, and structure, research based guessing and conjecture, and hypothesis formulation. The researcher should develop multiple scenarios that cover all possibilities of explanation of investigated issue.

The third step is “planning.” It includes “design and plan,” predictive modeling, research method selection and design, schematics, charts, directions, instructions, step by step process, etc.. The fourth step is “operations.” Operations is a more useful term to include experimentation, observation, data collection, prototypes, or beta application development, and more. Operations move us to implementation of developed plans. The researcher wants to create an empirical application to test the hypothesis. It applies an empirical test to the planned studies. The fifth step is “reporting.” This combines above Figure 2.1.1 steps 6 and 7 into one step. It includes validation, verification, evaluation, data analysis, conclusions, acceptance or rejection of hypothesis, theory development, document development, and publication. The following Figure 4 Is our representation of the scientific method that we developed for the proper synthesis of sociology and software architecture into the evolution of sociology of software architecture (“SSA”).

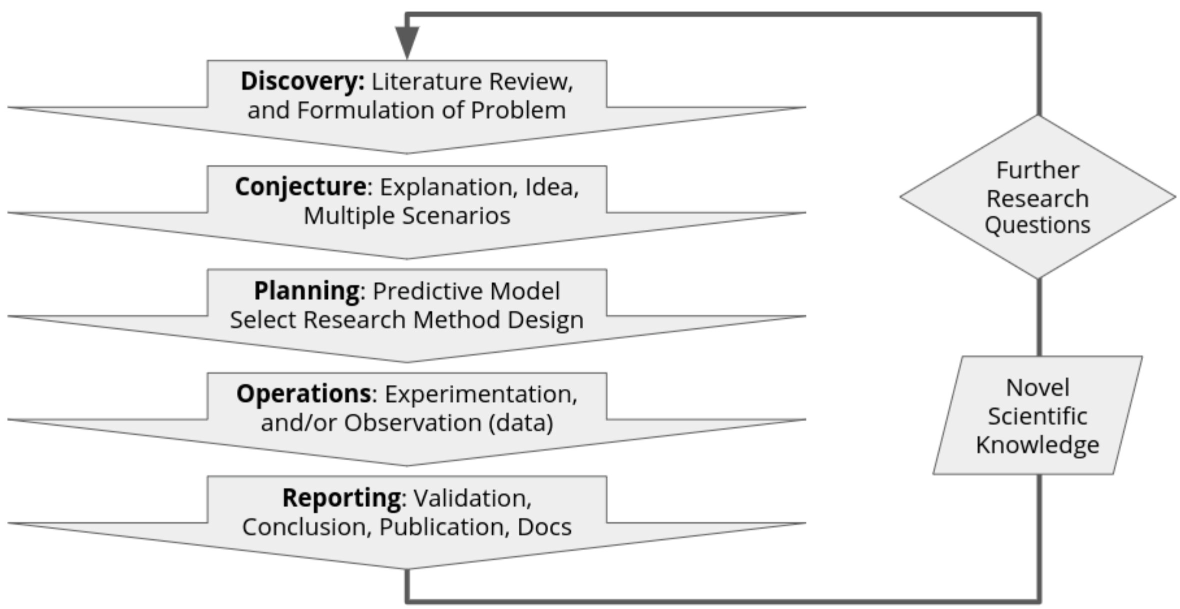

Figure 4 Proposed Scientific Method Flowchart

Our simplified representation of the scientific method uses the sequential terms: discovery, conjecture, planning, operations, and reporting. We will use these terms in this sequence throughout our examination of the scientific method in sociology as well as software architecture. We will utilize it as the track on which we synthesize sociology and software architecture to develop the sociology of software architecture. We draw an analogy with the development and writing of an essay: introduction, body, and conclusion. Discovery is the introduction of the essay; hypothesis, planning, and operations are the body of the essay; and reporting is the conclusion of the essay.

3.1.1. Discovery

We start the scientific method with the first step of discovery. We ask a lot of questions starting with: What is it that we are doing? Where do we start from? What is the history of it? What related progress has been made already? Can we build on previous knowledge and science? What literature, theories, axioms, and assumptions review should we conduct? What do we start with? Where are we going with it? What do we hope to achieve with it? Why is it important? What related knowledge is relevant? Why? What cases studies or experiences can we emulate? What are the demands and expectations? What are the costs and benefits? What are we competing with? Whom are we competing against? Whom can we collaborate with? What is the problem that we are trying to solve? What kind of solution is desired? What resources do we have? What resources do we need? Is this achievable? Is it cost effective? Is it productive? Is it optimized?

We want to discover all related knowledge, experiences, demands, problems, expectations, case studies, and solutions. We want to clearly define the specifications of the project. We want to gain all the important and necessary knowledge to understand the research project, identify all related issues and knowledge, investigate the problems, manage expectations, and identify the goals and objectives. This includes literature review, questions, and the formulation of a principal problem through rigorous collection of evidence and scientific research. It also includes defining the principal problem/topic, qualifying and quantifying the principal issues of the principal problem, identifying related and relevant scientific knowledge, and asking good, relevant, and pointed questions.

3.1.2. Conjecture

With all the information gathered in the first step of discovery, we move to the second step of conjecture. We begin to intelligently utilize our research to guess and develop scenarios for the explanation of patterns, correlations, causality, etc.. We ask ourselves: What could it be? What common threads and patterns did we discover? What are the relationships? What are the possible causes? What different scenarios arise? Which is the more likely scenario?

This includes attempts at explanation [multiple scenarios] through laws or algorithms or desired solutions or use cases that could help resolve the principal problem. This also includes conjectural propositions, hypothesis formulation (a testable statement about the causal logic, inferential, or correlational relationship between two or more variables), different scenarios, and critical thinking analysis.

3.1.3. Planning and Design

After developing multiple scenarios or hypotheses, we want to plan our development, experimentation, prototypes, and tests. We ask: How do we apply it? What are the best methods, approaches, models, and techniques for this project? How do we insure optimization? How do we develop measures? How do we collect data? What is our predictive model? What are our predictions? What are our expectations? How do we manage and communicate expectations? This includes Predictive modeling and selection of research method design [input/independent variable $\Rightarrow$ output/dependent variable] based on a causality or an inference relationship between the input and output. This also includes the design of an experiment or observation process, selection of methods, qualifying and quantifying of variables, defining universe or audience for data collection, developing formulas and relationships, and defining expectations. This can also include a nullification method.

3.1.4. Operations

Operations is applying step three planning and design in a laboratory or in the virtual or real worlds. We get to test our hypothesis. This includes prototypes, experimentation, and/or observation [data collection] of empirical data that validates or nullifies the hypothesis.

On the sociological requirements side, we are looking at populations, samples, treatment, dependent and independent variables, data collection, and biases. On the software architecture side, we are looking at coding, prototyping, testing, etc.

3.1.5. Reporting

We start the last step five by asking: What is the solution? Did we meet expectations? Did we achieve our goals and objectives? Is this going to work? This includes statistical analysis, validation, verification, evaluation, conclusion, theory formation, publication, and/or documentation, novel knowledge development, successes, failures, and future of research and development. What is the future of this new knowledge development or product or application? What recommendations do we make for future research and development? Where do we think this field is heading? What are competing threats? What are the frontiers of opportunities? What benefits do we gain? At what cost?

Some scientists break this step into two steps: interpretation or drawing of results and analysis, and reporting the research findings and results. Again, for the purpose of synthesizing sociology and software architecture, we find keeping them under one step with two substeps is more useful.

3.2. How to Synthesize SSA methods

This above leads us to important questions: How are software architecture and sociology similar or different in their scientific methods? How do we synthesize SSA methods?

3.2.1. Software Architecture

Software Architecture is about "{Elements, Form, Rationale}" (Perry and Wolf, 1992) and "is a level of design that] goes beyond the algorithms and data structures of the computation: designing and specifying the overall system structure emerges as a new kind of problem. Structural issues include gross organization and global control structure; protocols for communication, synchronization, and data access; assignment of functionality to design elements; physical distribution; composition of design elements; scaling and performance; and selection among design alternatives" (Taylor, 1999, p. 9) Software Architecture is about software components, connectors, interconnection topology, configuration, code, design, style, computation, data, rules, algorithms, and etc.

3.2.2. Sociology

Sociology is about studying social group interaction and behavior. Groups are people: females, males, races, nations, organizations, companies, generations, social status, demographics, lifestyle, consumers, producers, government, people, etc. Interaction is about communication, connection, affiliation, transaction, collaboration, jointed work, development, growth, and etc. And behavior is about collective action related to grouping and interacting. The spectrum of Sociology studies ranges from the qualitative to the quantitative analysis, and from the deeply theoretical (like Symbolic Interaction Theory, Conflict Theory, Functionalist Theory, Feminist Theory, Critical Theory, Labeling Theory, Social Learning Theory, Structural Strain Theory, Rational Choice Theory, Game Theory, Sociobiology, Social Exchange Theory, Chaos Theory, Social Phenomenology, Disengagement Theory, etc.) (Crossman, 2019) to the fairly empirical and statistical (like segmentation, clustering, surveys, profiling, and data science applications) (Charnock, *et. al.*, 2006).

3.2.3. Synthesis of Software Architecture and Sociology

SSA synthesis is about applying the sociological methods that relate to SA methods: rationale, interface, communication, information distribution, interaction, and behavior. Fortunately, the nature of SA development makes it more on the "fairly empirical and statistical" side of sociological methodology. Although deeper sociological theories may have valuable implications on SSA development in some projects, for our purposes we will focus on the more empirical and statistical side of sociological methods. SSA methods will integrate both methodologies to give us the best techniques and tools to develop best practices "sociological requirements" and optimize SSA development.

There are two ways to start this synthesis process:

- After SA method development
- Concurrently with SA method development

New SSA developers will find it easier to start this synthesis after SA method development. However, to maximize the value proposition, it is best to do concurrently. With practice, SSA developers will find it easier, more efficient, and better optimized to conduct concurrent SSA synthesis and development.

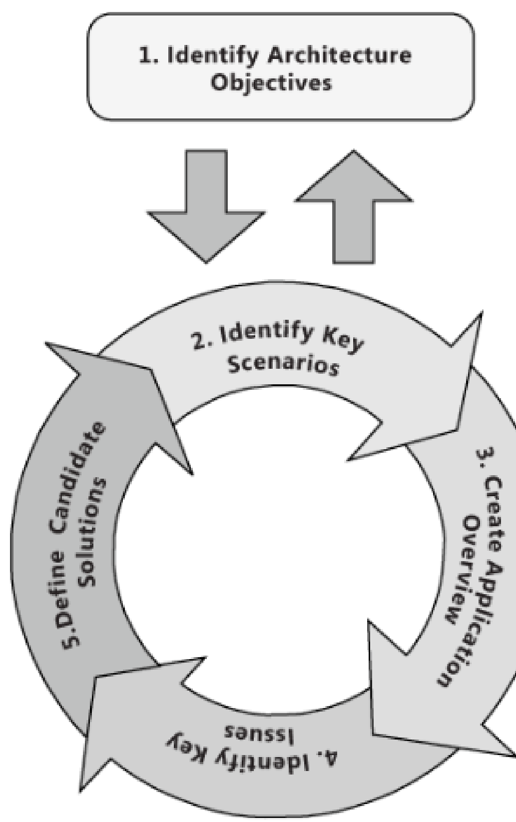

Figure 5 MSDN Methodology

3.3. Methods of Software Architecture Design

Based on MSDN's methodology (Microsoft, 2009) and inline with our five step scientific method recipe above, here is a five step recipe for software architecture design and development:

3.3.1. Objectives

"Objectives" is the discovery first phase. It includes identification of Architecture Objectives [discovery, research, and formulation of principal problem]: scope and time; identify goals, consumers of architecture, and constraints; formalize functional, non-functional, and technical requirements, the target deployment environment, and other constraints.

3.3.2. Key Scenarios

"Key scenarios" is the conjecture or hypothesis second phase. It includes Architecturally Significant Use Cases [hypothesis with explanation].

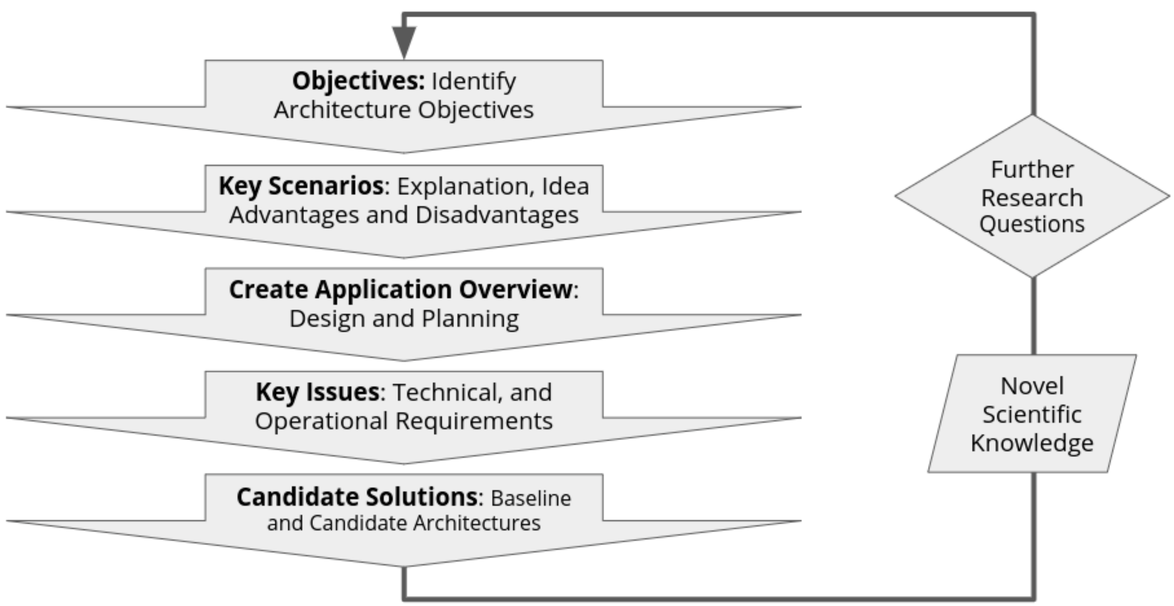

Figure 6 MSDN Software Architecture Scientific Method Flowchart

3.3.3. Application Overview

“Application overview” is the planning and design third phase. It includes relevant technologies, whiteboarding your architecture [predictive model; input ⇒ output]: baseline and candidate architectures, architectural spikes, what to do next.

3.3.4. Key Issues

“Key issues” is the operations fourth phase. It includes quality Attributes, Crosscutting Concerns; Designing for Issue Mitigation: [evaluation, experimentation, and/or observation]. Critical business requirements; quality attributes.

3.3.5. Candidate Solutions

“Candidate solutions” is the reporting fifth phase. It includes baseline and candidate architectures, architectural spikes; what to do next; reviewing your architecture.

3.4. The Scientific Method and Research Methods in Sociology

These are two sociological terms that can be confused by non-sociologists. Sociology, like every other science, aims to apply the scientific method to study social groups, behavior, and interactions. The scientific method steps in sociology are not different from any other science. In Figure 7, we show the five steps: discovery, hypotheses, planning, operations, and reporting as applied to sociology.

But there is the challenge of difference between animate human behavior and inanimate physical behavior (please review Chapter One, Section 1.1.). In the physical sciences, the researcher is dealing with empirical data that can be quantified. In the social sciences, the sociologist is dealing with human group behavior that is very complex. It includes qualitative and quantitative data. It happens mostly in the real world (because there are very stringent limits on subjecting humans and most animals to laboratory experiments). It is plagued with biases. And there are large numbers of known and unknown variables. How do you apply the scientific method (originally invented to experiment with or observe physical objects behavior with quantitative data) to qualitative human behavior?

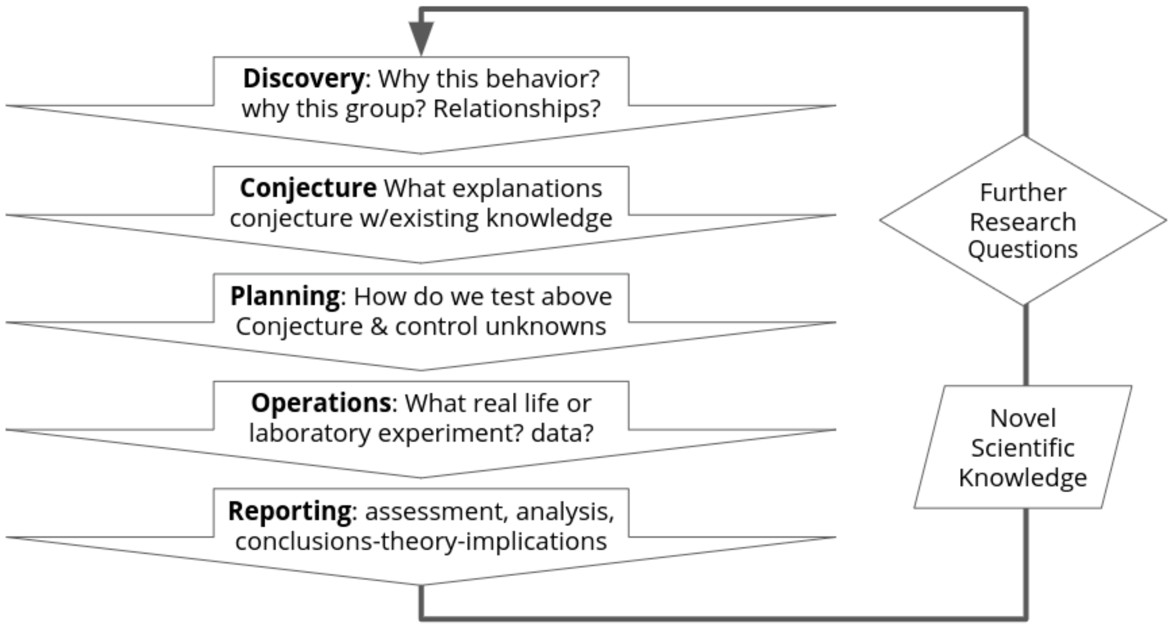

Figure 7 Sociology Scientific Method Flowchart

Sociologists have innovative ways to address this challenge. First, the sociologist must know the type of data available for this research. It could be qualitative, quantitative, or a mix of the two. Second, the researcher must also determine if he/she will have primary or secondary source data. Third, because of the vastness of unknown variables in social behavior, there is a lot of subjectivity in sociology. This means that sociologists would rely on professional sociological opinions versus universally accepted scientific theories. But subjective opinions carry within them social epistemology and cultural values than are biased. Sociologists developed several methodical approaches to these challenges. They are referred to as “research methods in sociology.” Think of it as the scientific method in sociology coming in shades of gray (as illustrated by Figure 2.4.2).

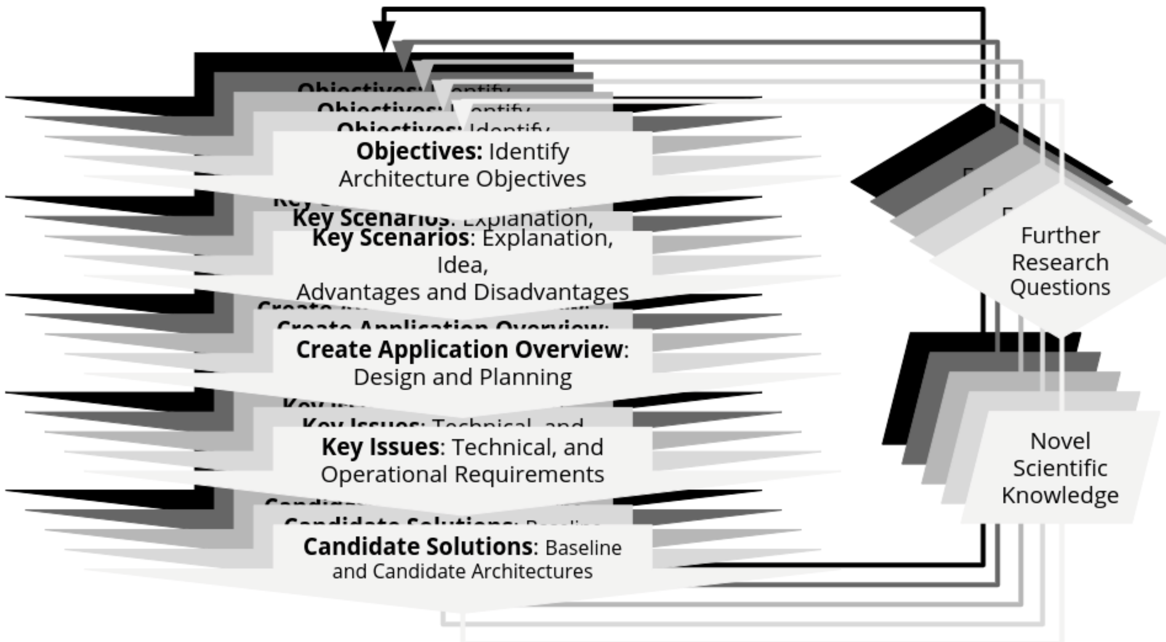

Figure 8 MSDN Software Architecture Scientific Method Flowchart

For the application of the scientific method, sociologists have developed six major, primary, and different tracks for research methods in sociology (Thompson, 2016).

1. Social surveys
2. Interviews
3. Experiments
4. Participant observation
5. Ethnographic and case studies
6. Existing data

The sociologist researcher should be aware of the research method that will be possible. He/she must select the appropriate method approach for his/her social inquiry.

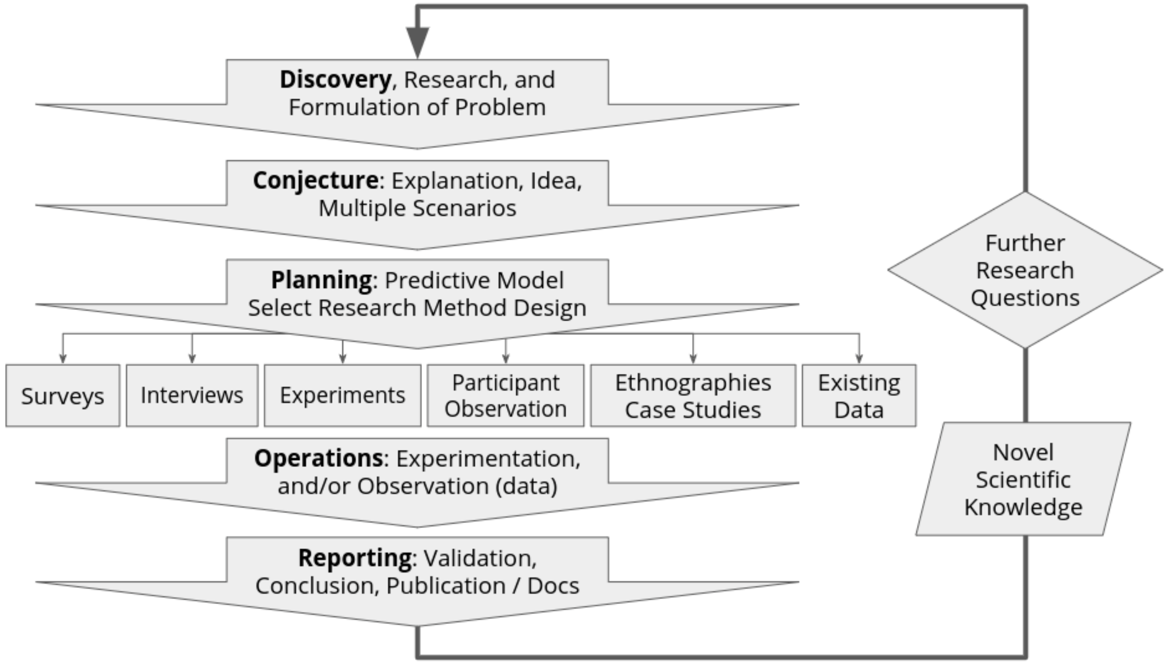

Figure 9 Research Methods in Sociology/Scientific Method Flowchart

3.4.1. Social surveys

Social surveys are planned and organized activities that involve the study and prediction of large group behavior. Most commonly, social surveys collect data through methods of questionnaires and/or structured interviews. Good examples are political elections, public opinion, and marketing surveys. Surveys use statistical sampling techniques to validate the representation of the survey sample to the larger populations. The populations can be defined by many parameters such as gender, ethnicity, age, demographics, lifestyle, or affiliation groupings. Surveys are a widely used application development. Sociological methods can be integrated to make these surveys much more powerful and effective tools for the collection and analysis of social groups and identification of their sociological requirements.

Social surveys are a good research methodology in sociology to synthesize and fit for the development of sociological requirements. Software developers are very familiar with surveys and reviews to collect response data. However, they can benefit greatly from sociological methods to empower their application with sociologically enhanced social surveys.

3.4.2. Interviews

Interviews are conducted by the researcher or the SSA developer. There are three types of interviews (Briggs, 1986). Because the researcher interacts with the participant to conduct the interview, human bias interference can happen. To eliminate bias and errors, the researcher needs to apply anti-bios sociological techniques. Additionally, the researcher could face interview structure biases.

3.4.2.1. Structured interviews

Structured interviews are designed to have an exact interview process with every interview participant. The sameness of the interview structure helps control interview design biases. Interviews ask the same questions and present them in the same order.

3.4.2.2. Unstructured interviews

Unstructured interviews are designed to give the interviewer freedom in conducting the interview. But normally, they cover the same topics in mind and seek to identify the sociological requirements for SSA development. There is more room for bias and errors. However, they give the researcher more freedom to understand and report on their participants. Unstructured interviews are more useful in smaller sample studies. If you want to interview the CEO of a company, unstructured interviews are a better tool. The CEO's opinion in forming sociological requirements weighs much more than other company stakeholders.

3.4.2.3. Semi-structured interviews

Semi-structured interviews are a hybrid of the above two. The researcher has an interview guide and a set of questions but wants the freedom to ask the questions in different ways with different participants. These are informal interviews.

Structured interviews are very appropriate research methods in sociology to be synthesized for the development of sociological requirements. Unstructured and semi-structured interviews are less useful and more challenging to synthesize.

3.4.3. Experiments

Experiments are conducted when the researcher has dependent and independent variables and wants to measure the effect of a treatment on independent variables. These experiments can either be done in a laboratory or field environment. Laboratory experiments are done in a controlled environment. Field experiments are done in the real world, such as the workplace, school.

Experiments are good research methods in sociology to be synthesized with software development and for the development of sociological requirements. SSA developers can empower their applications with these sociological methods, techniques, and experiences.

3.4.4. Participant observation

This research technique is used by researchers who participate and interact in the real world social group setting. The researcher gains membership (or the right to participation) in the group which, in most cases, is an alien group to the researcher. This technique is used when the researcher wants to have direct access to the internal structure, norms, interactions, and dynamics of the group. This helps the researcher better understand social behavior and sociological requirements.

This research method in sociology is least applicable for the development of sociological requirements. Hence, it will not be included in the synthesis of scientific methods.

3.4.5. Ethnographic and case studies

Ethnographic studies originated in anthropology. They are useful for studying smaller groups. Case studies are “a process or record of research into the development of a particular person, group, or situation over a period of time” (LEXICO, 2019).

3.4.5.1. Ethnographics

Ethnographic studies are qualitative. They allow the researcher to study, over a period of time, the internal structure, culture, norms, belief systems, interactions, and behavior of the group.

This research method in sociology is least applicable for the development of sociological requirements. Hence, it will not be included in the synthesis of scientific methods.

3.4.5.2. Case studies

Case studies rely on a single case where the researcher has more control of the entire case and data collection. This control allows for detailed observation, testing, modification, and development over extended time periods.

3.4.5.3. Longitudinal studies

This method of study allows the researcher to revisit the subject group and collect data repeatedly.

Case and longitudinal studies are good research methods in sociology to be synthesized with software development and for the development of sociological requirements. SSA developers can empower their applications with these sociological methods, techniques, and experiences.

3.4.6. Existing data

Thanks to the IT revolution, the collection of data is experiencing exponential growth. It is called the Cambrian Explosion of Data. The term “Cambrian Explosion” (Marshall, 2006) refers to an event that happened 541 million years ago. In the Cambrian period, there was a dramatic increase in the number of animals. The following graph shows the Cambrian Explosion of Data (Rizzatti, 2016). Existing Data availability makes it easier to use for the development of sociological requirements.

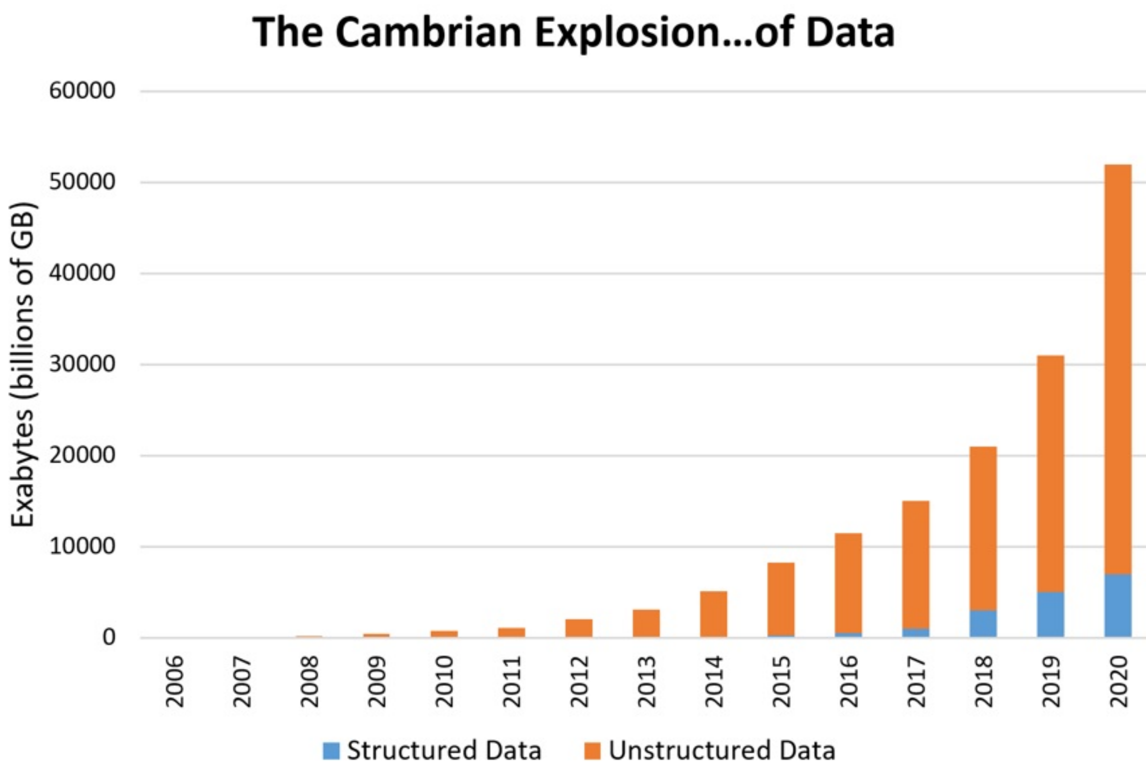

Figure 10 The graph shows the growth curve of data from 2006-2020

Source: Patrick Cheesman

3.5. Synthesis of Methods of Sociology of Software Architecture

In our synthesis of methods of Sociology and Software Architecture to create SSA methods, we will create a five step process: discovery, conjecture, planning, operations, reporting. This will run parallel to MSDN's SA methodology steps: objectives, key scenarios, create application overview, key issues, and candidate solutions. Then we build in a parallel column the process for sociological requirements development. Our focus is on defining our social groups or stakeholders and developing our sociological requirements running parallel to technical, functional, and nonfunctional requirements and restrictions. From the above research methods in sociology, we have removed participant observation and ethnographic methods.

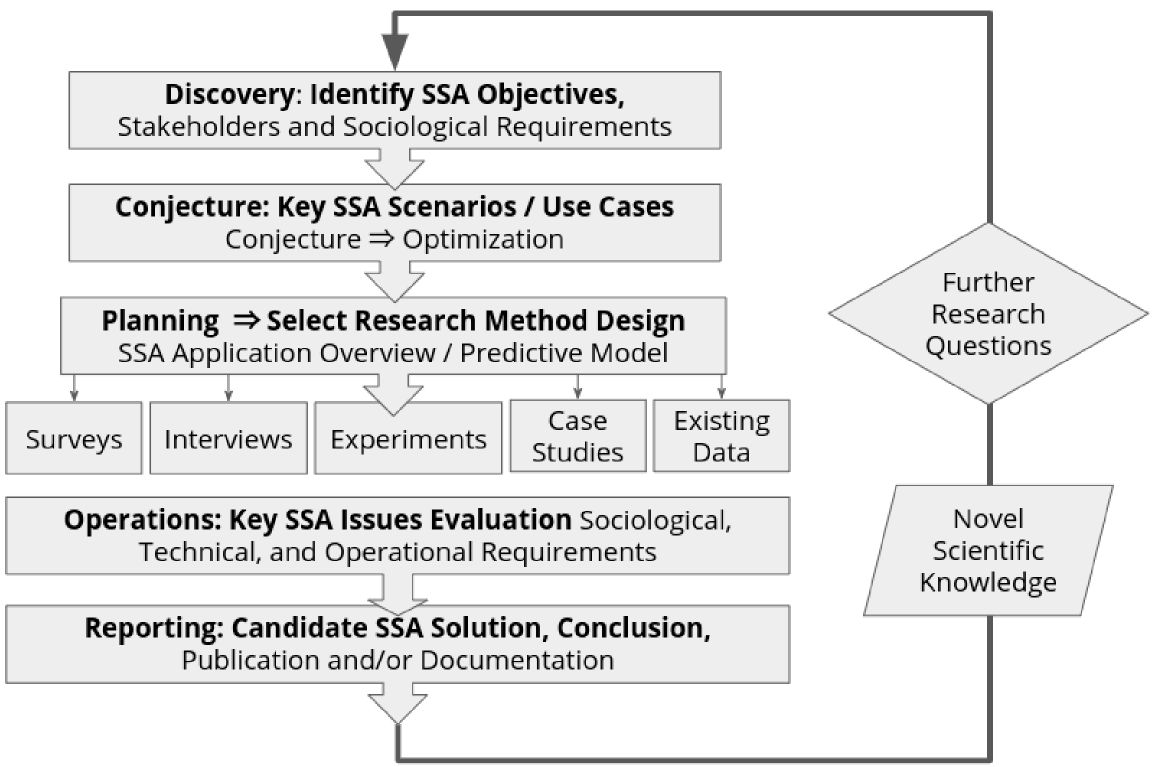

Figure 11 Synthesis of SSA Scientific Method Flowchart

3.6. Traditional MSDN SA Model Synthesis: Sociological Research Design

The SSA developer needs to become minimally familiar with sociological research methods. This investigation aims at the synthesis and integration of the sociological methods with the SA methods to produce the SSA methods. However, we will be adding extensive references.

How will the SSA design produce the desired solution and satisfy the sociological requirements?

This will be developed in parallel steps with the MSDN design steps example. This synthesis model can be applied to other traditional SA models. The following table synthesizes SSA development in parallel path with traditional MSDN SA development.

In the next five tables (3.6.1. to 3.6.5.) we synthesize the two methods software architecture and sociology along the common rail of the scientific method (discovery, conjecture, planning and design, operations, and reporting).

Traditional MSDN SA (Microsoft, 2009) (Figure 5)	**SSA** (Sociology of Software Architecture)
1. Identify Architecture Objectives	Discovery
2. Identify Key Scenarios	Conjecture
3. Create Applications Overview	Planning and Design
4. Identify Key Issues	Operations
5. Define Candidate Solutions	Reporting

In the next Section 3.6.1., we pair “Discovery” with “Identify Architecture Objectives.”

3.6.1. **Discovery**: Identify Architecture Objectives

There are two ways to develop sociological requirements. It can either (first) be developed in parallel with SA requirements or (second) after a full SA plan is initially completed. The first is better optimized. The second is easier. For new SSA developers, we expect the second will be more popular. After few experiences, the first will become easier and more optimal.

Traditional MSDN SA (Microsoft, 2009)	**SSA** (Sociology of Software Architecture)
Discovery, Research, and Formulation of Principal Problem Asking the right questions you intend to answer in research	
Identify technical, functional, and nonfunctional requirements (Bushkin, 2013),	Identify **social groups** (stakeholders) and **sociological requirements** Qualitative or quantitative data? Primary or secondary data? Objective or subjective? Method(s) of research in sociology? 1. Social surveys 2. Interviews 3. Experiments 4. Case studies 5. Existing data
Literature review, research case study, discover the client's goals and objectives, gather and evaluate data, conduct history, descriptive and historical analytics, ask relevant questions, and identify problems.	
Identify (1) your architecture goals at the start; (2) who will consume your architecture;	

(3) your constraints; and (4) scope and time.
Target deployment environment (technical, operational, and **social**)
Review related literature review and research; ask good questions
Hypothesis with Explanation: Multiple Scenarios (Kazman, *et al.*, 1996) ⇒ Optimization An intelligent and educated guess explaining causal relationship between independent and dependent variables

Table 1 Synthesis of traditional MSDN and SSA: Discovery

The green box above is our focus for SSA development. At this stage we want to discover and identify our sociological ("social groups") stakeholders and start defining our sociological requirements. Our sociological stakeholders maybe similar to SA stakeholders and may differ. SA stakeholders look at it primarily for an application user perspective and the laws that apply to technical development (i.e. security, privacy, etc.). "Sociological groups" expands beyond SA stakeholders. It looks at the entire social structure and identifies social groups that are dialectically engaged, directly or indirectly, with the application deployment. These groups are divided into two types: those that gain benefits and those that lose benefits. The benefits could be material or social (ethinic, gender, race, socioeconomic class, political, economic, business, legal, etc.). Once we discover all our social groups, we want to quantify and prioritize them. We need to devise a way to measure their material and social impact. We also need to check for conflicts of interest and priorities.

The second major issue to discover is data. For most SSA developers, qualitative data is not an option. You need quantitative data. Look into primary and secondary sources of data. With the help of data science, you might be able to find innovative solutions that most sociologists can't reach.

The third major issue is objectivity versus subjectivity. If the SSA developer is captive to a company's CEO or team subjective (may be advanced and innovative entrepreneurial ideas), you live by it. But if you can ground your research in objective science that is supported by much data, experiments, and professional opinions, you may discover very beneficial knowledge. This can propel your project forward at very rewarding speed.

The fourth major issue is what options in the SSA research methods in sociology do you have? The SSA research methods in sociology are narrowed to five options: social surveys, interviews, experiments, case studies, and existing data. Investigate how you can enhance and empower existing software application survey techniques with sociological methods, techniques, and experience. Look into using third party interview services that may give you quick access to social group thinking. If you want to dive into qualitative data, examine "focus group" research methods (Kitzinger, 1995). Explore conducting virtual experiments with machine learning methods and techniques. Case studies (Feagin, Orum, and Sjoberg, 1991; and LEXICO, 2019) can be very useful to use as templates, model after, emulate, build on top, or learn from. Last, but not least, discover the Cambrian Explosion of Data sources available. Existing data can be a very useful and cost effective solution for discovering patterns, relationships, or correlations in sample groups. Statistically representative samples (good size and random) can provide a quick discovery of the sociological requirements of the target social group population.

In the next Section 3.6.2., we pair "Conjecture" with "Identify Key Scenarios."

3.6.2. **Conjecture**: Identify Key Scenarios

Traditional MSDN SA (Microsoft, 2009)	**SSA** (Sociology of Software Architecture)
Business critical: The use case has a high usage level or is particularly important to users or other	**Social** critical: Development of SSA Model (see next section) Positioning of social groups

stakeholders when compared to other features, or it implies high risk.	Parallel development to business model: Consumer centric model? Disruptive? Compliance? Pricing? 3rd party market players?
Architecturally Significant Use Cases (Rouse, 2019): High impact	**Sociologically** Significant Use Cases: High impact

How multiple different scenarios can lead to optimal results / resolution
Predictive Model: Select Research Method (A research method is your plan for conducting your research, validating the relationship and/or causality between the independent and dependent variables, and proving your hypothesis.) and Research Design (Research design: the plan for conducting your study. Method Design: the sequential and systematic steps to be implemented to validate the relationship (causality) between independent and dependent variables.) Determine your model, approach, and techniques

Table 2 Synthesis of traditional MSDN and SSA: Conjecture

In the hypothesis formulation phase, we contemplate and conjecture social group patterns of behavior, causality, influence, hierarchy, social structure, social conflict and cohesion, social inefficiencies, and their possible explanations. We need to position the social groups pro and against, relevance, importance, and competing interests.

In the next chapter we introduce models that can help the SSA developer approximate the social structure and relationships between the social groups. Since most SA development is happening in a business environment, the SSA developer needs to coordinate, collaborate, and develop sociological requirement conjectures in parallel paths with business goals and objectives. The SSA developer needs to be aware of whether his/her project is consumer-centric. If not, will sociological research and requirements tip the balance in favor of a consumer centric model?

Since consumers are the largest social group population, their position in the development process should be very high in importance. Disruptive technologies should be weighed carefully for their social impact. We need to predict the social impact of technological disruptions. What social compliance applies to this application? Social compliance is not easily defined, compared to technical compliance. The CFPB (Consumer Finance Protection Bureau) has a lot of power to interpret what might constitute a violation of consumer protection. Social compliance, like sociology, inclines to be more qualitative and subjective. Getting subjective legal or institutional opinions becomes relevant. Instead of hypothesizing about social compliance, the SSA developer needs to create scenarios and get professional legal, business, or marketing opinion.

High impact and sociologically significant use cases help illustrate the benefits and costs of sociological requirements. A “use case” is “a specific situation in which a product or service could potentially be used” (LEXICO, 2019) Technopedia defines a use case as follows: “A use case is a software and system engineering term that describes how a user uses a system to accomplish a particular goal. A use case acts as a software modeling technique that defines the features to be implemented and the resolution of any errors that may be encountered” (Techopedia, 2019). IBM defines a use case as “ built to refine a set of requirements based on a role or task” (IBM 2016) SSA developers need to include their sociological requirements based on social group roles, behavior patterns, and predicted interactions.

In the next Section 3.6.3., we pair “Planning and Design” with “Create Application Overview.”

3.6.3. **Planning**: Create Application Overview

Traditional MSDN SA (Microsoft, 009)	**SSA** (Sociology of Software Architecture)
1. Determine your application type. 2. Identify your deployment constraints. 3. Identify important architecture design styles. 4. Determine relevant technologies.	**Sociological Methods** 1. Identify how you are going to collect your sociological data. 2. Choose theoretical framework and assumptions. 3. Outline your validity and reliability parameters.
	Methods of Reasoning: 1. Inductive logic (looking at data and inferring a model, theory, or framework from it.) or 2. Deductive logic (starting with a model, theory, or framework and test if the data fits).
Baseline and candidate architectures, architectural spikes	**Mixed research methods** 1. Quantitative 2. Qualitative 3. Mixed

	4. Naturalistic inquiry (Lincoln and Guba, 1985) 5. Historical 6. Comparative 7. Statistical
Whiteboard Your Architecture Including SSA Design Model	
Experimentation, and/or Observation (data)	

Table 3 Synthesis of traditional MSDN and SSA: Planning

In the SSA planning phase, we need to address the following: sociological data types and collection, sociological theory framework selection with axioms and assumptions, and validity and reliability parameters. In Chapter Three we introduce approaches, models, and techniques for data management and social theory framework approach. In Chapter four, we address the issues of validity and reliability requirements.

In the next Section 3.6.4., we pair "Operations" with "Identify Key Issues."

3.6.4. **Operations**: Identify Key Issues (requirements)

Traditional MSDN SA (Microsoft, 2009)	**SSA** (Sociology of Software Architecture)
Quality Attributes: • System qualities. • Run-time qualities. • Design qualities.	**Social Group Attributes**: • Segmentation • Clustering • Attributes

<table>
<tr>
<td>

- User qualities.

Crosscutting Concerns;

- Authentication and Authorization.
- Caching.
- Communication.
- Configuration Management.
- Exception Management.
- Logging and Instrumentation.
- Validation.

Designing for Issue Mitigation:

- Auditing and Logging.
- Authentication.
- Authorization.
- Configuration Management.
- Cryptography.
- Exception Management.
- Input and Data Validation.
- Sensitive data.
- Session Management.

</td>
<td>

  - Demographics,
  - Psychographics,
  - Lifestyle,
  - Social Media Activity,
  - Financial Information,
  - Etc.
- Behavior scores

Crosscutting Concerns (i.e.):

- Privacy
- Confidentiality
- Compliance
- Sharing of Data
- Communication media

Designing for Issue Mitigation (i.e.):

- Payment Processing
- Refunds
- Anonymity
- Reporting
- Referral

</td>
</tr>
<tr>
<td colspan="2">Critical business requirements;</td>
</tr>
</table>

Collection of data and prototyping the model.
Evaluation, Conclusion, Publication, and Documentation
Reviewing and Evaluating Your Architecture

Table 4 Synthesis of traditional MSDN and SSA: Operations

In SSA operations step we are focused on running experiments and collecting data. Examples of quantitative experiments are virtual machine learning studies and statistical samplings from hypothetical data modeling. Qualitative experiments may include focus groups and tele-interviewing a sample group. Unstructured or semi-structured interviews can help us understand influential decision makers, market players, and social activists and leaders. Social survey techniques can enhance any survey application. Longitudinal studies allow us to create virtual focus groups and visit them regularly to measure progress. In all of the above, we need to clearly define and quantify (whenever possible) our population segments, clusters, attributes, and behavior scores. Attributes include demographics, psychographics, lifestyle, social media activity, financial information, etc.

Additionally, similar to SA operations, the SSA developer needs to address crosscutting concerns and issues that require mitigation.

In the next Section 3.6.4., we pair "Reporting" with "Define Candidate Solutions."

3.6.5. **Reporting**: Define Candidate Solutions

Traditional MSDN SA (Microsoft, 2009)	**SSA** (Sociology of Software Architecture)
Scenario-Based Evaluations ● Software Architecture Analysis Method (SAAM).	**Mixed-Method Evaluation Designs (Greene, Caracelli, and Graham, 1989; and Caracelli and Greene, 1993)**

• Architecture Tradeoff Analysis Method (ATAM) • Active Design Review (ADR). • Active Reviews of Intermediate Designs (ARID). • Cost Benefit Analysis Method (CBAM). • Architecture Level Modifiability Analysis (ALMA). • Family Architecture Assessment Method (FAAM). **Representing and Communicating Your Architecture Design** • 4+1. • Agile Modeling. • IEEE 1471. • Unified Modeling Language (UML)	• Theoretical Review • Empirical Review Purposes for mixed-method evaluation designs: • Triangulation (Jick, 1979; Hales, 2010; and Hussen 2009) • Complementarity, • Development, • Initiation, and • Expansion **Design Methods (Creswell and Creswell, 2017)** 1. Concurrent (Conger and Killeen, 1974) 2. Triangulation Design (Morse, 1991) 3. Embedded Design 4. Transformative (sequential and concurrent) Design **Data Analysis/Validation (Creswell and Creswell, 2017)** **Sociological Evaluations (Patton, 2005; Cole and Cole, 1971; and Giorgi, 1997)**
Baseline (existing system) and Candidate (new) Architectures	

Architectural Spikes (An *architectural spike* is a test implementation of a small part of the application's overall design or architecture. The purpose is to analyze a technical aspect of a specific piece of the solution in order to validate technical assumptions, choose between potential designs and implementation strategies, or sometimes to estimate implementation timescales.) (Microsoft, 2009);
Give clear documentation to software developers. Show gained knowledge; ask more questions for future development.

Table 5 Synthesis of traditional MSDN and SSA: Reporting

The reporting step can be divided into two sections or substeps: (1) Data analysis, evaluation, and conclusions and (2) documentation. The researcher should conduct theoretical and empirical reviews. Furthermore, sociology offers several valuable evaluation techniques. These will be covered more extensively in Chapter Four. This will be an opportunity to explain many of the sociological terms, methods, and techniques introduced above.

3.7. Words of Scientific Wisdom

In 1812, four men at Cambridge University, Charles Babbage (1791), John Herschel (1792), Richard Jones (1790), and William Whewell (1794), met for breakfast. What began as an impassioned meal grew into a new scientific revolution, in which these men, called themselves "natural philosophers" until they later coined the term "scientist" (at the third meeting of the British Association for the Advancement of Science, Cambridge, June 24, 1833). This was the first time in history the term “scientist” had been used, instead of “natural philosopher” which was protested by Samuel Taylor Coleridge. Historian and philosopher Laura Snyder, in her book The Philosophical Breakfast Club, says, “Coleridge felt that true philosophers like himself pondered the cosmos from their armchairs. They were not mucking around in the fossil pits or conducting messy experiments with electrical piles like the members of the British Association” (Snyder, 2011). Ever Since, the term “science” meant “empirical science” instead of the previous general meaning of science as knowledge. The group also introduced four major principles into scientific inquiry.These four men introduced a new science belief system with four major changes to science:

1. Inductive, Evidence-Based (Scientific) Method
2. New Scientific Societies (British Science Association)
3. External Funding of Science
4. Science for Public Good

In 1733, Voltaire (the French philosopher) introduced Francis Bacon (1561-1626) as the “father” of the scientific method (Gaukroger, 2001). The majority of historians contend that al-Haytham pioneered the modern scientific method (Gorini, 2003). More recent research points to Ibn al-Haytham (965-1040), also known in the West as Alhazen, as being the father of the scientific method and the first “scientist” (Moen and Norman, 2006). He is definitely the “father” of optics. In doing our own further research, we wanted to find out the real “father” of the scientific method, and hence the first real “scientist.” Our research lead to Jabir ibn Hayyan (721-815) (Stoddart, 2009). He was also known in the West as Geber. His writings were difficult to understand from Arabic to European languages; hence the term “Gibberish” (MWD, 2019)

Jabir ibn Hayyan’s corpus, according to Ibn Al-Nadim (Al-Nadim, 1988, p. 355-358), included the publication of hundreds and possibly up to three thousand books and scientific paper covering many sciences and lots of experiments. Ibn Hayyan is the father of modern chemistry and invented many of the methods and tools still used today in chemistry labs. We researched the wisdom of the scientific method with Jabir ibn Hayyan and discovered the following quotes:

1) Jabir Ibn Hayyan says that the mastery and perfection of science is in its application and experiments. He further elaborates that he who does not apply and experiment with science gains absolutely nothing”(Najib, 1962).

2) “Don’t apply or experiment until you have learned the science. You must know the body of knowledge from beginning to end with all its techniques and reasoning, then you attempt experimentation”(Najib, 1962).

3) “You should never conduct experiments until you have truly studied the subject. You should know everything about the subject from beginning to end with all the available methods and possible pitfalls. Then you should plan and conduct your experiment. You shall find that experimentation brings perfection to ilm (knowledge - science)” (Mousa, 1988, p. 126 and 127).

4) After mastering the science, understanding its reasoning, learning and applying its techniques, and researching your subject of next research thoroughly, Jabir explains his scientific method as follows (Najib, 1962):

    a) The scientist should develop from his research a hypothesis that explains the phenomenon under examination.

    b) The scientist should predict, based on her/his hypothesis, the results that would confirm the scientific and theoretical framework.

    c) The scientist then should go back to nature to see if it validates or negates his predictions. If validated, then The scientist has a scientific law on which he can depend that would help him predict what will happen if the same circumstances occur again.

5) “He who is well trained (in the methods of science) is a true scientist; and he who is not trained, is not a scientist. A quality of good scientific training is an intelligent guess; he who is not trained, failed to make intelligent guesses” (Kraus, 1935, p. 464).

6) “You should know that we write in these titles the qualities of what we have seen, and exclude what we heard, was said to us, or we read. We write it after conducting tests and experiments: We accept what is confirmed by experiment and reject what

was refuted. We also write our conclusions and we compare them with what others say" (Kraus, 1935, p. 232).

3.8. Conclusion

Chapter Two synthesized and developed SSA methods in parallel steps with traditional MSDN SA methods. We used our simplified sequence of scientific method steps: discovery, conjecture, planning, operations, and reporting. Then we corresponded sociological steps with software architecture steps: objectives, key scenarios, application overview, key issues, candidate solutions. This SSA methodology should serve as a good planning guide for developing SSA methods. we have also introduced many sociological concepts and terms with extensive reference but not much explanation. In the next two chapters, we will focus on the many approaches, models, and techniques used. We will also explain the main and most useful sociological terms and concepts used in SSA methodology.

PART II: SSA DEVELOPMENT, APPLICATION, AND ASSESSMENT

Chapter Four

SSA Toolbox Development: Approaches

Types of Synthesized Approaches: Worldview

4.1. Introduction

Approach is a way “to deal with something,” or “a way of dealing with a situation or problem,” or “start to deal with (a situation or problem) in a certain way,” or “to take preliminary steps toward accomplishment or full knowledge or experience of.” SSA approaches are about developing ways especially for SSA architects, developers, team practitioners, or companies to view, qualify (define), and quantify (measure) the development of sociological requirements. Approach is an artistic or scientific way to start a project. It refers to either the social epistemology of thinking, the worldview from which the researcher views a project, the theoretical sociology framework that helps explain social behavior, the empirical data approach, and/or the way of reasoning (inductive versus deductive logic).

This first section reviews interdisciplinary approaches. It evaluates and compares their application, and synthesizes and develops SSA approaches for SSA development projects. You can understand the difference between SA approaches and sociological approaches by comparing the discipline’s ability to predict its object’s behavior. For example: a physicist can predict the behavior of stars, planets, and moons with great precision far into the future; a sociologist cannot do the same to predict the behavior of social groups. This is due to the nature of epistemological and theoretical frameworks, and the empirical data collection and measurement of tolerant animate social behavior versus rigid inanimate behavior.

In software terms, algorithms for inanimate behavior are simple compared to algorithms of social behavior. This is because of intelligence, intent, choices, ability to hold back or delay reaction, and much more. Sociological data is much more complex and has exponentially more unknown than known variables. When known, the data is more qualitative than quantitative. Applying empirical methods in sociology is significantly more challenging that in software development. This is why sociologists differ more over the fundamental nature of human social group behavior than SA architects and developers differ on the fundamental nature of software or application behavior. Software developers working with artificial intelligence have a better appreciation of the above facts. Attempting to emulate human intelligence in software is extremely challenging.

In software development, the developer's personal, social, religious, language, history, and/or cultural views and biases have little impact on architecting technical and operational requirements. But to architect sociological requirements, these views and biases could have great influence on development. Hence, there is a need to learn proper sociological approaches that insure academic, scientific, and professional investigation, thinking, methodology, and application.

How does the SSA developer approach the development of sociological requirements? In sociology, the developer must be very aware and conscious of how she/he views social issues. She/he should be aware of their social epistemology and how it may differ from the audience's social epistemology. SSA developers should adopt a well defined worldview approach. They should state clearly the theoretical framework used, define it assumptions and axioms, and articulate its findings in sociological requirements. Furthermore, the SSA developer should choose an appropriate SSA empirical data approach. Software developers are rarely exposed to qualitative data. SSA developers find it easier to deal with quantitative data because they are used to it. But dealing with social behavior opens up a pandora's box of qualitative data. SSA developers will sometimes find themselves dealing with real world projects with qualitative data. They should expect some of it and know how to approach it.

Lastly, they should also carefully select their inductive and/or deductive logic and reasoning approach.

The absence of a dominating theoretical framework in sociology leads sociologists to rely on a variety of different philosophical assumptions, axioms, and foundations on which they can build their theoretical frameworks. Hence, there are many theoretical frameworks in sociology to choose from as a foundation for any sociological research. There are two major theoretical frameworks in physics today: quantum physics and relativity. And most physicists believe that there must be a single theoretical explanation that combines them and all physics into one. In the social sciences, we are at the stage where the number of theoretical frameworks is increasing. There is no social science singularity on the horizon. Hence, choosing a sociological theory framework approach is relevant to SSA development. The next challenge is worldview approach. We introduce Cresswell's four worldview approaches (Creswell and Creswell, 2017) are: Postpositivism, constructivism, advocacy/participatory, and pragmatism. These worldview approaches are intended to make the SSA developer more conscious and aware of their approach and theoretical framework.

4.2. Types of sociological approaches?

There are five interdisciplinary approaches that can be useful for and synthesized with SSA approaches:

1. Social epistemology approach
2. Worldview approach
3. Sociology theory framework approach
4. Empirical data approach
5. Logic and reasoning approach

4.2.1. Social epistemology approach

Epistemology is the study of how we know what we know. It is “the study or a theory of the nature and grounds of knowledge, especially with reference to its limits and validity” (MWD, 2019) It is “the part of philosophy that is about the study of how we know things” (CED, 2019). It is “the theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion” (LEXICO, 2019). Justified belief is two types: universal and social. The universal belief is justified across human societies vertically (over time) and horizontally (across languages, cultures, belief systems, and geography). The social belief is justified within a social group who believes it is a universal human belief. In other words, the social group develops “justified” beliefs, projects them on all humans, thinks that these beliefs are universal in nature, and that they should apply to every human being.

“Social epistemology is the conceptual and normative study of the relevance to knowledge of social relations, interests and institutions” (Schmitt, 2019). It is “the study of the social dimensions of knowledge or information” (Goldman, 2006). Religious belief systems are a good example of social epistemology. The social sciences, also, are a good example of social epistemology. On the other hand, the physical sciences are a good example of universal epistemology. Since the SSA developer is developing the sociological requirements for his/her project, she/he should be aware of the social epistemology of the targeted audience. For example, globalization through the internet is projecting Western social epistemology knowledge on non-Western audiences. Social networking applications are Westernizing non-Western audiences around the world. Is this a good or bad thing? It depends. The point we wish to emphasize here is that the SSA developer should be aware of the social epistemology she/he is projecting on other non-Western societies, or visa versa. If the assessment is to maintain a Western approach (i.e. because it is a desirable thing and it promotes the causes and/or interests of the developers), then it will be consciously applied. But there are instances where an approach modified to the audience’s social epistemology might be more optimal. Then the SSA developer will make a conscious development effort to adapt to the audience's social epistemology.

We have identified the following social attributes to help the SSA developer identify and discover the social epistemology of the targeted audience:

1) Language
2) Time/modernity
3) Geography
4) Social interaction systems and norms: inter and intra social
5) Socio-economic development
6) Knowledge development
7) Religion
8) Ethics
9) Heritage
10) Asabiyyah: "Social solidarity with an emphasis on group consciousness, cohesiveness, and unity. Familiar in the pre-Islamic era, the term became popularized in Ibn Khaldun 's (d. 1406) Muqaddimah. Asabiyyah is neither necessarily nomadic nor based on blood relations. In the modern period, the term is analogous to solidarity" (OISO, 2019)

4.2.2. Worldview Approach

We introduce Creswell's Four Worldviews (Creswell and Creswell, 2017, p. 6):

Postpositivism	**Constructivism**
• Determination • Reductionism • Empirical observation and measurement	• Understanding • Multiple participant meanings • Social and historical construction • Theory generation

• Theory verification	
Advocacy /Participatory	**Pragmatism**
• Political • Empowerment Issue-oriented • Collaborative • Change-oriented	• Consequences of actions • Problem-centered • Pluralistic • Real-world practice oriented

Table 6 Creswell's Four Worldviews

"**Postpositivism** reflects a deterministic philosophy in which causes probably determine effects or outcomes." (Creswell and Creswell, 2017, p. 7). This worldview represents the traditional form of research using the scientific method and empirical assumptions. Hence, it is more supportive of quantitative versus qualitative methods.

"**Social constructivists** hold assumptions that individuals seek understanding of the world in which they live and work. Individuals develop subjective meanings of their experiences—meanings directed toward certain objects or things" (Creswell and Creswell, 2017, p. 8). This approach is more supportive of qualitative research.

"**An advocacy/participatory worldview** holds that research inquiry needs to be intertwined with politics and a political agenda. Thus, the research contains an action agenda for reform that may change the lives of the participants, the institutions in which individuals work or live, and the researcher's life." This worldview approach "arose during the 1980s and 1990s from individuals who felt that the postpostivist assumptions imposed structural laws and theories that did not fit marginalized individuals in our society or issues of social justice that needed to be addressed. This worldview is typically seen with qualitative research, but it can be a foundation for quantitative research as well" (Creswell and Creswell, 2017, p. 9).

“**Pragmatism** as a worldview arises out of actions, situations, and consequences rather than antecedent conditions (as in postpositivism). There is a concern with applications—what works—and solutions to problems (Patton, 1990)” (Creswell and Creswell, 2017, p. 10). This worldview doesn’t restrict itself to a specific method, belief system, or a school of philosophy. It is pragmatic in its willingness to use any method that will help explain the behavior under investigation in research.

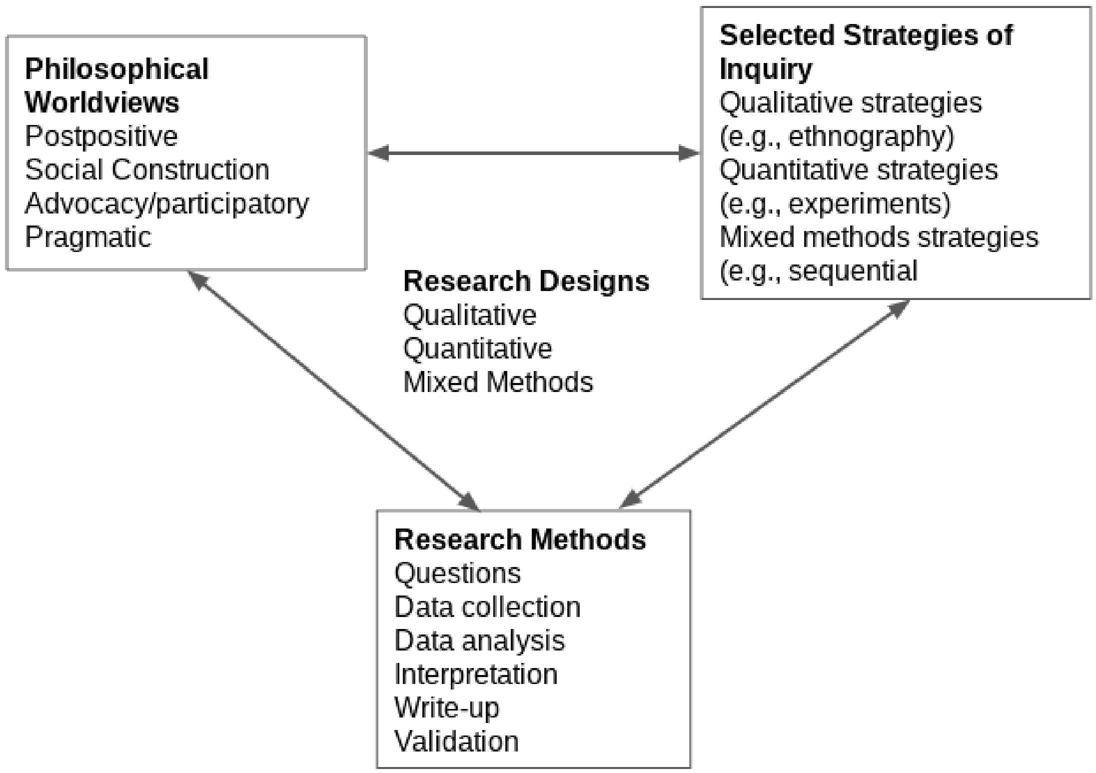

Figure 12 A Framework for Design—The Interconnection of Worldviews, Strategies of Inquiry, and Research Methods

4.2.3. Sociology Theory Framework Approach

There are several useful sociology theory frameworks that can be very helpful in defining your sociological requirements’ stakeholder groups. We will illustrate how we use and apply the three top sociology theory frameworks: Structural Functionalism, Symbolic

Interactionism, and Conflict Theory. These illustrations should serve as a guideline for the remaining theory frameworks.

4.2.3.1. Structural Functionalism

"What is software architecture? Software architecture involves

- the structure and organization by which modern system components and subsystems interact to form systems, and
- the properties of systems that can best be designed and analyzed at the system level" (kruchten, Obbink, and Stafford, 2006).

The key words (structure, organization, modern, system, component, subsystems, interact, etc) help us understand "structural functionalism."

Garlan & Shaw introduce software architecture as follows: "As the size and complexity of software systems increases, the design problem goes beyond the algorithms and data structures of the computation: designing and specifying the overall system structure emerges as a new kind of problem. Structural issues include gross organization and global control structure; protocols for communication, synchronization, and data access; assignment of functionality to design elements; physical distribution; composition of design elements; scaling and performance; and selection among design alternatives" (Garlan and Shaw, 1993). Looking at software architecture as a complex system structure and the "assignment of functionality to design elements" leads to an easier understanding of "Structural Functionalism" in sociology.

Structural Functionalism theoretical framework views society as a complex system whose components work together to achieve social stability and solidarity (Giddens, 1979). In almost the same breath, an SSA developer can look at software architecture as a complex system whose components work together to achieve optimal software performance. The commonality between the two definitions (system, structure, components, function of each component to make the whole system achieve optimal social/software stability and solidarity (compatibility, seamless integration, cohesiveness) can help the SSA developer with the project. If the SSA developers looks at the stakeholders as “social components”, this creates harmony in the development process.

> The mapping between **components** and **functions** could reveal the cohesion and coupling aspects of a ... scenario generation is closely tied to various types of objectives: stakeholder, architecture, and quality. ... The method has been applied to a telecommunication software system (Dobrica and Niemela, 2002).

For a different perspective on “functional analysis,” please look at Davis’ study. Davis concludes that: “Although functionalism may have been salutary at the time it arose, the ambiguities of its special terminology make the myth that it is a special method a liability now. It seems wise to abandon the myth for the sake of increased clarity and efficiency” (Davis, 1959, p. 757).

4.2.3.2. Symbolic Interaction Theory

If “structural functionalism” takes a “macro” approach to studying society, “symbolic interactionism” (Blumer, 1986) takes a “micro” approach; it looks on how people interact and how they interpret their interpretation (Becker and McCall, eds., 2009). “Herbert Blumer, a student and interpreter of Mead, coined the term "symbolic interactionism" and put forward an influential summary of the perspective: people act toward things based on the meaning those things have for them; and these meanings are derived from social interaction and modified through interpretation"

> Central to symbolic interactionist thought is the idea that individuals use language and significant symbols in their communication with others. Rather than addressing how common social institutions define and impact individuals, symbolic interactionists shift their attention to the interpretation of subjective viewpoints and how individuals make sense of their world from their unique perspective. Symbolic interactionists are often less concerned with objective structure than with subjective meaning – how repeated, meaningful interactions among individuals come to define the makeup of ‘society.’ Summarized succinctly, the basic tenets of symbolic interactionism states that: (1) individuals act based on the meanings objects have for them; (2) interaction occurs within a particular social and cultural context in which physical and social

> objects (persons), as well as situations, must be defined or categorized based on individual meanings; (3) meanings emerge from interactions with other individuals and with society; and (4) meanings are continuously created and recreated through interpreting processes during interactions with others (Carter and Fuller, 2015, p. 1).

If you look at software architecture primarily from the view of "user interface" prototype development, then "symbolic interactionism" is very useful and complementary (Dix, 2009). The following is an example of how the SSA developer can lead with "symbolic interactionism" applied over the user interface:

1. Prototyping User Interface Models (Jacobson and Bylund, 2000):

2. Bass: "Another technique that helps us understand requirements is the creation of prototypes. Prototypes may help to model desired behavior, design the user interface, or analyze resource utilization. This helps to make the system 'real' in the eyes of its stakeholders and can quickly catalyze decisions on the system's design and the design of its user interface" (Bassand Clements, 2003)

3. Designing the User Interface (Shneiderman, *et al.*, 2016): Objection-Action Interface Model.

4. Garlan & Shaw (Garlan and Shaw, 1993) (below) use a "Layered Model" that starts with the user interface:

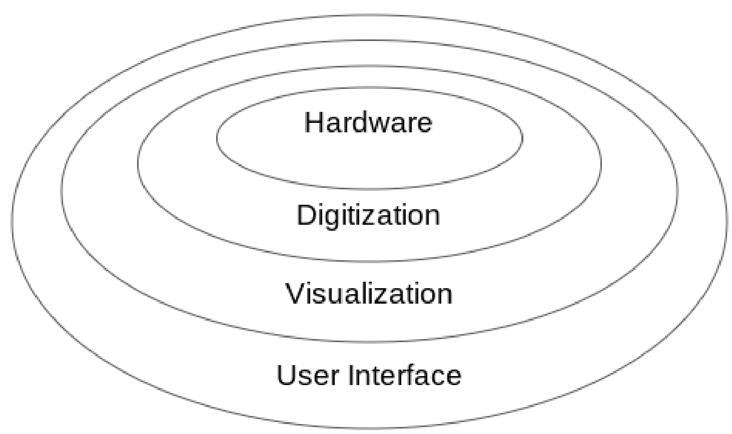

Figure 13 Garlan & Shaw Oscilloscopes - A Layered Model

4.2.3.3. Conflict Theory

Have you ever experienced conflicts of requirements by competing stakeholders?

Conflict theory in sociology can help especially with conflict in sociological requirements. Conflict theory started with Karl Marx (1818-1883) who proposed that social relationships are driven by conflict over scarce or limited resources between the owners of resources (the bourgeoisie) and the workers. Marx theorized that social order is maintained by power and domination of the aristocracy over the working class, rather than consensus and conformity. Conflict theory also appears in the "survival of the fittest" concept in evolution theory. Different sociologists have applied this concept over race, gender, and other sociological relationships (Collins, 1975).

The authors of "working with stakeholders using viewpoints and perspectives" (Rozanski and Woods, 2012) advise you where you may "have conflicts between advice in different relevant perspective," you should (1) "decide on the most important qualities for the system you've been considering" and (2) "for the most important (or interesting) property, identify the likely impact of applying its perspective." then ask yourself: "How does achieving that quality affect the architecture?"

From a sociological framework, the above solution may not satisfy a social conflict situation. Hence, the social conflict theory can be the better solution.

4.2.3.4. More Sociological Theory Frameworks

In addition to the above discussed top three theory frameworks, there are few more including: Feminist Theory, Critical Theory, Labeling Theory, Social Learning Theory, Structural Strain Theory, Rational Choice Theory, Game Theory, Sociobiology, Social Exchange Theory, Chaos Theory, Social Phenomenology, Disengagement Theory (Crossman, 2019), Social Constructionism, Actor-Network Theory, Positivism, Anti-Positivism, Post-Positivism, Marxism, Neo-Marxism, Division of Labor, Interactionism, Globalization, Modern World-System, Communication and Social Order, and etc. (Giddens, 1996).

4.2.4. Empirical Data Approach

Before we explore the different approach (Creswell and Creswell, 2017; Orlikowski and Baroudi, 1991; and Morse, 1991) options available in sociological methods, we want to define some unique SSA development qualities that favor some approaches over others. The selection of approaches depends to a great degree on the data available (Abbot and Sapsford, 2006) to the SSA developer as well as the tools and techniques at hand.

In most sociology, there a struggle and a challenge between quantitative and qualitative data. Quantitative data is data that you can measure and count using statistical, mathematical, and computational tools and methods. Qualitative data can't be measured or counted easily; it represents nominal scales (categories) such as gender, economic class, religious affiliation, education, etc.

Software developers have the following tools that can make them more useful of quantitative methods:

1. Abundance of computer data (including logs) and collection methods
2. Abundance of market data and available attributes
3. The recent rapid development of data science and machine learning
4. Online and other computer survey tools
5. The ever decreasing cost of computational power

These strong qualities of software developers make quantitative, computational, statistical, and mathematical approaches more handy, useful, and desirable. However, this should not mean that the SSA developer may never use other sociological methods such as qualitative, ethnographic (participant observation), historical, or comparative study.

Based on the above, the following are, in order, the most desirable and effective approaches to SSA research (Lewis-Beck, Bryman, and Liao, 2003):

1. Quantitative
2. Computational
3. Statistical
4. Mathematical
5. Data science and machine learning
6. Historical
7. Comparative
8. Qualitative, and
9. Mixed

4.2.4.1. Quantitative Approach

If you have quantitative (countable and measurable) data, then the quantitative approach is you best approach. A quantitative approach (Punch, 2013; Denzin, 1989; and Creswell, 2002) allows you to apply computational, statistical, mathematical, and data science and machine learning applications, tools, resources, methods, and techniques. For the SSA developer, this could be a utopian SSA development environment. In the following, we will be referencing Creswell as the primary SSA reference for sociological approaches.

According to Creswell:

> Quantitative methods involve the process of collecting, analyzing, interpreting, and writing the results of a study. Specific methods exist in both survey and experimental research that relates to identifying a sample and population, specifying the strategy of inquiry. collecting and analyzing data, presenting the results, making an interpretation, and writing the research in a manner consistent with a survey or experimental study. In this chapter [Creswell, Chapter 8. Quantitative Methods], the reader learns the specific procedures for designing survey or experimental methods that need to go into a research proposal. Checklists provided in the chapter help to ensure that all important steps are included (Creswell and Creswell, 2006, p. xxiv).

Quantitative approach~Postpositivist worldview, experimental strategy of inquiry, and pre- and post-test measures of attitudes. In this scenario, the researcher tests a theory by specifying narrow hypotheses and the collection of data to support or refute the hypotheses. An experimental design is used in which attitudes are assessed both before and after an experimental treatment. The data are collected on an instrument that measures attitudes, and the information is analyzed using statistical procedures and hypothesis testing (Creswell and Creswell, 2006, p. xxiv).

For example, if the problem calls for (a) the identification of factors that influence an outcome, (b) the utility of an intervention, or (c) understanding the best predictors of outcomes, then a quantitative approach is best. It is also the best approach to use to test a theory or explanation (Creswell and Creswell, 2006, p. 18).

4.2.4.2. Computational Approach

In general, the goal of this formal [computational approach] research is to build new concepts, theories, and knowledge about complex systems such as groups, organizations, institutions and societies. Using formal techniques, theorists search for fundamental social objects, processes and the mathematical formalism with which to describe their behavior and interactions. Another goal of this research is to discover the most reasonable basis from which, at least in principle, theories of all other processes and behaviors can be derived" (Carley, 2001, p. 2).

4.2.4.3. Statistical Approach

If you are experienced with spreadsheets, statistics software (Python, R, SPSS, or etc.), then you have an advantage in conducting quantitative methods. "An individual trained in technical, scientific writing, statistics. and computer statistical programs and familiar with quantitative journals in the library would most likely choose the quantitative design" (Creswell and Cresswell, 2017, p. 22).

4.2.4.4. Mathematical Approach

Mathematical models and computer simulations of complex social systems have become everyday tools in sociology. Yet until now, students had no up-to-date textbook from which to learn these techniques.Introduction to Mathematical Sociology fills this gap, providing undergraduates with a comprehensive, self-contained primer on the mathematical tools and applications that sociologists use to understand social behavior. Phillip Bonacich and Philip Lu cover all the essential mathematics, including linear algebra, graph theory, set theory, game theory, and probability. They show how to apply these mathematical tools to demography; patterns of power, influence, and friendship in social networks; Markov chains; the evolution and stability of cooperation in human groups; chaotic and complex systems--and more. Introduction to Mathematical Sociology also features numerous exercises throughout, and is accompanied by easy-to-use Mathematica-based computer simulations that students can use to examine the effects of changing parameters on model behavior. Provides an up-to-date and self-contained introduction to mathematical sociology Explains essential mathematical tools and their applications Includes numerous exercises throughout Features easy-to-use computer simulations to help students master concepts (Goleman, 1964, Overview)

4.2.4.5. Data Science and Machine Learning Approach

WE ARE ALL SOCIAL SCIENTISTS NOW: The big data revolution has been hailed as a triumph of computation and, indeed, it is. Computational advances have led to monumental changes in the tools that everyday people use to live their life, immense progress in how the data are stored, and unprecedented tools to analyze large collections. The results are the largest and most detailed datasets in the history of the world. However, the big data revolution also is a recognition that the problems addressed by quantitative social scientists—measuring quantities of interest from noisy data and inferring causal effects—are abundant. Therefore, for big data to be useful, we must draw on the substantial knowledge base that social scientists have amassed about how to most effectively use quantitative tools to solve social scientific problems. Recognizing the value of social science will lead to fruitful collaboration. Although social scientists have little experience with massive datasets, we have extensive experience with causal inference. Data scientists have significantly more experience with large datasets but they tend to have little training in how to infer causal effects in the face of substantial selection (Grimmer, 2015, P. 82).

Social scientists must have an integral role in this collaboration; merely being able to apply statistical techniques to massive datasets is insufficient. Rather, the expertise from a field that has handled observational data for many years is required. For "big data" to actually be revolutionary, we must recognize that we are all social scientists now—regardless of in which field our degree is (Grimmer, 2015, P. 82).

4.2.4.6. Historical Approach

> The process of learning and understanding the background and growth of a chosen field of study or profession can offer insight into organizational culture, current trends, and future possibilities. The historical method of research applies to all fields of study because it encompasses their: origins, growth, theories, personalities, crisis, etc. Both quantitative and qualitative variables can be used in the collection of historical information. Once the decision is made to conduct historical research, there are steps that should be followed to achieve a reliable result. Charles Busha and Stephen Harter detail six steps for conducting historical research (Busha and Harter, 1980, p. 91):
>
> 1. the recognition of a historical problem or the identification of a need for certain historical knowledge.
> 2. the gathering of as much relevant information about the problem or topic as possible.
> 3. if appropriate, the forming of hypotheses that tentatively explain relationships between historical factors.
> 4. The rigorous collection and organization of evidence, and the verification of the authenticity and veracity of information and its sources.
> 5. The selection, organization, and analysis of the most pertinent collected evidence, and the drawing of conclusions; and
> 6. the recording of conclusions in a meaningful narrative" (Busha and Harter, 1980, p. 91)

4.2.4.7. Comparative Approach

The comparative approach in Sociology has historically been used to compare large social group such as nations or cultures. The biggest challenge is in the large number of variables typically associated with large social groups.

> The comparative method is defined here as one of the basic methods--the others being the experimental, statistical, and case study methods--of establishing general empirical propositions. It is, in the first place, definitely a method, not just 'a convenient term vaguely symbolizing the focus of one's research interest.' Nor is it a special set of substantive concerns in the sense of Shmuel N. Eisenstadt's definition of the

> comparative approach in social research; he states that the term does not 'properly designate a specific method…, but rather a special focus on cross-societal, institutional, or macro societal aspects of societies and social analysis... Second, the comparative method is here defined as one of the basic scientific methods, not *the scientific method*. It is, therefore, narrower in scope (Lijphart, 1971, p. 682).

4.2.4.8. Qualitative Data Approach

Definition (Cresswell and Poth, 2016):

A situated activity that locates the observer in the world. Qualitative research consists of a set of interpretive, material practices that make the world visible. These practices, transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.

Qualitative Approaches:

1. Narrative Research
2. Phenomenology
3. Grounded Theory
4. Ethnography
5. Case Study

Qualitative frameworks:

- Postpositivism: This means engaging in qualitative research using a scientific approach has elements of being reductionistic, logical, empirical, cause and effect oriented, and deterministic based on a priori theories.
- Social constructivism: This theory framework seeks an understanding of the world in which they live and work. Develop subjective meanings of their experiences. Relies on participant views.

- Transformative: In this theoretical framework, knowledge is not neutral and it reflects the power and social relationships within society, and thus the purpose of knowledge construction is to aid people to improve society.
- Postmodernism: In this theoretical framework, knowledge claims must be set within the conditions of the world today and in the multiple perspectives of class, race, gender and other group affiliations.
- Pragmatism: This theory focuses on the outcomes of the research -the actions, situations, and consequences of inquiry- rather than antecedent conditions. There is concern with applications- what works- and solutions to problems.
- Feminism: This theory uses a feminist worldview.
- Critical theory: This theory is concerned with empowering human beings to transcend the constraints placed on them by race, class, and gender.
- Critical race theory: This theory focuses theoretical attention on race and how racism is deeply embedded within the framework of American society.

Characteristics of qualitative research:

- Natural setting.
- Researcher as key instrument.
- Multiple methods.
- Complex reasoning through inductive and deductive logic.
- Participants' meaning.
- Emergent design.
- Reflexivity.
- Holistic account.

Characteristics of a good qualitative study:

- The researcher employs rigorous data collection procedures.
- The researcher frames the study within the assumptions and characteristics of the qualitative approach to research.

- The researcher uses an approach to qualitative inquiry such as one of the five approaches.
- The researcher begins with a single focus or concept being explored.
- The study includes detailed methods, a rigorous approach to data collection, data analysis, and report writing.
- The researcher analyzes data using multiple levels of abstraction.
- The researcher writes persuasively so that the reader experiences being there.
- The study reflects the history, culture, and personal experiences of the researcher.
- The qualitative research in a good study is ethical (Brownstein, 1990).

4.2.4.9. Mixed Methods Approach (Sack, *et al*., 2006)

“Mixed methods approach-Pragmatic worldview. collection of both quantitative and qualitative data sequentially The researcher bases the inquiry on the assumption that collecting diverse types of data best provides an understanding of a research problem. The study begins with a broad survey in order to generalize results to a population and then. in a second phase, focuses on qualitative, open-ended interviews to collect detailed views from participants” (Creswell and Clark, 2017, p. 43)

Creswell’s Qualitative, Quantitative, and Mixed Methods Approaches

Tend to or Typically ...	**Qualitative Approaches**	**Quantitative Approaches**	**Mixed Methods Approaches**
Use these philosophical assumptions	Constructivist I advocacy/ participatory knowledge claims	Post~positivist knowledge claims	Pragmatic knowledge claims
Employ these strategies of inquiry	Phenomenology, grounded theory.	Surveys and experiments	Sequential, concurrent, and transformative

	ethnography, case study, and narrative		
Employ these methods	Open-ended questions, emerging approaches, text and or image data	Closed-ended questions, predetermined approaches, numeric data	Both open- and closed-ended questions. both emerging and predetermined approaches. and both quantitative and qualitative data and analysis
Use these practices of research as the researcher	• Positions him- or herself • Collects participant meanings • Focuses on a single concept or phenomenon • Brings personal values into the study • Studies the and context or setting of participants • Validates the accuracy of findings • Makes interpretations of the data • Creates an agenda for change or reform • Collaborates with the participants	• Tests or verifies theories or explanations • Identifies variables to study • Relates variables in questions or hypotheses • Uses standards of validity and reliability • Observes and measures information numerically	• Collects both quantitative and qualitative data • Develops a rationale for mixing • Integrates the data at different stages of inquiry • Presents visual pictures of the procedures in study • Employs the practices of both qualitative

		● Uses unbiased approaches ● Employs statistical procedures	and quantitative research

Table 7 Creswell's Qualitative, Quantitative, and Mixed Methods Approaches

For a comprehensive review of the strengths and weaknesses of quantitative, qualitative, and mixed methods approaches, please refer to Johnson and Onwuegbuzie discussion of "Mixed Methods Research" (Johnson and Onwuegbuzie, 2004).

"By integrating qualitative and quantitative methods together, we are able to investigate three different questions concerning the dynamics and structures of OSS projects" (Sack, *et al.*, 2006, p. 12):

1)

> How is power distributed across three information spaces (the discussion, implementation and documentation spaces)? Our ethnographic analysis shows how the design process is affected by the Python project's social and governance structures (Sack, *et al.*, 2006, p. 12).

2)

> How do links evolve between people in the socio-technical structure of the project, specifically the discussion and implementation spaces of the project? Using a combination of methods from ethnography and information visualization (through the use of custom built OSS project visualization software) we demonstrate a form of "computer-aided ethnography." This aspect of our work shows how participants are progressively integrated into the socio-technical networks of the project and illustrates how newcomers are socialized into the accepted (or rejected) by the project (Sack, *et al.*, 2006, p. 12).

3)

> How is the cognitive activity of discussion influenced by the social and governance structures of the project? Using methods from cognitive science and discourse analysis we show, for instance, how the explicitly assigned roles in the project exert an implicit influence over the shape and development of the design discussions. We are coding our quotation-based analysis into a piece of software that will provide us with a means to at least partially automate this analysis process (Sack, *et al.*, 2006, p. 12).

4.2.5. Logic and Reasoning Approach

4.2.5.1. Inductive Logic

Inductive logic is “The inference of a general law from particular instances” (LEXICO, 2019) Empirical science based on collection of data via experimentation, observation, or study of existing data is inductive. The researcher looks for patterns in the data to infer a more general law or theory that can be applied.

4.2.5.2. Deductive Logic

Deductive logic is “Characterized by or based on the inference of particular instances from a general law” (LEXICO, 2019). Mathematics is a good example of deductive law: the mathematician applies theorems to deduce the characteristics of an instance.

5. Chapter Five

SSA Toolbox Development: Models and Techniques

Utilizing Sociological Models and Multi Purpose Techniques

5.1. Introduction: Models

A model is "a thing used as an example to follow or imitate" (LEXICO, 2019), or "an example for imitation or emulation" (MWD, 019). It is also defined as "a simplified description, especially a mathematical one, of a system or process, to assist calculations and predictions." It refers to structural graphic image (i.e. flowchart, schematic, chart, etc.) or templates or step by step process available or invented to map out or envision the systematic solution or to explain the relationships between the systems components and parts. Models are very useful for planning and architecture. SA developers are used to models. Hence, we define a SSA model as a sociological model that can be an example to use, follow, or imitate in the methodology of SSA development.

A scientific model is "based on or characterized by the methods and principles of science" (LEXICO, 2019); it is "systematic; methodical." Models can be graphic representations such as related images, flowcharts, schematics, tables, etc. A sociological model is a scientific model that employs the methods, processes, and systems of sociology. It explains social relationships between groups and helps explain social behavior. In the following, we will review and evaluate some sociological models and modify them for our purposes of developing SSA models and sociological requirements for software architecture development. There are many sociological models that can be modified for the benefit of further SSA development. This research hopes to review several models and use a couple of models that open the way and encourage further research and application of other sociological models. We start with two important questions:

> *How does an architect developing sociological requirements represent stakeholders, groups, and users in the SSA model used to optimize development? (Lewin, 1947)*
>
> *How does the individual connect with family, school, organizations, groups, companies, government, parties, etc.?*

5.2. Types of Sociological Models?

We are looking for sociological models that can be an example to use, follow, or imitate in the methodology of SSA development.

5.2.1. ME-Ego Model

Norbert Elias' "basic pattern of the egocentric view of society" puts the individual (ME-Ego) at the center of the society surrounded by four ascending layers: family, school, industry, and state (Elias, 1978). Elias' structure of society represents a simpler (easier to identify with), secular (religion is not included), modern (industry), and Westernized (nation state) model. This simplicity can be efficient and optimal in industrialized Western societies; however, it doesn't account for other important sociological forces that impact the study of sociological settings. An example is the impact of the church on social and family issues in the USA or the impact of political parties in a two-party system.

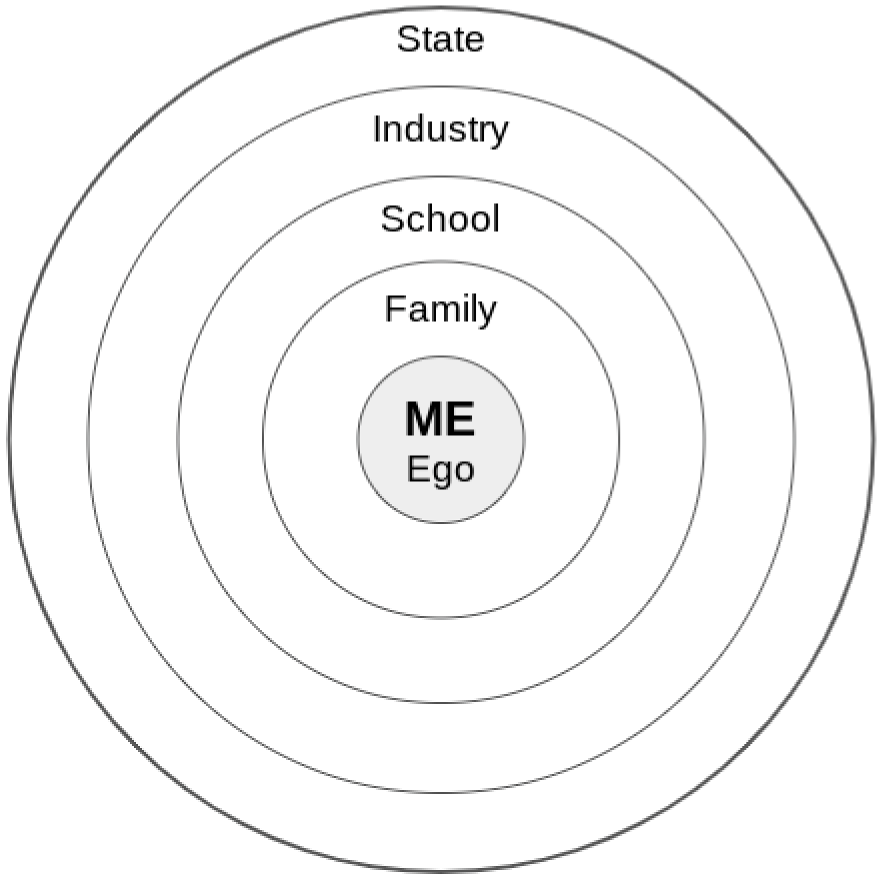

Figure 14 Norbert Elias' ME-EGO Model: Basic pattern of the egocentric view of society

5.2.2. SSH Simple Socio-hierarchical Model

We develop this model and call it the simple socio-hierarchical model ("SSH" Model). We suggest modifying the above model to create a more potent but yet simple SSA model for this SSA research purposes. We replace industry with market; this includes industry, businesses, and other market players. We replace "school" by "educators" to include the entire education system. We also add a layer of "social groups" between "market" (replacing "industry") and "educators." Social active groups can include political, social, and economic activism organizations. Additionally, we add a media layer between "market" and "state," and "religion" between family and educators.

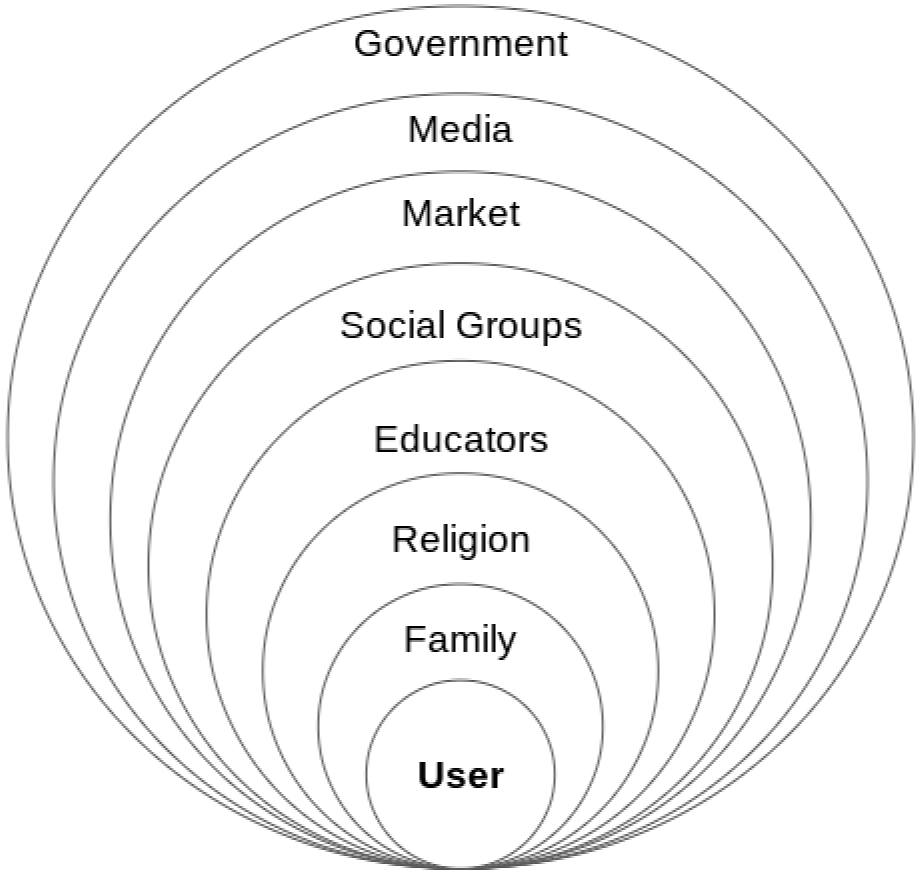

Figure 15 SSH: The "Simple Socio-Hierarchical Model" or SSH Model

The SSH model (Figure 15) can be modified depending on the target primary user and stakeholder. If the primary user is the individual consumer, then the model is fairly effective as presented here. But, if the target primary user is the family, religion, educators, social groups, market, media, or state, then this model becomes less applicable. In this study, we focus on the consumer as the primary user and targeted stakeholder.

In the school of social sciences, the scientific study of society is departmentalized primarily into the study of economics, political science, sociology, and psychology. When software development is called upon to solve sociological problems, it is useful, beneficial, and wise to define these problems on the scale of social science. We can begin by identifying the sociological attributes of the problems, ask questions, research issues, and assign a scale (i.e. 1 $\Rightarrow$ 10 value) on each attribute relative to social science definitions. What are the primary economic, political, social, psychological, etc. attributes? If the primary issue is economic (costs, pricing, quality, quantity, brand, income, budget, lending, debt, credit, etc.), political (affiliation, voting issues, organization, contributions, elections, causes, trends, etc.), social (racism, ethnicity, religious affiliation, group organization, social change, education, culture, etc), or psychological (consumer behavior, association, affiliation, security, fear, risk, etc.), then it can broken down into elements (as above), ranked, and scaled in importance and relevance.

5.2.3. Complex Socio-Genetic Model

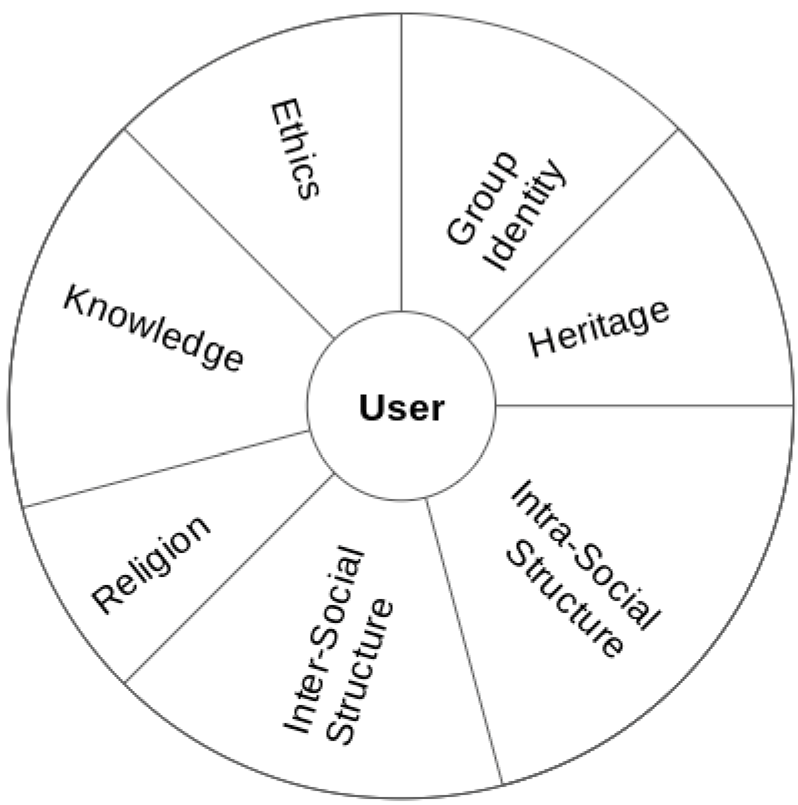

Figure 16 CSG Model: The “Complex Socio-Genetic Model”

For more complex social settings, we develop another novel, promising, complex, and scalable model. We call it the Socio-Genetic Model ("SGM"). This model identifies seven primary sociological attributes that define the framework for sociological study; these are: (1) knowledge, (2) heritage, (3) religion, (4) ethics, (5) group identity (social ego, asabiyyah, racism, or ethnicity), (6) intra-social (internal) interaction, and (7) inter-social (external) interaction. In addition, we may consider geography and language. These attributes are ranked hierarchically in importance and given a weight, then they are broken down into elements (such as dividing knowledge into science, information, education, development, etc.) and the elements are also ranked hierarchically in importance and give a weight. This is a more complex model that can be applied in more varied sociological settings. Depending on the complexity of the sociological problem, this model can be expanded to create a socio-genetic code for every study. With machine learning applications and resources and depending on the economics of budget and scalability of the project, SGM can be developed into a sophisticated software platform with multiple applications.

5.2.4. The "Social Software" Model

A team from the University of Amsterdam's Department of Information Management, Faculty of Economics and Business argues for the design of "Social Software." They "consider this orientation toward sociality, not functionality, a valuable contribution to the field of study" (Bouman, *et al.*, 2007, p. 21). They suggest the following scheme/model for development:

	One-dimensional	***Multi-dimensional***
People- or group-based	*Network-centered sociality* A sense of belonging arises from connectivity in a network. The degree of sociality stems from the	*Community-centered sociality* A feeling of companionship arising from a community in which participation and

	number of people known, social invitations and so on.	membership shape social relations over time.
Artifact-based	*Object-centered sociality* A shared experience and meaning arises from objects valued as belonging to or characteristic for a certain group or an in-crowd.	*System-centered sociality* A mode of belonging based on the feeling of participating in a social software system.

Table 8 "Social Software" model developed by the University of Amsterdam's Department of Information Management, Faculty of Economics and Business

This is a simpler but useful model that does not delve heavily into sociological methods and modeling. However, it offers a "Design Framework for Social Software." This model could be useful for softer SSA approaches.

5.2.5. Communities of Practice: Learning, meaning and identity

Wenger's "Communities of Practice" (Wenger, 1999) (CoPs) model has had a strong appeal for software development. Wenger argues that "learning is an intrinsically social process and that one of the primary sites where learning occurs is in communities of practice." Wegner summarizes his theory with four premises:

1. People are social beings; hence, this is the central aspect of learning.
2. Knowledge is a matter of competence with respect to valued enterprises.
3. Learning is a matter of participating in the pursuit of such enterprises.
4. Meaning is ultimately what learning is to produce.

The primary focus of this theory is on learning as a social participation. Participation. "We all belong to communities of practice. At home, at work. At school, in our hobbies—we belong to several communities of practice at any given time. And the communities of practice to which we belong change over the course of our lives … Communities of practice are everywhere.” (Wenger, 1999, p. 3)

A “Community of Practice” is, in sociological terms, a “social group” that are defined by what they know and practice (architects, engineers, physicians, teachers, etc.). Social groups can also be defined by racial, ethnic, geographic, and many other attributes. Fred Nickols (Nickols, F., 2003) breaks “Communities of Practice” into two types: Self-Organizing and Sponsored. Jane Bozarth (Bozarth, 2008) argues further that “scholars and practitioners now have research findings that support a shift in focus from managing a community of practice, to nurturing and understanding the significant internal dynamics of learning, meaning, and identity.”

We suggest the following useful research projects for a beneficial insight to SSA practitioners who are designing software architecture for a CoPs.

- What is a Community of Practice and How Can We Support It? (Hoadley, 2012)
- WHAT ARE COMMUNITIES OF PRACTICE? A CRITICAL REVIEW OF FOUR SEMINAL WORKS (Cox, 2005)
- UTAS Community of Practice Initiative (Skalicky and West, 2008)
- Communities of Practice: Never Knowingly Undersold (Kimble, 2006)
- Innovative Approaches for Learning and Knowledge Sharing (Scott, 2006)
- COMMUNITIES OF PRACTICE: EXPLORING THE DIVERSE USE OF A THEORY (Roos and Palmér, 2015)

5.2.6. Qualitative and Quantitative Modeling

Sociological methods are applied to qualify (define) and quantify (measure or add metrics) to sociological attributes, elements, and behavior. “Like” is a quality that is widely used in social networking applications; the more likes (can count them) the more successful is the message, product, and/or service. There are many sociological methods already incorporated in software applications especially on statistical data and modeling. There are many more sociological methods that can be used to define “sociological requirements” in software application architecture or to qualify and quantify the attributes and elements of a sociological problem seeking a software solution. Ranking, scaling, and conversion rates due to different conversion forms are commonly used; this paper encourages a deeper look into sociological methods to further incorporate them as sociological requirements.

5.2.7. Threshold models of collective behavior

This “Threshold models of collective behavior” (Granovetter, 1978, p. 1420) model is a good example of sociological models that help qualify and quantify an SSA model. Software applications are about collective (user-group) behavior and having multiple groups participate is often key to success. Some groups are more important to others; some groups are mandatory; other groups are optional.

How do you determine which groups will be considered?

What will it take to get the group engaged to achieve optimal success?

What are the architect’s thresholds for group users?

A “threshold” is “the magnitude or intensity that must be exceeded for a certain reaction, phenomenon, result, or condition to occur or be manifested” (LEXICO, 2019) “In mathematical or statistical modelling a threshold model is any model where a threshold value, or set of threshold values, is used to distinguish ranges of values where the behaviour predicted by the model varies in some important way” (Wiki2, 2019). Hence, a “Threshold models of collective behavior” is a sociological threshold model with important applications for user-group behavior is both desirable and beneficial in developing software architecture.

“Models of collective behavior are developed for situations where actors have two alternatives the costs and/or benefits of each depend on how many other actors choose which alternative. The key concept is that of “threshold”: the number of proportion of others who must make one decision before a given actor does so; this is the point where net benefits begin to exceed net costs for that particular actor”(Granovetter, 1978, p. 1420). “These models are particularly valuable in helping to understand situations where outcomes do not seem intuitively consistent with the underlying individual preferences. Such ‘paradoxes’ may occur far more than we realize, since we observe mainly outcomes and tend to assume that the preferences generating them were consistent with rather than opposed or unrelated to them” (Granovetter, 1978, p. 1441)

5.2.8. Enhancing individual and organizational learning: A sociological model

Designing the software architecture of an application requires special attention to learning how to use the application, and using the application to learn about other than the application (content, benefits, etc.). “Learning at all levels is essential for organizational survival. Drawing on the literature in adult and organizational learning, this article proposes a sociological model of organizational learning based on Parsons’ general theory of action. The model defines individuals and organizations as learning systems, and uses diagnostic questions related to adaptation, goal attainment, integration, and pattern maintenance to identify individual and organizational learning needs” (Casey, 2005, p. 131).

5.2.9. Socio Economic Models

A very common way to look at social grouping is through a social class (socioeconomic classification) model (occupation, employment status, income, wealth, spending habits, etc.). This BBC study, “A new model of social class? Findings from the BBC's Great British Class Survey experiment” (Savage, *et al.*, 2013, p. 219) analyzed “the largest survey of social class ever conducted in the UK, the BBC’s 2011 Great British Class Survey, with 161,400 web respondents, as well as a nationally representative sample survey, which includes unusually detailed questions asked on social, cultural and economic capital” (Savage, *et al.*, 2013, p. 220). this study demonstrates “the existence of an ‘elite’, whose wealth separates them from an established middle class, as well as a class of technical experts and a class of ‘new affluent’ workers.” It also shows “that at the lower levels of the class structure, alongside an ageing traditional working class, there is a ‘precariat’ characterised by very low levels of capital, and a group of emergent service workers" (Savage, *et al.*, 2013, p. 222). The researchers "think that this new seven class model recognises both social polarisation in British society and class fragmentation in its middle layers, and will attract enormous interest from a wide social scientific community in offering an up-to-date multi-dimensional model of social class."

What makes the above model very attractive is the use of tools and techniques widely available and familiar to SSA developers. This includes surveys and web format. Furthermore, most businesses target their audiences in socioeconomic (social class) context. The study divides people into seven social classes:

1. **Elite**: "Very high economic capital (especially savings), high social capital, very high highbrow cultural capital."
2. **Established middle class**: "High economic capital, high status of mean contacts, high highbrow and emerging cultural capital."
3. **Technical middle class**: "High economic capital, very high mean social contacts, but relatively few contacts reported, moderate cultural capital."
4. **New affluent workers**: "Moderately good economic capital, moderately poor mean score of social contacts, though high range, moderate highbrow but good emerging cultural capital."
5. **Traditional working class**: "Moderately poor economic capital, though with reasonable house price, few social contacts, low highbrow and emerging cultural capital."
6. **Emergent service workers**: "Moderately poor economic capital, though with reasonable household income, moderate social contacts, high emerging (but low highbrow) cultural capital."
7. **Precariat**: "Poor economic capital, and the lowest scores on every other criterion."

A social class model maybe a more European than American model. Additionally, with the mammoth data being collected on consumers (thousands of attributes available in the open data marketplace), and with data science tools becoming widely available now, we suggest the above model can be modified to create much more complex socioeconomic models with cultural and ethnic variations. Socioeconomic models can be very powerful for the development of an SSA model.

5.2.10. Socio Demographic Models

Socio demographic models use demographic attributes (now available in abundance especially due social networking) to define more numerous and dynamic niche social groups. The study titled "Testing a dynamic model of social composition: Diversity and change in voluntary groups" (McPherson and Roloto, 1996) tests "a dynamic model of the social composition of voluntary groups."

This type of socio demographic model can have great application in dynamic social networks. The SSA developer can also combine the above two models to create a socio demographic and economic model.

5.2.11. The Sociological Concept of "Group"

The following study, "The sociological concept of" group": An empirical test of two models," compares "two models of the structural form of small, informal groups."

Two important notes here:

1. These are "small" groups; hence the size of your grouping is an important consideration, and
2. It tests for "social affiliation be strictly transitive" or "a special limited form of transitivity;" hence the affiliation and relative relationships between groups can be an important consideration in developing your own SSA model.

"Over the years sociologists have distinguished various kinds, or what Simmel (1902 called 'forms' of human groups. Among these, on form in particular has continued to interest investigators for more than a century. Groups that are relatively small, informal, and involve closer ties--those that Tönnies ([1877] 1940) characterized as based on Gemeinschaft, Durkheim ([1893] 1933) portrayed as reflecting solidarité or organique, and both Spencer ([1893] 1993) and Cooley (1909) described as primary--remain at the core of the discipline"(Freeman, 1992).

5.2.12. Additional Candidate Models

- Agent-based model (Macy and Willer, 2002; Axelrod, 1997; and Macal and North, 2005)
- Balance theory (Clark, 2000; and Davis, 1963)
- Breaching experiment (Carabtree, 2004)
- Comparative historical research (Mahoney and Rueschemeyer, eds., 2003; and Kiser and Hechter, 1991)
- Computational sociology (Macy and WIller, 2002; and Hummon and Fararo, 1995)
- Dynamic network analysis (Hummon and Fararo, 1995; Carrington, Scott, and Wasserman, eds., 2005; and Bastian, Heymann, and Jacomy, 2009)
- Ethnomethodology (Hummon and Fararo, 1995)
- Genre criticism (Williams, 1984)
- Ideal type (Martindale, 1959; and Hendricks and Breckinridge Peters, 1973)
- Photo elicitation (Harper, 1986; Harper, 2002; and Clark-Ibáñez, 2004)
- The Rules of Sociological Method (Durkheim, *et al.*, 1938; Giddents, 2013; and Rammert, 1997)
- Social framework analysis (Monahan, Walker, and Mitchell, 2009; and King and Amin, 2008)

- Social geometry (Simmel, 2011; and Ethington, 1997)
- Social network analysis (Scott, 1988; Carrington, Scott, and Wasserman, 2005; and Freeman, 2004)
- Visual sociology (Becker, 1995; and Harper, 1988)

There are many sociological models that are useful for the development of an SSA model. These focus on ways of defining groups in terms of size, quality, connectivity, interaction, affiliation, and etc. The SSA developer needs to research, qualify, quantify, and determine which model of grouping best fits the SSA project.

SSA developers are neither limited on one particular model nor compelled to use the exact model. Models can be combined, modified, and synthesized.

5.2.13. Stakeholder Types: RIOTU Model

Patton divides stakeholders into "**primary**" and "**secondary**" types (Patton, 2005); we divide them into "**user**," "**technologist**," "**owner,**" "**influencer**," and "**regulator**." we call it the RIOTU (**R**egulator, **I**nfluencer, **O**wner, **T**echnologist, **U**ser) model. Figure 17 illustrates their hierarchy.

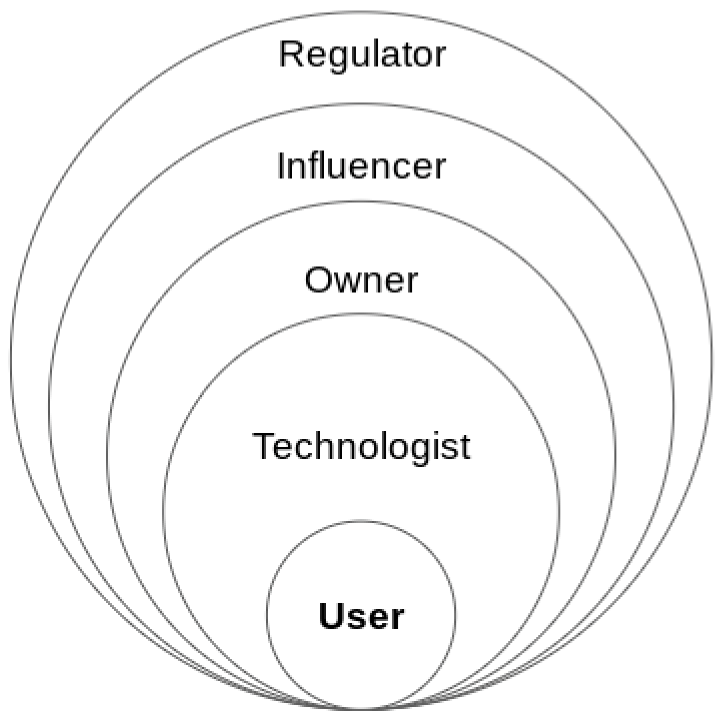

Figure 17 RIOTU Model

The **user** is divided into two subtypes: buyers and sellers. The sellers are selling ideas (or brand or leadership promoting cause), products, and/or services. The buyers can be followers or buyers of product and/or services.

The **technologist** includes acquirers, communicators, developers, maintainers, production engineers, suppliers, support staff, and testers (LEXICO, 2019).

The **owner** is the decision maker of the project who has the ultimate decision and choice between options or conflicting stakes.

The **influencer** may never use the software application or tool, but may have primary or secondary influence on its sociological requirements. The influencer, like family, educators, social groups, media (reviews), or even the executive team of the business owner of the SA project, can have a dominant stake and much influence on your design without ever becoming a direct user of the software.

The **regulator** is a federal, state, and/or local regulator, the courts, and assessors. They have the power to dictate certain social requirements.

5.3. Introduction: Techniques

Technique is a clear scientific procedure or artistic way with detailed, step-by-step tasks and instructions to execute, perform, and accomplish the desired socio-technological solution. They are “the manner in which technical details are treated,” or “a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure.” They are the tools in a tool box of utility solutions, set of programs, or functions accessible and used to make the components, parts, and/or the elements of a systematic solution.

According to the Oxford Dictionary, a “technique” (LEXICO, 2019) is “a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure.” We are looking for successfully tried and tested artistic and/or scientific technical steps, processes, ways, procedures, tasks, and instructions to execute our SSA research and development project. We want simple, valid, reliable, and replicable techniques that can be taught and applied for the purpose of developing our sociological requirements. Our goal is to give the researcher and the developer all the technical tools necessary to conduct a beneficial and meaningful SSA development, promote optimization, efficiency, and productivity, increase return on investment, expand profitability and economic development, and advance social progress. techniques are very handy and useful tools in the SSA toolox. In this section we will explore all the useful and fitting techniques from related fields. We will also synthesize and integrate techniques especially from statistics for sociology, software development techniques, and data science techniques. We believe the synthesis of these techniques can provide the SSA developer a unique toolbox for SSA development innovation and creativity. In the following, we investigate the following techniques:

1. Representation techniques
2. Data techniques
3. Sociology research techniques
4. Statistical techniques,
5. Mathematical modeling
6. Data science techniques
7. Computer based techniques:
8. Team techniques
9. Assessment techniques
10. Software Development Integrated Techniques (i.e. Scrum and Kanban)

In this section we will cover some important SSA techniques (Hines, 1993). we will cover data, people (stakeholders and social groups), data science, machine learning, statistics, schematics and graphs, and general research techniques; we will also cover definition of SSA terms only. we will not cover literature review, abstracting studies, style manuals, etc. For additional help with techniques we don't cover, please reference Creswell's (Creswell and Creswell, 2017) and other techniques.

5.3.1. Representation techniques

This includes tables, step by step checklist, templates, schematics, flowcharts, graphs, images, etc.

5.3.2. Data techniques

SA developers are very familiar with data techniques. Sociological techniques expand it to qualitative data.

Provides:	Nominal	Ordinal	Interval	Ratio
The "order" of values is known		✔	✔	✔
"Counts," aka "Frequency of Distribution"	✔	✔	✔	✔
Mode	✔	✔	✔	✔
Median		✔	✔	✔
Mean			✔	✔
Can quantify the difference between each value			✔	✔
Can add or subtract values			✔	✔
Can multiple and divide values				✔
Has "true zero"				✔

Table 9 Summary of data types and scale measures

Source: My Market Research Methods

Quantitative data is numerical. We can apply mathematical, statistical, and data science techniques to study patterns, correlations, and inference, and conjecture hypothesis. "Qualitative data describes qualities or characteristics. It is collected using questionnaires, interviews, or observation, and frequently appears in narrative form" (Macalester, 2019)

Qualitative data can be in the form of text, media, symbols, observations, or even physical items. However, we can transform some qualitative data into statistical data: nominal, ordinal, interval, and ratio data. SPSS is a good sociological tool for analyzing statistical data. Other qualitative data remains in textual form and is analyzed in textual form (Patton, 1980; and Patton, 1990).

Nominal data is used to name or label different values. Ordinal data is used to order a spectrum of choice answers (such as from least favorable to most favorable). Interval data defines a specific value of difference between choice answers. "Finally, Ratio scales give us the ultimate–order, interval values, plus the ability to calculate ratios since a "true zero" can be defined" (MMRM, 2019)

What are good techniques for qualitative data that is in text, media, symbols, observations, or physical form?

> Qualitative data may be difficult to precisely measure and analyze. The data may be in the form of descriptive words that can be examined for patterns or meaning, sometimes through the use of coding. Coding allows the researcher to categorize qualitative data to identify themes that correspond with the research questions and to perform quantitative analysis (Macalester, 2019).
>
> Qualitative research can help researchers to access the thoughts and feelings of research participants, which can enable the development of an understanding of the meaning that people ascribe to their experiences…. Doing qualitative research is not easy and may require a complete rethink of how research is conducted, particularly for researchers who are more familiar with quantitative approaches. There are many ways of conducting qualitative research, [including] the practical issues regarding data collection, analysis, and management. Further reading around the subject will be essential to truly understand this method of accessing peoples' thoughts and feelings to enable researchers to tell participants' stories (Sutton and Austin, 2015, p. 226).

According to the Center for Innovation in Research and Teaching ("CIRT") (CIRT, 2019), there are five key steps that are commonly followed to qualitative data analysis:

1. Become familiar with data

2. Focus the analysis
3. Categorize the data and create a framework
4. Identify patterns and make connections
5. Interpret the data and explain findings.

Some of the most commonly used approaches include:

1. Content Analysis
2. Narrative Analysis
3. Discourse Analysis
4. Grounded Theory - also called analytic induction
5. Conversation Analysis

The above approaches to qualitative analysis are just a few of the most common types.

5.3.3. Sociological research techniques?

Sociology research techniques include:

1. Case study
2. Survey
3. Observational
4. Correlational
5. Experimental
6. Cross cultural

5.3.4. SSA Data Collection Methods Techniques

Out of the many data collection methods available in sociology (Cresswell and Cresswell, 2017; and Ackroyd, 1992), we will focus on the following five methods:

1. Existing data
2. Surveys

3. Interviews
4. Experiments
5. Case study

5.3.4.1. Existing Data

The types and sources of existing data are unlimited, especially in this wonderful age of the internet. However, there are three exceptionally important recent data trends:

1. Digital
2. Multimedia
3. Exponential Growth

According to IDC Research (Rizzatti, 2016), digital data will grow at a compound annual growth rate (CAGR) of 42% through 2020 (Rizzatti, 2016). The opportunities for collecting good and useful data are limitless; the tools for collection and analytics are promising; and new data collection techniques are new opportunities that should be exploited.

> Hal Varian, Chief Economist at Google, was reported (no reference found) as saying that *"between the dawn of civilization and 2003, we only created five exabytes; now we're creating that amount every two days. By 2020, that figure is predicted to sit at 53 zettabytes (53 trillion gigabytes)."* Forbes (Marr, 2019) magazine estimates it will be around 44 zettabytes by 2020.

Software developers have a great advantage over other researchers in data collection. In additional to the traditional data collection techniques, we want to focus your attention on the mammoth amount of online digital footprint data collected. You can know access thousands of attributes per online user giving you a very rich digital profile that will help you develop your stakeholders, sub-groups, clusters, and segments. As a result, there is an explosion in data analytics tools and applications; use them. But not all data requires sophisticated analytics tools. A spreadsheet can be a very powerful tool in analyzing and studying data.

Government Datasets: All most all branches of the US government, especially the Census Bureau and the Federal Reserve (FedRes, 2019), have very useful datasets and issue periodic statistical reports. The Census Bureau also offers data tools and apps (USCB, 2019) and APIs (USCB, 2019.

Academic Datasets: Start with Google Scholar (GS, 2019). Wikipedia offers a list of academic databases and search engines (Wikipedia, 2019). Also check: iSEEK Education (iSEEK, 2019), RefSeek (ASE, 2019), Virtual LRC (Bell and Bell, 2019), BUBL LINK (W3S, 2019), Digital Library of the Commons Repository (DLC, 2019), OCLC Research (OCLC, 2019), IPL: The Internet Public Library (Simcox, 2019), Microsoft Academic Search (MAS, 2019), Google Correlate (GC, 2019), Wolfram|Alpha (WA, 2019), Dogpile (Dogpile, 2019), MetaCrawler (MetaCrawler, 2019), Mamma (Mamma, 2019), Library of Congress (LOC, 2019), Archives Hub (Archiveshub, 2019), National Archives (Archives, 2019), arXiv e-Print Archive (arXiv, 2019), and much more (Heick, 2015). Here are 100 Time-Saving Search Engines for Serious Scholars (Staff, 2010). Here is UCLA's help in choosing and using library databases (UCLA 2019).

Industry Datasets: Every industry has industry organizations with useful datasets.

Private Datasets: Here are some examples: EBSCO Information Services (EBSCO, 2019), ProQuest (ProQuest, 2019),

5.3.4.2. Surveys

Surveys have become synonymous with software (especially online and mobile) development. Again, this gives the SSA developer an edge over others. Plan you SSA development with special attention to a wide range of survey techniques that can help you better achieve and develop your SSA groups and sociological requirements.

5.3.4.3. Interviews

There are two interview techniques that we believe can be very powerful to achieve your SSA development goals:

1. Experts and consultants: for example, if there are legal requirements, you can consult legal experts to address, define, qualify, and quantify your sociological requirements.

2. Focus groups: focus group interviews have become a very powerful and successful technique in marketing; use similar techniques.

5.3.4.4. Experiments

Software developers have an edge in software related experiments since they have superior tools and techniques for applying experiments and collecting results data with software automation.

5.3.4.5. Case Study

Starting with a case study that can serve as a model for your research is a powerful technique. Here are additional references (Snyder, 2012; Yin, 2013; and Noor, 2008).

5.3.5. Consumer Attributes

As mentioned above, "The Cambrian Explosion… of Data" provides us wonderful data opportunities never imagined before. Personalized data is generated, permitted, and collected every second on the internet and other digital and mobile devices. This data is being made available in the open market (Zhu, *et al.*, 2009). For every digitally active person, the market can provide thousands of consumer attributes (Kramer and Vogel, 2001) that can be used to enhance your research data and analytics. These attributes are broken into several categories:

5.3.5.1. Contact Information

In addition to the traditional contact information (name, address, and phone), you can now obtain digital address (email, IP address, mobile). Even if you never intend to contact the people in your database, having digital address allows you to collect much broader and deeper data than traditional contact information.

5.3.5.2. Demographics

Demographic data is important since age, sex, ethnicity, education, class, and other demographic data can be very powerful attributes in grouping, segmentation, clustering, and definition of common stakeholder sociological attributes.

5.3.5.3. Lifestyle

The lifestyle attributes (Swinyard and Smith, 2003) have exploded in recent years since it has become easier to track people's interest and purchasing habits through search engines and credit card purchase. You can now identify people who are green, athletic, have political affiliation, belong to groups and clubs, etc. (Orth, *et al.*, 2004)

5.3.5.4. Social Media

Social media is rich in content and very popular. This is obviously an opportunity for social media publishers to collect much data on social media users, their likes and desires, and their behavior.

5.3.5.5. Financial Information

Digital credit card, online, and mobile wallet shopping have created a wealth of financial information that can be used to define stakeholder sociological attributes.

5.3.5.6. Behavior Scores

Many data organizations are now creating all types of scores that keep track of data on people. In addition to the traditional credit scores, there are scores on lifestyle, wealth, education, politics, etc. These scores can be valuable in grouping, segmenting, and clustering your targeted audiences.

5.3.6. Statistical Techniques

SPSS is a full statistical techniques toolbox for sociologists (Cramer, 2003). We recommend it for SSA development.

5.3.7. Mathematical Techniques

Mathematical techniques in sociology (Coleman, 1964) have advanced over the past fifty years. The following are very well established techniques. we will offer references to apply them:

- Spreadsheets (Fillebrown, 1994)
- Graphs and charts (Triola, 2006)
- Schematics, flowcharts, and tables: SA developers should be skilled with schematics, flowcharts, and tables.
- Regression analysis (Cameron and Trivedi, 2013)
- Segmentation (Peterson, 1992)
- Clustering (Ball and Hall, 1967)
- General research techniques (Myers and Avison, eds., 2002)

5.3.8. Data Science and Machine Learning Techniques

The exponential evolution and rapid proliferation of data science (Chen, Chiang, and Storey, 2012), machine learning, and BIG DATA analytical tools and applications has generated many useful techniques that can be used effectively in SSA research and development.

5.3.8.1. Fix and transform data

Software developers have an advantage over all other group in their skills and techniques to fix and transform data. we hope not much advice is needed.

5.3.8.2. Python / R / SPSS

Python and R are now the dominant data science statistical languages; you should be familiar with one of them. SPSS can do; but Python and R have now lead the way, especially Python. Learning any of them should introduce a lot of useful techniques in data manipulation and analytics. The following are useful analytics techniques:

1. Historical analytics
2. Descriptive analytics
3. Predictive analytics
4. Prescriptive analytics

5.3.8.3. Deploy algorithms with web services

There are many useful techniques to deploying your predictive data science model to operationalize and apply it in prototypes, alpha, beta and other experiments, data collection, and surveys. This includes web services.

5.3.9. Computer Based Techniques

The most basic techniques using the computer for sociological research include the many applications used for collection of data, writing, editing, internet research, email, online libraries, Google Scholar, citation generators, surveys, etc.

Computer applications in the social sciences also include: Simulations (i.e. Agent based social simulation (Davidsson, 2002). Computer modeling, Computer programming, Resignation from office, Role conflict, Computer simulation, Questionnaires, Executive committees, Group pressure, Cognitive models, etc (Gullahorn and Gullahorn, 1965). Computational sociology (Macy and Willer, 2002) utilizes computer simulations, complex mathematical and statistical modeling, machine learning, and artificial intelligence to analyze and model its data intensive sociological investigations. Software developers have many techniques, especially in data collection, processing, management, analysis and presentation. These techniques are very useful in sociological requirements. (Xu and Jin, 2014)

SPSS is a statistical application that was developed on mainframe computers for social scientists (Connolly, 2007). Nearly three decades ago, it was moved over to the PC platform. It is the most widely used software for statistics in the social sciences.

Advances in the computer sciences are making breakthroughs on how to deal with qualitative data (such as unstructured textual material and content analysis) (Seale, 2003). “In the past decade a variety of computer-aided techniques have been developed to aid the qualitative analysis of unstructured textual material in interpretive sociology and ethnography. This contribution gives an overview of these techniques, focusing especially on the building typologies” (Kelle, 1997, p. 342).

5.3.10. Team Techniques

How you organize your SSA team specialization, collaboration, brainstorming, and communication can add valuable techniques to your toolbox. If no one on your team is comfortable with sociological techniques, you should consider sociology consultation.

5.3.11. Assessment Techniques

Assessment techniques, including validation, verification, and evaluation, will be covered in Chapter Seven.

5.3.12. Software Development Integrated Techniques (i.e. Scrum and Kanban)

Scrum and Kanban are good frameworks for agile software development that can integrate sociological requirements. Whether you are using Scrum or Kanban, you should consider how to integrate the development of your sociological requirements add a column for it.

	Scrum	Kanban	Sociological requirements
Cadence	Regular fixed length sprints (ie, 2 weeks)	Continuous flow	

Release methodology	At the end of each sprint	Continuous delivery	
Roles	Product owner, scrum master, development team	No required roles	
Key metrics	Velocity	Lead time, cycle time, WIP	
Change philosophy	Teams should not make changes during the sprint.	Change can happen at any time	

Table 10 Atlassian Agile Coach comparison of Scrum and Kanban (Rehkopf, 2019)

5.4. Conclusion: Models and Techniques

SSA models and techniques are critical SSA development tools. As we will demonstrate in the next chapter (SSA Application Methodology: Step-by-Step Instructions), along with methods and approaches, models and techniques help us develop our planning and design stage. Models help us visualize the social relationships between stakeholders (social groups) within the environment. They allow for a systematic development process. Techniques help us as tools to qualify, quantify, and operate on stakeholders, the social environment, their relationships, interactions, and behavior. Models and techniques are the machinery with which we can construct our SSA system and mechanics.

Chapter Six

SSA Application Methodology

Step-by-Step Instructions

6.1. Introduction

This chapter includes a step-by-step instructions checklist, assessment methods, and application case studies. We discuss how the SSA developer learns from and applies the theories, assumptions, axioms, methods, approaches, models, and techniques we discussed in the previous three papers. The first step-by-step instructions checklist section organizes knowledge from the first three chapters. It sets desired sociological goals and objectives. It organizes a toolbox of fitting methods, approaches, models, and techniques. It aims to apply the appropriate methods, select the best approaches, construct the most guiding models, and choose the proper techniques to achieve the targeted results. And it strives to simplify the SSA development process and make it easy, testable, and replicable.

At the start of the SSA development process, we assume the SSA developers have chosen an SA method (i.e. the MSDN SA method) and have already developed SA technical and operational requirements. This includes SA stakeholders, views (Rozanski and Woods, 2005), viewpoints (Woods and Rozanski, 2012), perspectives (Woods and Rozanski, 2012), concerns, and resolution scenarios. Experienced SSA developers can develop sociological requirements ("SRs") at the same time with SA technical and operational requirements; this should lead to an optimized process. As we have done in Chapter Two on methods, we add a third column for developing SRs. We start the SSA development process by asking questions: What are SSA requirements? What are SRs? How do we define, qualify, and/or quantify SSA Stakeholders ("social groups," "SSA Groups," or interest groups)? Are our SSA Stakeholders the same or different from our SA groups? What is the SSA environment ("social situation")? What is the SSA interface ("social interaction")? How does it compare with traditional SA interface development? What is SSA behavior ("social role" and action desired)? What model do we use? What approaches and/or sociological theory frameworks fit our model? What are the appropriate techniques for our model? How do we develop and integrate SRs with technical and operational requirements? What are the SSA requirements for this specific project? How do we use our SSA tools for mapping our SSA requirements and stakeholder's stakes? How do we deal with competing interests and conflict resolution? And how do we develop our validation test?

This chapter's goal is to be a practical training and demonstration manual on how to develop SSA and SRs, and apply and validate them. SSA requirements include SRs and SSA developer requirements ("SDRs"). We also develop SSA views, viewpoints, and perspectives. We want to determine stakeholders stakes and concerns, evaluate conflicts and/or cooperation, and conjecture multiple scenario resolutions. We re-evaluate our UX/UI development in light of the developed SRs. We plan the inclusion of SSA data collection, acquisition, and treatment in beta testing as well as live deployments, versions, and devices. We develop our metrics for success/failure and announce them (to the team or company) before running analytics. We plan how to manage expectations. In the latter part of this chapter we discuss some earlier development case study applications used in the development of sociology of software architecture as well as other candidate applications where we believe SSA methodology yields maximum benefits and high return on investment. We ask: When software development is the solution for social problems, What are the SRs of optimal software architecture development? What are some of the leading applications demanding a powerful "Sociology of Software Architecture" methodology?

6.2. Step by Step Checklist (“SSC”)

This step by step checklist follows the methods structure developed in Chapter Two: discovery, conjecture, planning and design, operations, and reporting. SSA developers can use this as a template and modify it to their needs. SSC# numbering is useful for team collaboration and communication.

✓	**SSC#**	**Step by Step Checklist**	**Description**
	1	Discovery	Objectives (MSDN SA)
	1.1	Questions for owner	Qualify/quantify the project
	1.1.1	Goals and objectives?	How and why project started?
	1.1.1.1	Material?	Cost benefit expectations
	1.1.1.2	Intellectual?	Social, political, economic, class, religion, race, cultural, language, or etc. activism and/or grouping
	1.1.1.3	Sentimental?	Attachment, branding, like, review
	1.1.2	SSA requirements (Kassir, 2019, Chapter One, Section 1.7)	"Knowledge societies" model (Nico, 1994, p. 40)
	1.1.2.1	SRs	Sociological Requirements
	1.1.2.1a	Stakeholders?	What social groups are we targeting?
	1.1.2.1b	Environment?	What social situation?
	1.1.2.1c	Interface?	What social interaction?
	1.1.2.1d	Behavior?	What social role/action are we modifying?
	1.1.2.2	SDRs	SSA Developer requirements
	1.1.3	Resources-budget?	What resources/budget is available?

	1.2	Questions for research	Research subjects and questions?
	1.2.4	Literature?	Review, theories, axioms, assumptions
	1.2.5	Data?	What data do we look for?
	1.3	Answers	Researching answers: above questions
	1.3.1	Literature review	
	1.3.1.1	Definitions	
	1.3.1.2	History	
	1.3.1.3	Theories	
	1.3.1.4	Principles	
	1.3.1.5	Axioms	
	1.3.2	Existing data	What existing data benefits this project?
	1.3.2.1	Academic	
	1.3.2.2	Government	
	1.3.2.3	Public share	Data collaborators
	1.3.2.4	Industry	
	1.3.2.5	Commercial	
	1.3.3	Missing data	What did we look for that we didn't find?
	1.3.3.1	Academic	
	1.3.3.2	Government	
	1.3.3.3	Public share	Data collaborators
	1.3.3.4	Industry	
	1.3.3.5	Commercial	

	1.3.4	SR components	"Knowledge societies" model (Nico, 1994, p. 40)
	1.3.4.1	Stakeholders	Define, qualify, quantify, target
	1.3.4.2	Environment	Define, qualify, quantify, target
	1.3.4.3	Interface	Define, qualify, quantify, target
	1.3.4.4	Behavior	Define, qualify, quantify, target
	2	Conjecture	Key scenarios (MSDN SA)
	2.1	Analysis & Conclusions	Post discovery reevaluation
	2.1.1	Goals & Objectives	Achievable?
	2.1.2	SR Components	How well do we know them?
	2.1.3	Resources/Budget	Manage expectations/deliverables
	2.2	Challenge(s)?	We know the solution but it requires additional resources, budget, etc.
	2.2.1	Data acquisition	
	2.2.2	Expertise	
	2.3	Problem(s)?	We don’t know the solution yet
	2.3.1	Conflict?	
	2.3.2	Collaboration?	Groups
	2.3.4	Interaction?	Social roles, actions, interface
	2.3.5	Driving interest?	What motivates stakeholders
	2.3.6	Competing interests?	Intra groups
	2.3.7	Regulations?	Federal, state, and local
	2.3.8	Sensibilities?	Culture, gender, ethnic, etc.
	2.3.9	Competition	Inter groups/companies

	2.4	Solution(s)?	Scenarios, hypothesis
	2.4.1	Resolution?	
	2.4.2	Engagement?	
	2.4.3	Response?	
	3.	Planning & Design	Application overview (MSDN SA)
	3.1	Methods	
	3.1.1	Step by step checklist	Prepare, edit, modify checklist
	3.1.2	Toolbox	Take inventory
	3.1.3	Data method	Quantitative, qualitative, mixed methods
	3.1.4	Sociology method	Interview, case study, survey, experiment, existing data
	3.2	Approaches	
	3.2.1	Social epistemology	
	3.2.2	Worldview	
	3.2.3	Sociology theory	
	3.2.4	Empirical data	
	3.2.5	Logic & reasoning	
	3.3	Models	
	3.3.1	ME-Ego model	
	3.3.2	SSH model	
	3.3.3	CSG model	

	3.3.X	More models…(Kassir, 2019, Chapter Three, Section 3.4)	
	3.4	Techniques	
	3.4.1	Representation	
	3.4.2	Data	
	3.4.3	Sociological	
	3.4.4	Statistical	
	3.4.5	Mathematical	
	3.4.6	Data science	
	3.4.7	Computer based	
	3.4.8	Team	
	3.4.9	Software dev	
	4.	Operations	Key issues (MSDN SA)
	4.1	Methods	
	4.1.1	Existing Data	
	4.1.2	Survey	
	4.1.3	Experiment	
	4.1.4	Observation	
	4.1.5	Prototype	
	.1.6	Beta application	
	4.1.7	Interviews	
	4.1.8	Case studies	

	4.2	Data collection	
	4.2.1	Data cleanup	
	4.2.2	Data transformation	
	4.2.3	Data analytics	
	4.2.4	Validity & Reliability	
	4.2.4.1	Validity	The extent to which measurement represents reality, considered useful and trustworth
	4.2.4.2	Reliability	Consistency of measurement
	5.	Reporting	Candidate solutions (MSDN SA)
	5.1	Assessment Types	
	5.1.1	Validation	
	5.1.2	Verification	
	5.1.3	Evaluation	
	5.2	Assessment Forms	
	5.2.1	Structural	
	5.2.2	Component	
	5.3.3	Operations	
	5.3	Assessment Methods	
	5.3.1	SRs	
	5.3.2	Quantitative data operations	
	5.3.3	Qualitative data operations	

	5.4	SSA Methodology	
	5.5	Writeup-Presentation	
	5.6	Replication	Can results be replicated?
	5.7	Generalizability	Can findings and conclusions be generalized?
	5.8	Future Development	Recommendations, future features, versions

Table 11 Step by Step Checklist

6.3. What Are SSA Requirements

This investigation assumes that the SSA developers (Eeles, 2004) know their technical and operational requirements (Kruchten, *et al.*, 2007). The first SSA question is: What are SSA (sociological requirements for software architecture) requirements?

In Chapter One, Section 1.7, we synthesized SSA requirements and divided them into two types:

1. Sociological Requirements (“SRs”)
2. SSA Developer Requirements (“SDRs”)

SRs include the following components:

1. SSA stakeholders (social groups or SSA groups),
2. SSA environment (“social situation”),
3. SSA interface (“social interaction”), and
4. SSA behavior (“social role” and action desired) (Nico, 1994, p. 40).

SDRs require either SA Developer SSA following an SSA checklist, or hiring a consultant with sociological credentials and experience to augment and help the SSA developer, or, in larger teams, hiring, teaching, and training an SA developer on SSA methods; the SSA developer becomes the team's SSA specialist.

6.4. What Are Sociological Requirements ("SRs")

The discovery phase is focused primarily on identifying, defining, qualifying, and quantifying the right SRs. SRs may mirror some existing SA requirements. SRs may also include sociological attributes and elements that are outside the software system but influence or are influenced by the software system. For example, if you automate the legal process of filing a summons, you save costs, reduce the price, save time, and create efficiency. But more importantly, in some cases, as is in the debt collection industry, you make it more cost effective for debt collectors to file thousands instead of hundreds of summons per portfolio and hence they can jam the court system and cause serious social stress by suing many more people (NCLC, 2010). When we speak of SRs, we include of the later. We discover the sociological ripple effect of a software development.

6.5. SSA Groups (Stakeholders)

The first SR is SSA Stakeholders. They may mirror SA stakeholders (Rozanski and Woods, 2012) and requirements (Chung, Gross, and Yu, 1999; and Van Der Raadt, Schouten, and Van Vliet, 2008) already identified by the SA developer; but they don't have to be the same. Some SA developers narrow their stakeholders to the owners of the SA enterprise and their direct interactions (i.e. customers and suppliers). SSA developers are interested in discovering every group that may directly or indirectly affect or be affected by the technology deployment. Technology can disrupt the total environment of society. SSA developers should study the total impact of technology disruption on the social ecosystem. We discover SSA Stakeholders concerns and desired resolutions. This is similar to Rozanski and Woods' viewpoints and views (Rozanski and Woods, 2012). We investigate how the SSA requirements are in agreement or conflicted. We optimize, prioritize, and determine implementation restraints and timeline. Then we interpret these desired solutions into clearly defined, qualified, and/or quantified SRs. The SSA developer may decide to exclude some (especially technical, operational, administrative, and/or business) stakeholders and decline to develop their SRs. However, we recommend that every SSA group should be a clearly defined SA stakeholder. Best practice recommendation is to have one hundred percent mirroring between SSA groups and SA stakeholders. SA developers are traditionally identify SA stakeholder groups as application user groups. Government regulators are a good example of direct impact social groups that are not user groups. The media, especially the internet bloggers and YouTube reviewers, industry circles, competitors, and social activist groups are good examples of indirect impact social groups. The right sociological stakeholders are groups that have been properly identified, prioritized, and judged as "should be included" in the SSA development.

6.5.1. SA Groups (Stakeholders)

How do we define, qualify, and/or quantify SSA groups (stakeholders) using group models and/or sociological theory frameworks? "A stakeholder in the architecture of a system is an individual, team, organization, or classes thereof, having an interest in the realization of the system" (Rozanski and Woods, 2012). And "The architect must ensure that there is adequate stakeholder representation across the board, including non-technology stakeholders (such as acquirers and users) and technology-focused ones (such as developers, system administrators, and maintainers)" (Rozanski and Woods, 2012). We need to redefine "having an interest in the realization of the system" to "who might directly or indirectly affect or be affected by the realization of the system." The internet and mobile devices have distributed software technology everywhere around the globe. Some "software systems" are more disruptive socially than others. The more widely distributed they are, the more SSA discovery and evaluation are needed. It is not our SSA development goal to manage social engineering; but it is important to study the full social impact of any system's development to anticipate its social impact and manage expectations. Rozanski and Woods classify stakeholders as follows: (Rozanski and Woods, 2012).

Acquirers	Oversee the procurement of the system or product
Assessors	Oversee the system's conformance to standards and legal regulation
Communicators	Explain the system to other stakeholders via its documentation and training materials
Developers	Construct and deploy the system from specifications (or lead the teams that do this)
Maintainers	Manage the evolution of the system once it is operational
Production Engineers	Design, deploy, and manage the hardware and software environments in which the system will be built, tested, and run
Suppliers	Build and/or supply the hardware, software, or infrastructure on which the system will run
Support Staff	Provide support to users for the product or system when it is running
System Administrators	Run the system once it has been deployed
Testers	Test the system to ensure that it is suitable for use
Users	Define the system's functionality and ultimately make use of it

Table 12 Rozanski and Woods classification of stakeholders (Woods and Rozanski, 2012)

As the above table shows, SA stakeholders are limited to groups directly associated with the system's development. We call them producers. In the next section, we use a sociological model (SSH) to demonstrate how we expand our stakeholder groups to include the social environment at large.

6.5.2. Synthesis of SA and SSA Models

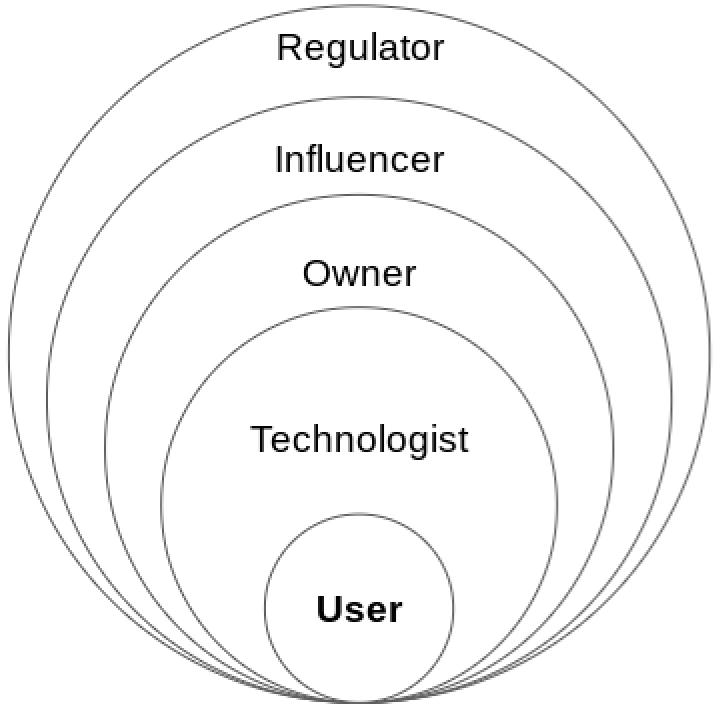

Figure 17 RIOTU Model

In this section we synthesize the above SA stakeholders model with the SSH sociological model introduced in Chapter Three, section 3.4.2. The SSH model is a simple and intuitive model. It is also a good template for SSA developers to make their own models.

In the previous Chapter Three, section 3.4.13 (Stakeholder Types: RIOTU Model), we divided stakeholders into "**user,**" "**technologist,**" "**owner**," "**influencer**," and "**regulator**." Figure 3.4.13 illustrates their hierarchy.

The SSH model includes the following.

1. **User** ["**user**"]: The **user** is divided into two subtypes: buyers and sellers. The sellers are selling ideas (or brand or leadership promoting cause), products, and/or services. The buyers can be followers or buyers of product and/or services.

2. **Family** ["**user**" or "**influencer**"]:

3. **Religion** ["**influencer**"]**:**

4. **Educators** ["**influencer**"]:

5. **Social Groups** ["**user**" or "**influencer**"]: There are a lot of social groups that are influencers or use the software application as a social network .

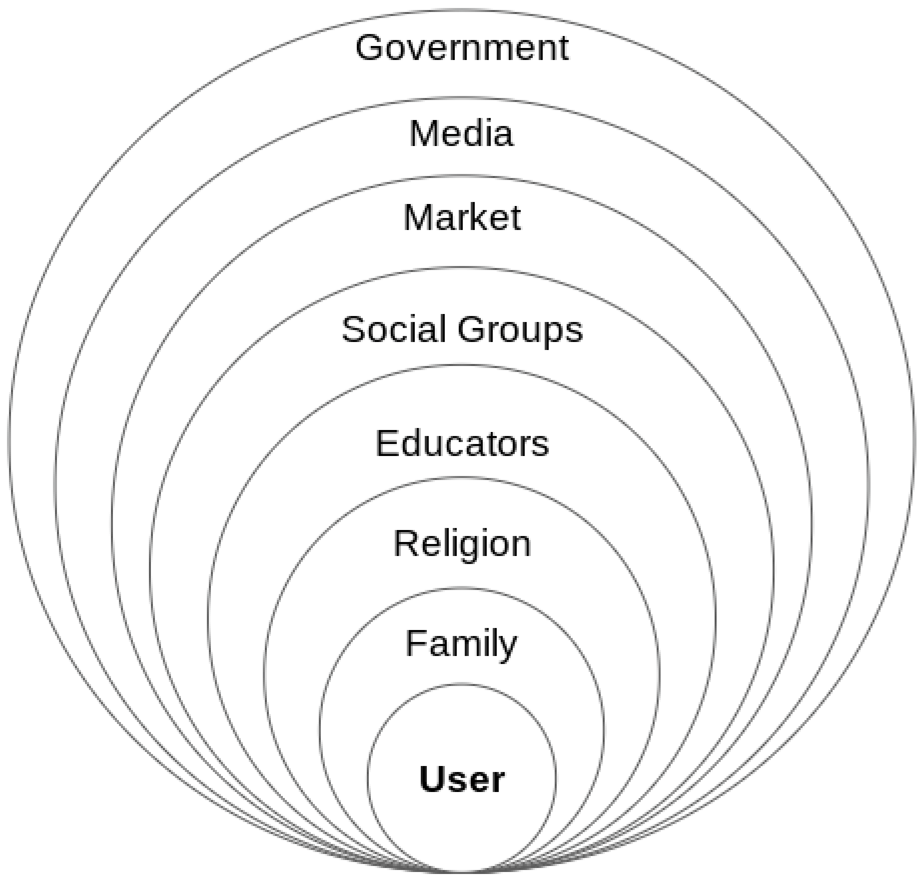

Figure 15 SSH: The "Simple Socio-Hierarchical Model" or SSH Model

6. **Market** ["**Owner**" and/or "**technologist**"]: Business or public organizations are the dominant market player in software development for commercial purposes. Since they are investing in the software for their business interests, their SRs (including

business requirements) can become very dominant in priority. In the business environment, you have multiple SA interest groups (sometimes called departments or target audiences).

7. **Media** ["**influencer**"]: The media is the most powerful general influencer after government. It is important to research and review the media trends.

8. **Government** (federal, state, and local) ["**regulator**"]: The **regulator** is, depending on the case study and the level of regulations in that particular environment, the ultimate influencer in the space.

"Without a well-defined set of quality-attribute requirements, software projects are vulnerable to failure. The authors [BARRY BOEHM and HOHIN, University of Southern California] have developed QARCC (Quality Attribute Risk and Conflict Consultant), a knowledge-based tool that helps users, developers, and customers analyze requirements and identify conflicts among them" (Boehm and In, 1996, p. 25). Their model includes the following "Win-Win" steps:

1. Identify next-level stakeholders.
2. Identify stakeholders' win conditions.
3. Reconcile win conditions. Establish next-level objectives, constraints, alternatives.
4. Evaluate product and process alternatives. Resolve risks.
5. Define the next level of product and process - including partitions.
6. Validate product and process definitions.
7. Review, commitment.

In a conflict of stakeholders situation, a win for one may be a loss for the other. How do you resolve it? This method may be adequate for softer conflicts or non-social conflicts; but is it adequate for sociological conflicts? Again, we believe sociological conflict theory methods and models may be more powerful models for conflict resolution.

6.5.3. Mapping SSA Groups

How do we map SSA groups?

At the end of the SSA grouping process we look to have a table as follows: [Please note this is an example template that can be modified based on your specific project grouping.] Please also note that Rozanski's stakeholder categorization is mirrored and colored. Please also notice how SSA requirements expands significantly on traditional SA stakeholder categorization.

Mapping of SSA groups				
	Type RIOTU Model	**SA Stakeholders**	**SSA Groups**	**SSA Rank Impact**
User/Users	User	Yes	Yes	**3**
Consumer 1	User	Yes	Yes	3.1
Consumer 2	User	Yes	Yes	3.2
Consumer 3	User	Yes	Yes	3.3
Family	Influencer	No	Yes	**9**
Education	Influencer	No	Yes	**8**
Social Groups	Influencer	No	Yes	**6**
Social Network	Influencer	No	Yes	6.1
Community	Influencer	No	Yes	6.2
Association	Influencer	No	Yes	6.4
Club	Influencer	No	Yes	6.3
Business	Owner	Yes	Yes	**1**
Executive Mgmt	Owner	Yes	No	**1**
Admin	Technologist	Yes	No	**--**

/**System Admins**				
Tech/**Developers** **/Maintainers** **/Production Engineers** **/Suppliers** **/Testers**	Technologist	Yes	No	--
Customer Support **/Support Staff** **/Communicators**	Technologist	Yes	Yes	--
Affiliate	User	Yes	Yes	**4**
Supplier/**Acquirers**	Technologist	Yes	Yes	**4**
Processor	User	Yes	No	--
Data provider	User	Yes	Yes	**5**
Media	Influencer	No	Yes	**7**
Industry	Influencer	No	Yes	7.1
General	Influencer	No	Yes	7.2
Government **/Assessors**	Regulator	No	Yes	**2**
Federal	Regulator	No	Yes	2.2
State	Regulator	No	Yes	2.3
Local	Regulator	No	Yes	2.4
Legal	Regulator	No	Yes	2.1

Table 13 Mapping of SSA groups

6.5.4. Conflict Resolution Model

In the next example, Alexander Egyed and Paul Grunbacher propose a useful approach for “Identifying Requirements Conflicts and Cooperation: How Quality Attributes and Automated Traceability Can Help” (Egyed, and Grunbacher, 2004). “Our approach is suited for identifying requirements conflicts at any state in the life cycle as long as we have as input requirements, their attributes, and their traces. We assume that any two requirements conflict or cooperate only if their software attributes do the same and a trace dependency exists between them. If dependencies among requirements aren’t available, then we generate them using a scenario-based approach to trace analysis that also requires test scenarios as input.”

They also offer the following “Model of potential conflict and cooperation:

Model of potential conflict and cooperation								
Requirement attribute	**Effect**							
	Functionality	Efficiency	Usability	Reliability	Security	Recoverability	Accuracy	Maintainability
Functionality	+	-	+	-	-	0	0	-
Efficiency	0	+/-	+	-	-	0	-	-
Usability	+	+/-	+	+	0	+	+	+
Reliability	0	0	+	+	0	0	0	0
Security	0	-	-	+	+	0	0	0
Recoverability	0	-	+	+	0	+	0	0
Accuracy	0	-	+	0	0	0	+	0
Maintainability	0	0	0	+	+	0	0	+
* + Represents a positive effect; - represents a negative effect; 0 represents no effect								

Table 14 Alexander Egyed and Paul Grunbacher propose a useful approach for Identifying Requirements Conflicts and Cooperation.

These are their model’s results in the prioritization of conflicting goals:

> Conflicts that might arise among the goals expressed by the different stakeholders will be aired. Each method includes a step in which the goals are prioritized by the group.

> If the architect cannot satisfy all of the conflicting goals, he or she will receive clear and explicit guidance about which ones are considered most important. (Of course, project management can step in and veto or adjust the group-derived priorities—perhaps they perceive some stakeholders and their goals as "more equal" than others—but not unless the conflicting goals are aired) (Clements, Kazman, and Klein, 2003, Section 2.8).

Traditional SA conflict resolution models, as shown above, may be sufficient for technical and operational requirements conflicts or soft conflicts. However, when developing SRs, we might run into serious social conflict. In Chapters 5 through 9, we will be discussing a case study of non performing debt markets. The conflict between debtors and debt collectors are tough and real making this industry the lowest consumer approval industry in the USA. we will be using conflict theory methods to examine the conflict and power struggle in courts between them.

6.5.5. SA Views and Viewpoints

Traditional SA views and viewpoints (Woods and Rozanski, 2012) (context, functional, information, concurrency, development, deployment, and operational) defined below should be mirrored with SSA development.

6.5.5.1. SA Views

“An architectural view is a way to portray those aspects or elements of the architecture that are relevant to the concerns the view intends to address—and, by implication, the stakeholders for whom those concerns are important.”(Rozanski and Woods, 2005, p. 4)

“A view conforms to a viewpoint and so communicates the resolution of a number of concerns (and a resolution of a concern may be communicated in a number of views).” (Rozanski and Woods, 2005, p. 7)

6.5.5.2. SA Viewpoints

Definition: “A viewpoint is a collection of patterns, templates, and conventions for constructing one type of view. It defines the stakeholders whose concerns are reflected in the viewpoint and the guidelines, principles, and template models for constructing its views.” (Rozanski and Woods, 2005, p. 5)

“A viewpoint defines the aims, intended audience, and content of a class of views and defines the concerns that views of this class will address.” (Rozanski and Woods, 2005, p. 7)

The following is Rozanski’s viewpoints (Woods and Roanski, 2012). We highlight in yellow section that SSA developers need to review and revize. Our discussion of these sections will be below the box and marked as SSA Discussion. The purpose of our discussion is to highlight the. difference between the SA and SSA focus. The SA focus is limited to the environment surrounding the software system. The SSA focus includes the entire social system.

Context	Describes the relationships, dependencies, and interactions between the system and its *environment (the people, systems, and external entities with which it interacts*). Many architecture descriptions focus on views that model the system’s internal structures, data elements, interactions, and operation. Architects tend to assume that the “outward-facing” information — the system’s runtime context, its scope and requirements, and so forth – is clearly and unambiguously defined elsewhere. However, you often need to include a definition of the system’s context as part of your architectural description.
	SSA Synthesis Discussion: Rozanski’s environment is limited to “the people, systems, and external entities with which it interacts.” The SSA environment (as discussed later in section 4.6) is a three dimensional model. The first dimension is the sociological model (such as SSH Model: “user, family, education, social groups, business, media, and the state.” The second dimension is quality: material, intellectual, and sentimental. The third dimension is process: concern => resolution => interaction => and transaction. Hence, the SSA environment captures the social system with its social grouping, qualities, and process. The SA environment centers

	primarily around the technical interaction; the SAA environment includes the entire social system.
Functional	Describes the *system's functional elements*, their responsibilities, interfaces, and *primary interactions*. A Functional view is the cornerstone of most ADs and is often the first part of the description that stakeholders try to read. It drives the shape of other system structures such as the information structure, concurrency structure, deployment structure, and so on. It also has a significant impact on the system's quality properties such as its ability to change, its ability to be secured, and its runtime performance.
	SSA Synthesis Discussion: Rozanski's "system's functional elements" and "primary interactions" are limited to the software system's interactions. SSA functional elements and interactions includes related social interactions.
Information	Describes the way that the architecture stores, manipulates, manages, and distributes information. The ultimate purpose of virtually any computer system is to manipulate information in some form, and this viewpoint develops a complete but high-level view of static data structure and information flow. *The objective of this analysis is to answer the big questions around content, structure, ownership, latency, references, and data migration.*
	SSA Synthesis Discussion: The SA objective is limited to the environment surrounding the software system. The SSA objective includes the entire social system.
Concurrency	Describes the concurrency structure of the system and maps functional elements to concurrency units to clearly identify the parts of the system that can execute concurrently and how this is coordinated and controlled. This entails the creation of models that show the process and thread structures that the system will use and the interprocess communication mechanisms used to coordinate their operation.

	SSA Synthesis Discussion: Concurrency is an SA, not SSA issue.
Development	Describes the architecture that supports the software development process. *Development views communicate the aspects of the architecture of interest to those stakeholders involved in building, testing, maintaining, and enhancing the system.*
	SSA Synthesis Discussion: SA is focused on "interest to those stakeholders involved in building, testing, maintaining, and enhancing the system." SSA includes the interest of SSA stakeholders.
Deployment	Describes the environment into which the system will be deployed, including capturing the dependencies the system has on its runtime environment. This view captures the hardware environment that your system needs (primarily the processing nodes, network interconnections, and disk storage facilities required), the technical environment requirements for each element, and the mapping of the software elements to the runtime environment that will execute them.
	SSA Synthesis Discussion: Deployment is an SA, not SSA issue.
Operational	Describes how the system will be operated, administered, and supported when it is running in its production environment. For all but the simplest systems, installing, managing, and operating the system is a significant task that must be considered and planned at design time. The aim of the Operational viewpoint is to identify system-wide strategies for addressing the operational concerns of the system's stakeholders and to identify solutions that address these.
	SSA Synthesis Discussion: Operational is an SA, not SSA issue.

Table 15 SSA Synthesis Discussion of Rozanski's viewpoints (italics added)

6.5.6. SA Perspectives

Rozanski's definition of an architectural perspective is as follows:

> an architectural perspective is a collection of activities, checklists, tactics and guidelines to guide the process of ensuring that a system exhibits a particular set of closely related quality properties that require consideration across a number of the system's architectural views (Woods and Rozanski, 2012).

In other words, a perspective is a collection of guidance on achieving a particular quality property in a system . Our definition of an SSA perspective takes into consideration the entire three dimensions (social group model, qualities, and process) social environment. SA concerns are limited to "achieving a particular quality property in a (software) system." SSA concerns look beyond to achieving a particular quality property in a social system.

A perspective contains the following information:

- the *Concerns* that the perspective is addressing;
- the *Applicability* of the perspective to the different possible architectural views of a system (and the types of system to which the advice within it relates, if this is not obvious);
- a set of possible *Activities* that are suggested as part of the process of achieving the quality property (ideally related to each other via a process to follow);
- a set of proven *Architectural Tactics* (i.e. design strategies) [3] that the architect can consider as part of their design;
- a list of common *Problems and Pitfalls* that the architect should be aware of and common solutions to them; and finally
- a *Checklist* that the architect can use to help ensure that nothing has been forgotten (Woods and Rozanski, 2005).

Rozanski's "Perspective Catalog" included the following: Accessibility, availability and resilience, development resources, evolution, internationalization, location, performance and scalability, regulation, security, and usability. “Regulation,” “internationalization,” “security,” and “usability” all have sociological dimensions to them. Otherwise it is technical and operational perspectives.

The following is Rozanski’s perspectives (Woods and Rozanski, 2012). We highlight in yellow section that SSA developers need to review and revize. Our discussion of these sections will be below the box and marked as SSA Discussion. The purpose of our discussion is to highlight the. difference between the SA and SSA focus. The SA focus is limited to the environment surrounding the software system. The SSA focus includes the entire social system.

Accessibility	The ability of the system to be used by people with disabilities
SSA Synthesis Discussion: Accessibility is an SA, not SSA issue.	
Availability and Resilience	The ability of the system to be fully or partly operational as and when required and to effectively handle failures that could affect system availability
SSA Synthesis Discussion: Availability and resilience are SA, not SSA issues.	
Development Resource	The ability of the system to be designed, built, deployed, and operated within known constraints around people, budget, time, and materials
SSA Synthesis Discussion: Development resources should take into consideration modifications due to the SSA synthesis.	
Evolution	The ability of the system to be flexible in the face of the inevitable change that all systems experience after deployment, balanced against the costs of providing such flexibility
SSA Synthesis Discussion: Evolution is an SA, not SSA issue.	

Internationalization	The ability of the system to be independent from any particular language, country, or cultural group
SSA Synthesis Discussion: Internationalization is an SA, not SSA issue.	
Location	The ability of the system to overcome problems brought about by the absolute location of its elements and the distances between them
SSA Synthesis Discussion: Location is an SA, not SSA issue.	
Performance and Scalability	The ability of the system to predictably execute within its mandated performance profile and to handle increased processing volumes
SSA Synthesis Discussion: Performance and scalability is an SA, not SSA issue.	
Regulation	*The ability of the system to conform to local and international laws, quasi-legal regulations, company policies, and other rules and standards*
SSA Synthesis Discussion: SA regulations are limited to software system regulations. SSA regulations extend to social environment regulations.	
Security	The ability of the system to reliably control, monitor, and audit who can perform what actions on what resources and to detect and recover from failures in security mechanisms
SSA Synthesis Discussion: Evolution is an SA, not SSA issue.	
Usability	*The ease with which people who interact with the system can work effectively*
SSA Synthesis Discussion: SSA usability may include SSA users not previously considered by SA developers.	

Table 16 SSA Synthesis Discussion of Rozanski's perspectives (italics added)

6.5.7. SRs Development

Once we define our SSA groups, we should evaluate each group's stakes. We follow the groups in terms of "SSA Rank."

	SSA Requirements Development
1. Market (Owner):	We start with the owner's G&Os. These could be broad and open for multiple scenarios; they could be narrow, specific, and rigid; and it could be a mix of both. Having flexibility for multiple scenarios allows for better optimization. If there is flexibility, the mapping of the owner's SSA Requirements may have to go through multiple iterations to achieve specific and well defined best G&Os optimization.
2. Government (Regulator):	Regulators determine the limits of the laws and what can and can't be done. Regulator's SSA requirements can be defined as the rules of the game or SSA regulatory requirements.
3. User (User/Buyer/ Consumer): 4. Affiliate and/or Supplier (User/Seller): 5. Data Provider (User/Marketer)	If the buyer and the seller are transacting in a free market environment with competition, then the relationship between should be permitted, persuasive, and by choice and agreement. If the environment is coercive (as in dead collection or legal disputes), then the transaction is hostile and often unpleasant and forceful. The Marketer is the communication channel between the buyer and the seller.

6. Social Groups (Influencer): 7. Media (Influencer): 8. Education (Influencer): 9. Family (Influencer):	Often these influencer groups can be forgotten is a traditional SA development process. We should look at committing some development resources to address as many of the influencer's SSA requirements as possible given an expectation of positive ROI (Return on Investment). After determining above SSA requirements, we should look at the Influencers and try to maximize the remaining resources to optimize Influencer's SSA requirements to help optimize the entire project.

Table 17 Mapping stakeholders stakes

We want to identify each group's pain points (problems) and desired solutions (market demand). Another supportive technique that can help prioritize SSA requirements are Patton's models below (Patton, 2005).

How high are the stakes for various primary stakeholders?	**Estimate of Various Stakeholders' Inclination Toward the Program**		
	Favorite	Neutral or Unknown	Antagonistic
High	**SSA Discussion**: The SSA developer should look at this table as a template. It should be modified to fit the SSA developer's data. Instead of using ordinal ranking like low, moderate, and high, the developer can use interval ranking (1 to 10).		
Moderate			
Low			
SOURCE: Patton (1997a:344) NOTE: Construct illustrative case studies for each cell based on field work			

Table 18 Patton's EXHIBIT 8.9: Mapping Stakeholders' Stakes

6.6. SSA Environment

The second SR is SSA Environment. The SSA environment differs from the SA environment. The SA environment limits itself to the software system. The SSA environment includes the entire social system including social groups, qualities, and process. Social groups are determined using SSA sociological models (Chapter Three). Social qualities are: material, intellectual, and sentimental qualities. The material include financial affairs, the human body (food, clothing, shelter, and medical), property, living space, transportation, geography, marketplace, the government, etc. The intellectual include religion, education, culture, knowledge development, information, communication space, entertainment, etc. The sentimental includes social, political, religious, ethnic, racial, brand, attachment, asabiyyah, etc. Sentimental qualities and related feelings affect users' interactions and transactions. The social process encompases concern, resolution, interaction, and transaction. Interaction looks at how the SSA Stakeholders interact, play their social roles, and project their behavior with actions, reactions, and responses, and how they express concerns, demand resolutions, interact and conclude transactions. The components of the sociological environment should be identified and clearly defined using sociological methods and techniques.

2nd and 3rd dimension: **Qualities** & **Process**	**SSA Environment**			
	SSH Model (1st dimension)**: user, family, education, social groups, business, media, and the state**			
	Concern =>	**Resolution** =>	**Interaction** =>	**Transaction**
Material (physical)				
Intellectual (thinking)				
Sentimental (feeling)				

Table 19 SSA Environment

The SSA environment development process is as follows: discover the concern, conjecture its resolution, plan and design its interaction including desired outcome scenario, test and operate its transaction, then measure, analyze and report its results.

6.7. SSA Interface

The third SR is SSA Interface. This includes the medium or media used, the user experience, interactions, transactions, reviews, feedback, etc. We want to identify, define, qualify and quantify the right medium, including the internet, mobile, email, texting, print, video, and/or etc. It is also confirmation that the user experience is streamlined, efficient, easy, attractive, pleasant, entertaining, functional, purposeful, and/or etc. It confirms that it produces the desired interactions and promote the desired actions and transactions. And it confirms that we have the necessary feedback and review interface and interaction. Verification confirms that we are executing the elements and components of user interface, interactions, and transactions in the right way producing optimal outcomes and maximal return on investment. SSA developers want to achieve the highest and best response. On the other hand, SSA developers should track and understand what is not going right so it can be fixed and verified.

6.8. SSA Behavior

The fourth SR is SSA Behavior. This includes the investigation of SSA user roles, actions, reactions, interactions, and responses. SSA users are studied in terms of their SSA social group/Sociological Stakeholders. We also study the “right” gender, ethnic, age, generational, and/or other social attributes shared with the SSA group. This is the most important of SRs. The value gained by SSA development is measured through the actions, reactions, and/or responses desired and achieved from the SSA nser interaction with the SSA application.

SSA behavior should be transactional. This means a closure on user response. SSA developers should build transactional pipeline and collect data on response, non-response, transactions, and transaction failures. Behavior interactions include: branding, education, advisory, lifestyle, demographics, social feature, social network, communication, connectivity, utility tools, health, weather, news, information security and privacy, affiliation (leader, star, group, etc.), advocacy, activism (feminism, poverty, child protection, consumer protection, etc.), politics (liberal, conservative, radical, activist, etc.), confidentiality, language, cultural identity, etc.

6.9. Conclusion:

We have demonstrated in this chapter how to synthesize and integrate SSA methods, approaches, models, and techniques into the five stages of scientific development, discovery, conjecture, planning and design, operations, and reporting. We developed a “Step by Step Checklist” (Table 11) that serves as a road map for SSA application development. Furthermore, we have clearly defined what are SSA requirements. SA stakeholders are turned into social groups called SSA groups. The SA environment is expanded to the social situation and called SSA environment. The SA interface is enhanced with social interaction and called SSA interface. And last but not least, the SA action desired is integrated with the social role and called SSA behavior. In synthesizing the SA and SSA models, we developed the RIOTU model. This model helps SSA developers expand their environment from the system environment to the social environment.

7. Chapter Seven

Assessment:

Validation, Verification, and Evaluation

7.1. Introduction

The chapter discusses methods of validation, verification, and evaluation. It aims to give the SSA developers the proper assessment tools to insure they are developing the right sociological requirements (validation), are developing them right (verification), and are on the right path to achieving desired sociological goals and objectives ("G&Os") (evaluation). The third case studies section discusses applications used for the development of sociology of software architecture and reviews candidate case studies. This "how to" manual aims to empower SSA application development. We ask and answer the following questions: What are SSA requirements? How do we define, qualify, and/or quantify SSA groups (stakeholders) using group models and/or sociological theory frameworks? How do we apply methods, approaches, models, and techniques to map SSA requirements? Then we discuss some applications including ones that we have researched, developed, and examined ourselves exploring and developing SSA methodology. This paper's goal is to be a practical training and demonstration manual on how to develop, apply, and validate SSA requirements.

Assessment is "the action or an instance of making a judgment about something" (MWD, 2019). The Cambridge dictionary defines it as "the act of judging or deciding the amount, value, quality, or importance of something, or the judgment or decision that is made" (CED,

2019) We define SSA Assessment as the action of making an approval, decision, or judgement on whether we are developing the right SRs, whether we are developing them the right way, and whether the SSA development is meeting its G&Os. The G&Os include quality production, value generation, increased return on investment, optimization, cost effectiveness, prioritization, importance, etc. We break SSA Assessment into three assessment types: validation, verification, and evaluation.

7.1.1. Validation

Validation (Kirk, Miller, and Miller, 1986; Carmines and Zeller, 1979; Wainwright, 1997; and Heise and Bohrnstedt, 1970) is “the act or process of making something officially or legally acceptable or approved,” or the “proof that something is correct” (CED, 2019). By SSA Validation we mean the action of making an approval, decision, or judgement on whether we are developing the right SRs. SSA Validation is a method to confirm that we are developing the correct/right SSA application and/or product.

7.1.2. Verification

Verification is “the process of testing or finding out if something is true, real, accurate, etc.”(CED, 2019). We define SSA Verification as the action of making an approval, decision, or judgement on whether we are developing the SRs accurately or the right way. SSA Verification is a method to confirm that we are developing the correct/right SSA application and/or product right.

7.1.3. Evaluation

Evaluation is “the process of judging something's quality, importance, or value, or a report that includes this information” (CED, 2019). We define evaluation as the action of making an approval, decision, or judgement on whether the SSA development is meeting its G&Os including quality, importance, and value. SSA Evaluation is a measurement method to confirm our progress towards achieving our SSA development G&Os with optimal results.

Assessing social behavior is much more complex and challenging than assessing IT behavior; social behavior is much more complex, has apparent and hidden variables (such as intent), and generates more qualitative than quantitative data. This is why we focus on statistics for sociology (i.e. SPSS). IT developers have the advantages and experience of having a toolbox of continuous user feedback data collection; we advocate using it for a better assessment of social requirements. There is a Cambrian explosion of consumer data and attributes. It is easier and cheaper to acquire. It can be very powerful in discovering sociological trends, and behavior elasticity and propensity. With the exponential growth and advancement of data science, many data transformation techniques allow for better transformation of qualitative to quantitative data. This is a promising era in the rapid development of assessment techniques that can keep the SSA developer's promise of efficiency, productivity, and optimization high and attractive. And the benefits could be mammoth.

Sociological research methods encourage to pay attention to gender, ethnic, cultural, and generational variations. There is a strong sociological momentum to promote and support consumer empowerment through distributed technology. This is an opportunity for SSA developers to exploit the wave and generate appreciable added value and benefits. We should be aware of whether we are promoting social cohesion or division, conflict or resolution, social interactionism or rejectionism, progressiveness or backwardness, etc. Regarding SRs, the law is often not as technical and clear as it is for SA technical and operational requirements; dealing with the FDA or FCC on IT requirements is much easier that dealing with the CFPB on consumer protection requirements. In this case, professional legal opinion from one or more experts in the specific law domain becomes very important for proper legal assessment.

How do we make the best and most optimal judgements and/or decisions?

The best and most optimal judgements and/or decisions are based on empirical science; they are quantitative, measurable, and testable. And they are easier to confirm through methodical assessments. However, not all decisions can be based on empirical science. The social sciences are challenged with the complexity of animate human behavior, a large number of unknown and known variables (more unknowns than knowns), and the complexity and variation of intelligent behavior (Savage and Burrows, 2007). Hence, not all sociology is quantitative. It is often qualitative and subjective; but it has to be rational knowledge, methodical, and well grounded and supported by the cumulative body of knowledge development. Johnson, Burke, Russo, and Schoonenboom call it "the meeting of philosophy, science, and practice (Johnson, Russo, and Schoonenboom, 2019). In SSA development, our decision making depends on a spectrum of methodical rational knowledge. This ranges from objective and replicable scientific knowledge based on empirical, quantitative, measurable, and testable data to subjective and not easily replicable near-scientific knowledge based on qualitative data and subjective theoretical frameworks. This spectrum of knowledge helps us contemplate, deliberate, and make optimal decisions.

How do we assess our SSA development?

We identify three forms of assessment: structural, component, and operations assessment. This is represented by a triangular diagram. The three sides include: "team and testing," "data and analytics," and "opinion and advice." Having the right team and doing things right especially conducting tests and making decisions on empirical evidence whenever possible is the most important factor to achieving the SSA G&Os. Data and analytics give us empirical evidence on which we can make better judgements and sounder decisions. Opinion and

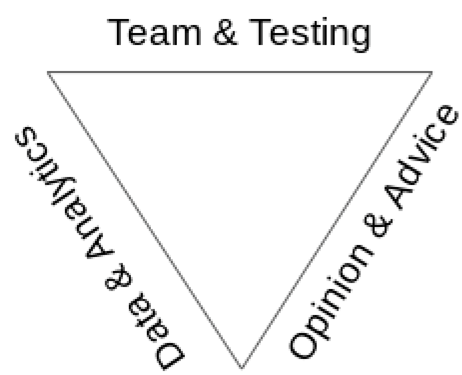

Figure 18
Triangular SSA
Assessment Structure

advice are necessary to insure that non-empirical qualitative variables are assessed best using expert and professional opinion and advice.

7.1.4. Structural Assessment

We start by assessing if we have the right team, if the team is operating the right way, and if we can measure members' contribution to progress towards SSA development G&Os.

✓		**SSA Structural Assessment Checklist**		
		Validation	**Verification**	**Evaluation**
		Team & Testing		
	Team	Do we have the right team?	Is the team operating the right way?	Can we measure team members contribution to progress?
	Testing, prototypes, & beta versions	Are we using the right tests?	Are we testing right?	Does the test measure progress?
		Theoretical and Empirical		
	Theoretical			
	Empirical			
		Data & Analytics		
	Own project data, knowledge, & experience	Are we collecting the right data?	Are we collecting it the right way?	Can we measure data value and contribution to progress?
	Public domain data	Right data?	Right way?	Measure?

	Academic data, knowledge, and research	Right data?	Right way?	Measure?
	Commercial	Right data?	Right way?	Measure?
	Industry circles data and Knowledge	Right circles, data, and knowledge?	Using resources right?	Measure cost and contribution to progress
	Government data, knowledge, and guidelines	Right data, knowledge, & guidelines	Using resources right?	Measure cost and contribution to progress.
		Opinion & Advice		
	Advisory board	Do we have the right mix of advisors? Are they the right advisors?	Do we use the advisory board the right way to produce good advice?	Can we measure advisors and advice value and contribution to progress?
	Expert opinion & consulting	Are we hiring the right expert or consultant?	Are we using their resources right?	Can we measure their contribution to progress and conduct a meaningful cost benefit analysis?
	Professional opinion	Right pro?	Using pro right?	Measure contribution?

Table 20 SSA Assessment checklist

7.1.5. Component Assessment

There are five components to the SSA structure: software architecture, coding applications, cost benefit analysis, SRs, and sociological data operations. The following is a check list of the areas of interest to SSA developers. These include software architecture, coding applications, cost benefit analysis, SRs and sociological data operations. Software architecture and coding applications development follows the assessment methods of their disciplines. SSA development shares in the cost benefit assessment (secondary focus). However, our primary SSA development assessment focuses on SRs and sociological data operations. Table 4.12 is an assessment checklist table. Green check marks are the primary focus of SSA development assessment and gray check marks are the secondary shared focus.

	SSA Component Assessment Checklist				
	SA Software Architecture	Coding Applications	Cost Benefit Analysis	SRs Sociological Requirements	Sociological Data Operations
Validation (building the right solution)			✓	✓	✓
Verification (doing it the right way)			✓	✓	✓
Evaluation (measuring progress relative to G&Os)			✓	✓	✓

Table 21 SSA Assessment checklist

7.1.6. Operations Assessment

Operations assessment is three types: quantitative, qualitative, or mixed data operations. Quantitative data assessment follows the tools of statistics or data science applications and techniques for validation, verification, and evaluation. Qualitative data operations is two types: sociological or non-sociological. Qualitative sociological data operations follow sociological assessment methods and techniques. Qualitative non-sociological operations include professional, expert, and consultant opinions and advice. These are assessed using professional business or public management methods and techniques. Mixed (quantitative and qualitative) data operations are three types: sociological, non-sociological, or mixed sociological and non-sociological. Mixed sociological operations utilize sociological mixed methods and techniques (Johnson, Russo, and Schoonenboom, 2019). Mixed non-sociological operations utilize non-sociological mixed methods and techniques. And Mixed sociological and non-sociological mixed methods can be synthesized. In this synthesis, the SSA team should develop guidelines to mitigate conflicting results. Should non-sociological expert opinion and advice weigh more or less heavily in the decision process. For example, smaller entrepreneurial startup technology companies may rely much more heavily on entrepreneurial decision making. Larger public organizations may rely more heavily on sociological conclusions.

7.2. Assessment of Sociological Requirements

Our SRs have four components (Kassir, 2019, Chapter One, Section 1.7):

1. Sociological stakeholders = social groups
2. Sociological environment = social situation
3. User interface = social interaction
4. User behavior = social role and action desired

Table 22 is an example of the type of assessment questions we need to investigate.

	Assessment of Sociological Requirements		
	Validation	**Verification**	**Evaluation**
Sociological Stakeholders (Social groups)	Right groups? Right order?	Did we define, qualify, and quantify group properly?	Measure and size progress on groups, sub-groups, segments, responders, nonresponders
Sociological Environment (Social Situation)	Right market? Right structure? Government?	Did we included all the related elements and/or components in the social situation?	Measure and size market/situation penetration as well as adding new situations and markets
User Interface (Social Interaction)	Right Media? Internet? Mobile? Other?	Are we using the optimal media and interface design?	Measure and size medium broadcasting as well as quality and quantity of interactions
User Behavior (Social role & Action Desired)	Right action or role? Right response?	Did we clearly define, qualify, and quantify the action/role progress desired.	Measure types of response, transactions, and engagements, size value per transaction,

Table 22 Assessment of Sociological Requirements

How are the terms “sociological” and “social” are used differently?

We use the term “social” to mean and group of people that have common social behavior. Their behavior could be based on socioeconomic, work, ethnic, racial, sex, demographic, generational or any other common attributes producing similar behavior. We use the term “sociological” to mean a social group that has science based definitions and attributes based on quantitative and/or qualitative data analytics. The term social is more general; the term sociological is more science specific.

Assessment of sociological stakeholders includes validation that we are identifying, defining, qualifying, and quantifying the right social groups. Verification of sociological stakeholders means we have applied the proper sociological methods and techniques to sociological (quantitative and/or qualitative data) to define the sociological stakeholders. Evaluation of sociological stakeholders means a measurement method to determine if the inclusion of a specific sociological stakeholder group confirms a cost effective value contribution towards the achievement of SSA development G&Os.

Assessment of the sociological environment includes validation that we are targeting the right social situation(s). Validation of the sociological environment means we are targeting the right sociological environment with the right components. Verification of the sociological environment means we are using the proper sociological methods and techniques to identify, qualify, and/or quantify them. Evaluation of the sociological environment means measuring the value and contribution of each specific component to the progress of our SSA development G&Os. An example is the creation of product branding attachment in college environment, or the changing of a sociological group’s political environment to support or oppose certain policies or causes, or creating a transaction momentum or trend that generates more sales and revenues for a company.

An SSA assessment of the user interface includes assessing the medium or media used, the user experience, interactions, transactions, reviews, feedback, etc. Validation of user interface is confirmation that we are using the right medium: Evaluation of the user interface measures the value and optimization generated from each and every resourced invested exceeds the cost of development. User interface evaluation should measure its contributions to the SSA development G&Os.

An SSA assessment of user behavior includes an investigation and assessment of the roles, actions, and reactions or responses by users while taking into consideration their sociological stakeholder grouping and group behavior. SSA user behavior validation means a confirmation that we have identified and targeted the right roles, actions, and reactions or responses. Within a sociological stakeholder group, the “right” gender, ethnic, age, generational, and/or other roles should be identified, defined, qualified, and/or quantified. Similarly, the “right” user behavior actions and reactions or responses should be validated. Verification means we can confirm that the SSA development is using the “right” sociological methods and/or techniques to develop the SSA user behavior components. Evaluation confirms that the “right” development of the “right” SSA user behavior components contributes measurable and cost effective value to the achievement of overall SSA G&Os.

7.3. Assessment of Quantitative Data Operations

Assessment of quantitative data operations begins with the selection of the right tools for its application. Sociological data can best be assessed using social science specialized tools such as SPSS. Data analytics methods, approaches, models, techniques, and assessment tools have produced a wide variety of assessment tool choices. SSA developers plan and design their architecture with added consideration for the collection of SSA data (data related to SSA requirements) and for considering sociological data analytics when selecting their data management, analytics, and assessment tools. We break this assessment into two stages: data preparation and data analytics and modeling. Data preparation includes data collection, acquisition, treatment, and enhancement. Data collection centers on your own data collection operations. We want to assess if we are collecting the right data, collecting it the right way, and if can measure its importance, value, and contribution to G&Os’ progress.

The following [EXHIBIT 8.10] is Patton's example (three dimensional graph) for data collection and analysis. This conceptual guide model is a good template to use and expand upon.

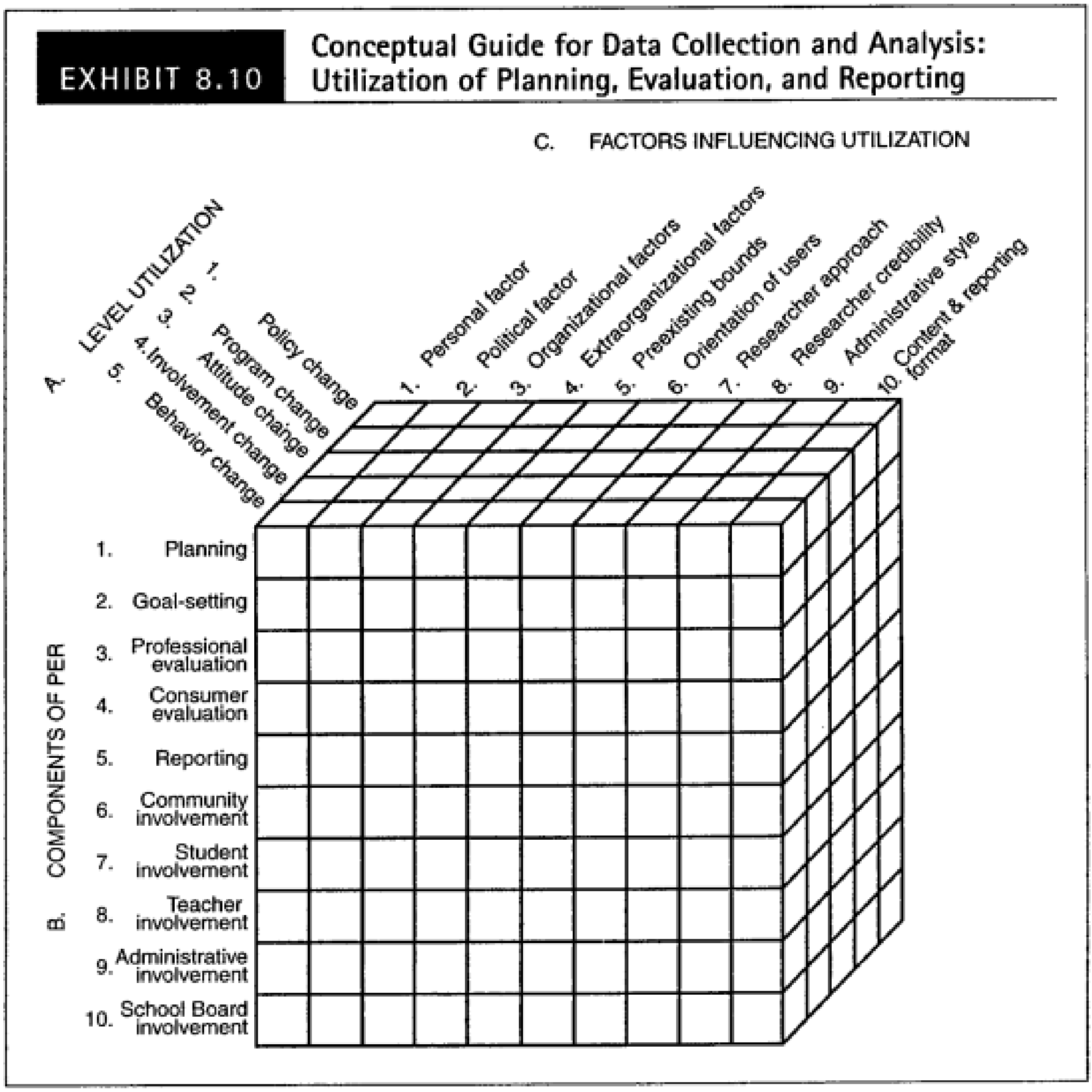

Figure 19 Patton's Conceptual Guide for Data Collection and Analysis

Data acquisition includes any third party academic, public domain, industry, commercial, and/or government data source. The application of data treatment comprises of missing values, outliers fixing, cleaning, deduping, and transforming data. And data enhancement involves appending with additional attributes. In each operation, we should validate that we are operating the right data, verify that we are doing it the right way, and measure our operation's value and contribution to O&Gs' progress.

Method	**Assessment of Quantitative Data Operations**		
	Validation	**Verification**	**Evaluation**
	Methods		
Existing data	Right method?	Applied right?	Measure progress?
Observational	Right method?	Applied right?	Measure progress?
Correlational	Right method?	Applied right?	Measure progress?
Experimental	Right method?	Applied right?	Measure progress?
Data	**Preparation**		
Collection (of your own)	Collecting the right data?	Collecting it the right way?	Measure how this contributes progress to goals/objectives?
Acquisition (Academic, public domain, industry, commercial, and government)	Acquiring the right data? Choose the best data from various sources.	Acquiring it the right way? Licensing, right attributes, etc.	Measure the value of acquired data to achieve goals/objectives?
Treatment (Missing values, outliers fixing; cleaning, deduping, and transforming)	Applying the right treatment?	Applying it the right way?	Measure contribution value of treatment towards G&Os?
Enhancement (appending with additional attributes)	Appending the right attributes?	Appending it the right way?	Measure contribution value of enhancement towards G&Os?

	Analytics & Modeling (Hair, *et al.*, 2006; Peirson, Butler, and Foster, 2003; and Cresswell and Cresswell, 2017) (Understanding & visualizing relationships & associations)		
Prescriptive (find the best SSA course of action)	Right operation?	Right application of operation?	Measure value and contribution to G&Os' progress?
Descriptive (Extracting and delivering new or meta attributes, Knowledge, or value from data)	Right operation?	Right application of operation?	Measure value and contribution to G&Os' progress?
Predictive (Make predictions about future and unknown events)	Right operation?	Right application of operation?	Measure value and contribution to G&Os' progress?

Table 23 Assessment of Quantitative Data Operations

Data analytics (Hair, *et al.*, 2006) an (Peirson, Butler, and Foster, 2003) and modeling includes perspective, descriptive, and predictive. Similarly, we need to validate the right method, verify right application of method, and measure its value and contribution to G&Os' progress. A key decision towards best results is to make sure we are using the right application.

7.4. Assessment of Qualitative Data Operations

We divided qualitative data into sociological and non-sociological data, decision making, and advice. In this study, we focus on sociological methods (Denzin, 2017) for the assessment of qualitative data (Giorgi, 1997; and Cole and Cole, 1971).

There are four primary sociological methods (Patton, 1987) that may generate qualitative data: survey, interview, fieldwork, and case study (Yin, 2013). And there are three primary threats to the validity and reliability of these methods: bias (personal, team, institution, etc.), subjectivity, and ethical considerations. Patton's qualitative evaluation checklist guides...

> evaluators in determining when qualitative methods are appropriate for an evaluative inquiry and factors to consider (1) to select qualitative approaches that are particularly appropriate for a given evaluation's expected uses and answer the evaluation's questions, (2) to collect high quality and credible qualitative evaluation data, and (3) to analyze and report qualitative evaluation findings (Patton, 2003).

	Assessment of Qualitative Data Methods		
	Validation	**Verification**	**Evaluation**
	Data Collection Method		
Survey	Right method?	Applied the right way?	Measure O&Gs' progress?
Interview	Right method?	Applied the right way?	Measure O&Gs' progress?
Fieldwork	Right method?	Applied the right way?	Measure O&Gs' progress?
Case study	Right method?	Applied the right way?	Measure O&Gs' progress?
	Threat		
Bias	Identify bias?	Mitigated properly?	Measure O&Gs' progress?
Subjectivity	Identify subjectivity?	Mitigated properly?	Measure O&Gs' progress?
Ethics	Identify ethics?	Mitigated properly?	Measure O&Gs' progress?
	Mixed Method Assessment & Design		

Sequential explanatory & exploratory	Right method?	Applied the right way?	Measure O&Gs' progress?
Concurrent triangulation and nested	Right method?	Applied the right way?	Measure O&Gs' progress?
Transformative sequential and concurrent	Right method?	Applied the right way?	Measure O&Gs' progress?
Complementary	Right method?	Applied the right way?	Measure O&Gs' progress?

Table 24 Assessment of Qualitative Data Methods

This study aims to introduce the SSA developer to the variety of sociological research and assessment methods including mixed methods (Creswell and Creswell, 2017; Caracelli and Greene, 1993; and Johnson, Onwuegbuzie, and Turner, 2007). We focus on a few of them especially sequential (Falleti and Mahoney, 2015), concurrent (Conger and Killeen 1974), transformative (Cram and Mertens, 2015) and complementary (Coffey and Atkinson, 1996) methods. Sequential methods are explanatory (Baskerville and Pries-Heje, 2010) and & exploratory (Schmitt, 2011). Concurrent methods are triangulation (Hales, 2010; Jick, 1979; Hussein, 2009; and Morse, 1991) and nested (Karlson, Holm, and Breen, 2012). Transformative methods are sequential (Falleti and Mahoney, 2015) and concurrent (Conger and Killeen, 1974). Other methods include complimentary, development, initiation, and expansion methods.

> By examining published research, Greene, Caracelli, and Graham (1989) inductively identified the following five broad purposes or rationales of mixed methodological studies: (a) triangulation (i.e., seeking convergence and corroboration of results from different methods studying the same phenomenon), (b) complementarity (i.e., seeking elaboration, enhancement, illustration, clarification of the results from one method with results from the other method), (c) development (i.e., using the results from one method to help inform the Johnson *et al.* / Toward a Definition 115 © 2007 SAGE

> Publications. All rights reserved. Not for commercial use or unauthorized distribution. Downloaded from http://mmr.sagepub.com at PENNSYLVANIA STATE UNIV on April 10, 2008 116 Journal of Mixed Methods Research other method), (d) initiation (i.e., discovering paradoxes and contradictions that lead to a reframing of the research question), and (e) expansion (i.e., seeking to expand the breadth and range of inquiry by using different methods for different inquiry components) (Johnson, Onwuegbuzie, and Turner, 2007, p. 115-116).

For a deeper look at sociological methods, we recommend the following sources: Denzin’s “Sociological methods: A sourcebook” (Denzin, 2017), Durkheim’s “The rules of sociological method: and selected texts on sociology and its method” (Durkheim, *et al.*, 1938), and Giddens’ “New rules of sociological method: A positive critique of interpretative sociologies” (Giddens, 2013) To study the challenges facing sociological research and methods we recommend the following books: Savage and Burrows’ “The coming crisis of empirical sociology” (Savage, M. and Burrows, 2007) and “After the crisis? Big Data and the methodological challenges of empirical sociology” (Burrows and Savage, 2014), and Yin’s “Yin, Robert K. "The case study crisis: Some answers" (Yin, 1981). For new and future methods of sociology we recommend the following: Giddens’ “New rules of sociological method: A positive critique of interpretative sociologies” (Giddens, 2013) and “Levitas, Ruth. "Back to the future: Wells, sociology, utopia and method" (Levitas, 2010).

7.5. Methods for Testing the Value of SSA Methodology

There are two methods to test the value of SSA method implementation and its contribution to the SA development project. The first method looks at existing application and results, applies SSA methods, measures the difference, analyzes results, and assesses its value and contribution to the progress towards the projects G&Os. The second method applies to new projects. It creates two versions: A & B. Then it compares benefits vs costs. SSA assessment includes identification of successes, shortcomings, and new SSA development versions or frontiers.

7.6. Methods of Software Architecture Testing

In this section we list some software architecture foundations, theory, practice, testing, and analysis and assessment methods resources. We aim to emphasize to SSA developers the importance of conducting SA assessment methods in synchrony and synthesis with SSA methods.

1. Foundations, theory, and practice (Medvidovic and Taylor, 2010)
2. Introduction to the Special Issue on Software Architecture (Garlan and Perry, 1995)
3. Software Architecture Evaluation Methods – A survey (Shanmugapriya and Suresh, 2012)
4. A Survey on Software Architecture Analysis Methods (Dobrica and Niemelä, 2002)
5. Software Architecture Quality Analysis Methods (Dobricaand Niemelä, 2002, April)
6. Comparison of Software Product Line Architecture Design Methods: COPA, FAST, FORM, KobrA and QADA (Matinlassi, 2004)
7. A Framework for Classifying and Comparing Software Architecture Evaluation Methods (Babar, Zhu, and Jeffrey, 2004)
8. Agile Software Development Methods: Review and Analysis (Abrahamsson, *et al.*, 2017)
9. A Comparative Analysis of Software Architecture Evaluation Methods (Athar, Liaqat, and Azam, 2016)
10. Software Architecture Evaluation Methods for Performance, Maintainability, Testability, and Portability (Mattsson, Grahn, and Mårtensson, 2006)
11. Preparing for a Literature Survey of Software Architecture using Formal Concept Analysis (Couto, *et al.*, 2011)

7.7. Conclusion

In this chapter, we discussed assessment in terms of three methods: validation, verification, and evaluation. SSA validation seeks to insure that we are developing the right sociological requirements. SSA verification seeks to insure we are developing them right. And SSA evaluation seeks to insure that we can measure progress on the right path to achieving our goals and objectives. To accomplish proper assessment, we provided multiple tables with step by step checklists and methods that deal with the different situations. This includes the following:

1. SSA Triangular SSA Assessment Structure (Figure 18)
2. SSA Structural Assessment Checklist (Table 20)
3. SSA Component Assessment Checklist (Table 21)
4. Assessment of Sociological Requirements (Table 22)
5. Assessment of Quantitative Data Operations (Table 23)
6. Assessment of Qualitative Data Operations (Table 24)

PART III: SSA CASE STUDIES

Chapter Eight

SSA Case Studies

Candidate Models and Applications

8.1. SSA Development Case Studies

The applications for SSA methodology are many. We briefly discuss three case studies we have utilized to develop this SSA methodology. In the next Chapter Five, we focus on the latest of them for full case study examination. We also briefly explore candidate applications for SSA development.

8.1.1. Case Study: Education Technology

Schooling for Information Society Introduction

The roots of this research project, the evolution of sociology in software architecture, were developed in earlier graduate research focused on the sociology of technology, the PC revolution. Initially it was modeled after the automobile age book by professor James J. Flink (Flink, 1991). Flink's study focused on the sociology of technology, the automobile revolution. The first decade of PC development promised that the sociological impact of the PC may exceed that of the automobile. The first hypothesis generated from the impact of PC technology on American culture research was titled: "The PC Revolution." It was hypothesized that "the PC revolution promises to transform American culture into a virtual society very different in its relationships and structure from the one we see now." The development of education technology project was a case study of larger PC revolution study.

Discovery of this education technology project generated many consequential questions: What impact will the PC technology revolution have on education, especially the education of our young? This was one of the most interesting questions raised. Then came the internet. Education technology was entering a new phase that promised and continues to promise to change society in dramatic ways never experienced before. The first case study project coming out of this research was the development of internet based interactive curriculum for intermediate school students.

The early development started with homeschooling and experimentation with education technology bits. This involved finding 3-5 minute cuts of videos that had educational content aimed at teaching an educational concept with a multi media interface. For example, a 3-5 minute section of a documentary included a presentation of the atom structure and how two atoms bond together and form molecules. Using colored balloons to portray different types of atoms attracted these very young home educated children. Although the concept was considered to be a high school or college education level concept, very young children ages 5-7 were quickly grasping the concept and gaining the knowledge. There were many similar examples. This transformed this homeschooling education technology experiment into an education technology project.

The next obvious research question was: what happens if we take any age level curriculum book, break it down into 3-5 minutes multimedia edutainment concepts, and create a non-linear edutainment interface? What if students (with teacher supervision) are empowered to control and manage their education content acquisition? What if knowledge delivery became entertaining and sticky? What if each student can study at own pace? What if the student is allowed to ponder knowledge in a non-linear fashion? What if teachers are no longer education content deliverers? What happens to the school system? How much of this online education can be done anywhere on any device? What if this technology disrupts the traditional schooling system? What if children's education is continually enhanced at an exponential growth rate? What if the cost of education drops appreciably while the quality and quantity of education progresses exponentially? How would education technology impact poorer societies around the globe? Numerous more profound questions with stupendous social impact become obvious. Education technology development cries out for SSA methodology. In the development of this project, the social impact of education technology demanded SRs to address many of the above questions.

The mass proliferation of the personal computer (and other smaller digital devices), the internet, search engines, and digital multimedia applications are destined to evolve schooling from the industrial to the post-industrial information age society. Five technologies will transform schooling, empower students and their parents, and disrupt traditional class structured and centralized schools:

1. Multimedia communication
2. Multi device platforms including the internet and mobile devices
3. The search engine
4. Distributed computing (content, tools, and applications)
5. Nonlinear self-paced learning

Multimedia communication will transform educational content and nearly eliminate the need for teacher delivery of content to a classroom with dissimilar pace students. The internet will network and connect everyone everywhere anytime any device. Search engines will make the world information at the student's fingertips. Distributed computing will allow for bite-size learning and personalized tools and applications. And nonlinear self-paced learning will allow the young brain to learn without the restrictions of subject by subject, book by book, chapter by chapter, and exercise by exercise learning. People think in a nonlinear fashion; hence learning should be nonlinear.

Schooling for the information age promises small and distributed satellite schools with self-paced learning and education advisors instead of traditional teachers. This could eliminate inefficient busing and expensive schooling complexes, better family and community time, more learning curiosity, better parent involvement, better self-paced development, and better prepared information age worker.

A project prototype was developed using an accredited curriculum and was tested in a real intermediate school environment. The traditional text curriculum was reproduced in bite-size (3-7 minute) learning videos ("BSLV"); it was self-paced learning, the student can repeat the video as often as desired; and could jump in learning in linear and nonlinear fashion, forward and backwards.

It was the first project with SRs in mind. The methodology was not developed yet; as a consequence, the SRs were rough and incomplete.

The prototype was a great success with students and parents. Schools and teachers felt the threat of school system disruption.

We underestimated SSA requirements especially for the disrupted traditional teachers (who saw the prototype as a very serious threat to their career and job). we equally underestimated how resistant is government educational department is to such a disruption of the traditional education system. On the operational and technical side, it was too early for video distribution over the internet; we had to use intranets with servers at schools. In the late nineties, this idea was fifteen to twenty years ahead of its time.

8.1.2. Case Study: Local Search

In early 2000, we consulted for a very promising internet startup called eLocal Network. eLocal model was to aggregate national content with local attributes, apply XML technology to create uniformed data structure, and redistribute content based on local attributes to local communities. eLocal's technology and value proposition were very attractive to leading market companies in the internet, telecom, marketing, and cable industries. We joined eLocal as its CMO (Chief Marketing Officer) and soon became it CEO. We co-authored eLocal's patent application with the CTO (Kassir and Peterson, 2002). This was our second attempt at applying SRs on software architecture development.

Local search was a much higher value search than global search (i.e. MSN, AOL, Yahoo, and Google). Building local community content on any digital device using XML technology (pioneering at the time) offers sticky content to targeted local shoppers. The goal was to build local communities around any device generating advertising revenues 10-20 times the value of global search.

As the leader of this project, we quickly applied my social requirements methodology to reevaluate eLocal's relationship with all its stakeholders. This resulted in a restructuring of eLocal's software architecture with three primary stakeholders:

1. **Content Suppliers**: Instead of paying for content as buyers of content, eLocal became a distributor of content and charged for distributing the content.
2. **Cable/Internet TV**: SRs showed a mirroring of local communities with local cable TV. This resulted in the development (in collaboration with Microsoft, AT&T Cable, and Motorola) of local iTV channels.
3. **Local Communities**: we created a process for developing local community social groups and requirements and mirroring them with local online communities.

Content suppliers were switched to content distributors successfully. This project generated a very promising patent application titled: "System for providing localized content information via wireless personal communication devices" (Kassir and Peterson, 2002).

SSA requirements were limited to above stakeholders.

Cable/Internet TV market test was conducted successfully (2001) with Microsoft as the operating system, AT&T as the cable company, Motorola as the set-top box provider, and eLocal as the local content provider. Local communities, initially planned for implementation and deployment on iTV, never materialized. The iTV market never materialized.

8.1.3. Case Study: Non-Performing Credit Card Debt Market

This following case study, reported extensively in the next five chapters (discovery, hypothesis, planning, operations, and reporting), has been applied as an exemplary model of SSA development.

8.1.4. Candidate Case Study Applications

Candidate case study applications are many starting with financial applications to social networks to search engines to significant portals to advocacy groups to political and social activism to education (especially education technology) to social groups, organizations, and associations, to UBER and the likes. The general SSA rule is: "the more social engagement and interaction between users in software development, the more beneficial and cost effective SSA requirements are; the more technical and operational, the less beneficial and cost effective SSA requirements are." And, "the bigger the audience(s), the more beneficial and cost effective it is; and the smaller the audience(s), the less beneficial and cost effective it is.

Chapter Nine

CCDM Case Study: Introduction

Concurrent or Sequential Development, Discovery, and Conjecture

9.1. Introduction

This and the following chapters (Ten, Eleven, and Twelve) report on the final and most important case study used for the development and evolution of sociology of software architecture. The case study is titled “How to repair the non-performing U.S. credit card debt market.” It will be referred to as the “CCDM (credit card debt market)” case study. The CCDM case study was the culmination of multiple case studies used for the development and evolution of sociology of software architecture over more than twenty years of research and development. This includes the education technology case study and the local search case study discussed in Chapter Four. This CCDM case study will be discussed in light of the final methodology outlined in the first four chapters of this thesis. We discuss not how CCDM was done but rather how it should be done. How it was done was a long and gradual process of trial and error. It included many iterations of the scientific method (discovery, conjecture, planning and design, operations, and reporting). This CCDM case study aims to demonstrate how the SSA developer utilizes the sociology of software architecture methodology instead of how to develop a novel methodology. This CCDM case study applies Chapter Four instruction manual and assessment techniques. The most important emphasis of our SSA methodology, versus traditional SA methodologies, is that the SA developer focuses on the software system environment and the SSA developer expands it to incorporate the social system environment. Incorporating sociological variables and data requires a synthesis of software architecture methodology and sociological methods, approaches, models, and techniques. The resulting synthesis is the sociology of software architecture (Fielding, 2000).

Choosing the proper and fit tools for your SSA project is key to an optimized outcome. The researcher may have many choices every step of the way. We will have the opportunity to explore, explain, and compare many of the options available. We will explore and explain many of the sociological terms used in the preceding chapter on methods. Our goal is to give the researcher and the developer all the tools necessary to conduct a beneficial and meaningful SSA development, promote optimization, efficiency, and productivity, increase return on investment, expand profitability and economic development, and advance social progress.

The Sociology Dictionary defines a sociological case study as “a detailed and in-depth study of a single case, involving an event, group, individual, or organization” (Bell, 2013) The USC Libraries’ definition is as follows: “The term case study refers to both a method of analysis and a specific research design for examining a problem, both of which are used in most circumstances to generalize across populations” (Mills, *et al.*, 2010) ThoughtCo defines it as follows:

> A case study is a research method that relies on a single case rather than a population or sample. When researchers focus on a single case, they can make detailed observations over a long period of time, something that cannot be done with large samples without costing a lot of money. Case studies are also useful in the early stages of research when the goal is to explore ideas, test and perfect measurement instruments, and to prepare for a larger study (Crossman, 2019).

In software architecture, case studies have traditionally been used ”to compare and contrast the selection of different architectural solutions. The case studies are key word in context, instrumentation software, mobile robotics, cruise control, three vignettes using mixed styles, and shared information systems” (Mall, 2016)

Our CCDM case study involves a single organization, a startup fintech company hereinafter referred to as Startup. The CCDM software solution referred to as the "Digital Mediation Solution" or "DM Solution" aims to resolve and repair the non-performing U.S. credit card debt market and use it to scale up into other non-performing debt markets. We make detailed observations on the case study's SSA development process over nearly ten years. This case study is particularly useful because it is in the early stages of research for two objectives: the development of the DM Solution and the evolution of sociology of software architecture. In this case study, we have explored ideas, tested different scenarios and solution components, conducted market experiments, and prepared for the deployment of the DM Solution as well as the methodology of sociology of software architecture.

9.1.1. Concurrent or Sequential Development

Before we start the SSA development process, we should determine if we are doing concurrent or sequential SA and SSA development process. If it is a sequential process, where the SA process is completed before starting the SSA process, the developer can use the existing SA development model table steps (like the MSDN model used in Chapter Two, Section 2.6) to mirror SSA development and recreate a sequential SSA-SSC table (Chapter Four, Section 4.2: Step by Step Checklist). The developer uses two mirrored checklist tables: the SA model table and the sequential SSA-SSC table. The developer continues to use his SA original SA model for SA development and uses the sequential SSA-SSC table for SSA development.

If it is a concurrent process, where the SA process and SSA process run concurrently and parallel to each other, the developer can expand the concurrent SSC table by adding another column (or two) for SA development: technical and operations requirements column. The concurrent SSA-SSC table is complete with three separate columns: sociological, technical, and operations requirements columns. With the concurrent SSA-SSC table, the developer is using one checklist table for all SA and SSA development. This is a more efficient for resource, easier for management, and flexible for change.

In our "how to repair the non-performing U.S. credit card debt market" case study, we choose a concurrent SSA-SSC model. Here is the startup basic table:

Concurrent SSA-SSC Model						
				Requirements		
				SSA Model	MSDN SA Model	
✓	SSC#	Step by Step Checklist		Sociological	Technical	Operations
		SSA Model	MSDN Model			
		Discovery =	Objectives			
		Conjecture =	Key Scenarios			
		Planning =	Create App Overview			
		Operations =	Key Issues			
		Reporting =	Candidate Solutions			

Table 25 Concurrent SSA-SSC Model

To develop this table, we use the MSDN SA model template (Microsoft, 2009) and the SSA-SSC model table (Chapter Four, Section 4.2). We move one phase at a time and step by step. We start with the discovery phase.

9.1.2. Synthesized Concurrent Checklist

The following is a developed Synthesized Concurrent Checklist ("SCC") table. We will use this table for the phase by phase and step by step development of our CCDM Case Study. The SSA column follows the SSC developed in Chapter Four, Section Two, 4.2. The MSDN SA column follows MSDN's model, Chapter 4: A Technique for Architecture and

Design (Microsoft, 2009). Our synthesis follows the following methodology developed in Chapter Three, Section 3.5, Figure 11.

“Software architecture is the process of converting software characteristics such as flexibility, scalability, feasibility, reusability, and security into a structured solution that meets the technical and the business expectations” (Aladdin, 2018).

“Software Design: While software architecture is responsible for the skeleton and the high-level infrastructure of a software, the software design is responsible for the code level design such as, what each module is doing, the classes scope, and the functions purposes, etc.” (Aladdin, 2018).

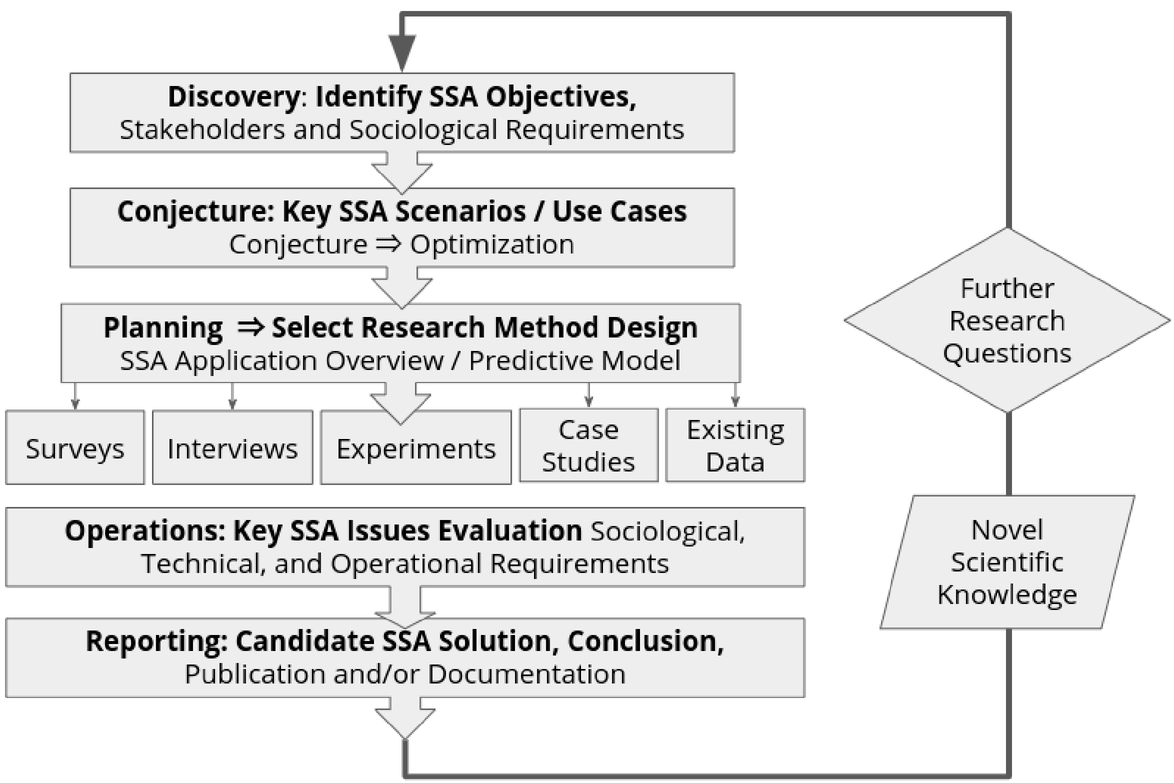

Figure 11 Synthesis of SSA Scientific Method Flowchart

Additionally, we have mirrored the development process and explained some of the steps in foot/endnotes. We aim to follow this SCC table phase by phase (discovery, conjecture, planning and design, operations, and reporting), and step by step.

✓	SSC#	SSA	MSDN SA
	1	**Discovery**	**Identify Architecture Objectives**
	1.1	**Questions for owner (client)**	
	1.1.1	**Goals and objectives?** How and why project was started? What is ilts history? Its vision? and Its mission? Discover the client's goals and objectives.	**Identify your architecture goals at the start**
	1.1.1.1	Material? Cost/ benefit goals: Cost/benefit expectations should be discovered. An early assessment of their possibility and probability is crucial to managing and/or meeting expectations.	Building a prototype
	1.1.1.2	Intellectual? Influence thinking: Influence how people think: social, political, economic, class, religion, race, cultural, language, activism and/or grouping, etc.	Testing potential paths
	1.1.1.3	Sentimental? Influence feelings: Influence how people feel: attachment, branding, like/dislike, review, etc.	Embarking on a long-running architectural process
	1.1.2	**SSA requirements**	**SA requirements**
	1.1.2.1	**SRs (Sociological Requirements)**	**TORs (Technical and Operational Requirements) (MITRE, 2018)** Operational requirements are those statements that "identify the essential capabilities, associated

			requirements, performance measures, and the process or series of actions to be taken in effecting the results that are desired in order to address mission area deficiencies, evolving applications or threats, emerging technologies, or system cost improvements." (Kossiakoff, *et al*., 2011)
	1.1.2.1.a	Sociological stakeholders? What social groups are we targeting? RIOTU Model: Stakeholder Types: RIOTU Model. We divided stakeholders into “user,” “technologist,” “owner,” “influencer,” and “regulator.” Kassir, H. A., 2019. The Evolution of Sociology of Software Architecture, Chapter Three, Figure 3.4.13 illustrates their hierarchy.	**Identify who will consume your architecture.**
	1.1.2.1.a.1	**U**ser	Other architects
	1.1.2.1.a.2	**T**echnologist	Developers
	1.1.2.1.a.3	**O**wner	Testers
	1.1.2.1.a.4	**I**nfluencer	Operations staff
	1.1.2.1.a.5	**R**egulator	Management
	1.1.2.1.b	Environment: social system? The environment is the social situation. It is the most critical difference between the SA and SSA models. The SSA environment differs from the SA environment. The SA environment limits itself to the software system. The SSA environment includes	Environment: software system

		the entire social system including social groups, qualities, and process. Social groups are determined using SSA sociological models (Chapter Three)	
	1.1.2.1.c	Interface: social interaction?	UI/UX
	1.1.2.1.d	Behavior: social role/action?	URA (User Role/Action)
	1.1.2.2	**SDRs (SSA developer requirements)**	
	1.1.3	**Resources-budget-constraints?**	**Identify your resources and constraints**
	1.1.4	**Timeline/milestones**	**Scope and Time**
	1.2	**Questions for research**	
	1.2.4	Literature? Review related literature review, research, and case studies. Ask good questions. Investigate definitions, history, theories, principles/assumptions, and axioms.	
	1.2.5	Data?	
	1.3	**Answers (Identify)**	
	1.3.1	**Literature review** Types: 1.3.1.1 Definitions; 1.3.1.2 History; 1.3.1.3 Theories; 1.3.1.4 Principles; 1.3.1.5 Axioms	
	1.3.2	**Existing data** Types: 1.3.2.1 Academic; 1.3.2.2 Government;	

		1.3.2.3 Public share/public collaborators; 1.3.2.4 Industry; 1.3.2.5 Commercial	
	1.3.3	**Missing data** Types: 1.3.3.1 Academic; 1.3.3.2 Government; 1.3.3.3 Public share/public collaborators; 1.3.3.4 Industry; 1.3.3.5 Commercial	
	1.3.4	**Identify SRs** "Knowledge Society" model: Define, qualify, quantify, target the following: 1.3.4.1 Stakeholders 1.3.4.2 Environment 1.3.4.3 Interface 1.3.4.4 Behavior	Identify TORs
	2	**Conjecture**	**Key Scenarios**
	2.1	**Analysis & Conclusions**	
	2.1.1	Goals & objectives achievable?	--It represents an issue
	2.1.2	SR Components (Stakeholders, environment, interface, and behavior.): hypothesize them	--It refers to an architecturally significant use case
	2.1.3	Resources/Budget/Constraints: Can you meet them? Manage expectations.	--It represents the intersection of quality attributes with functionality.
	2.1.4	What are your priorities?	--It represents a trade-off between quality attributes.

	2.2	**Challenge(s)?** How are challenges different from problems. Challenges are when we know the solution but it requires additional resources, budget, etc. Problems are when we don't know the solution yet.	
	2.2.1	Data acquisition	
	2.2.2	Expertise	
	2.3	**Problem(s)?**	
	2.3.1	Conflict?	
	2.3.2	Collaboration?	
	2.3.4	Interaction?	
	2.3.5	Driving interest?	
	2.3.6	Competing interests?	
	2.3.7	Regulations?	
	2.3.8	Sensibilities?	
	2.3.9	Competition	
	2.4	**Solution(s)?**	
	2.4.1	Resolution? Use cases?	**Architecturally Significant Use Cases**
	2.4.2	Engagement?	
	2.4.3	Response?	
	3	**Planning & Design**	**Application overview**
	3.1	**Methods**	
	3.1.1	Step by step checklist	**Identify your deployment constraints.**
	3.1.2	Toolbox: take inventory of available tools.	**Identify important architecture design styles.**
	3.1.3	Data method	
	3.1.4	Sociology method Sociology Methods: Interview, case study, survey,	

		experiment, and existing data. Identify how you are going to collect your sociological data. Choose your theoretical framework and assumptions. Outline your validity and reliability parameters. Reasoning Methods: Inductive or Deductive logic. Mixed research methods: Quantitative/Qualitative Mixed, Naturalistic inquiry, Historical, Comparative, Statistical, etc.	
	3.2	**Approaches**	
	3.2.1	Social epistemology	**Determine your application type**
	3.2.2	Worldview	**Determine relevant technologies.**
	3.2.3	Sociology theory	
	3.2.4	Empirical data	
	3.2.5	Logic & reasoning	
	3.3	**Models**	
	3.3.1	ME-Ego model	**Whiteboard Your Architecture**
	3.3.2	SSH model	
	3.3.3	CSG model	
	3.3.X	More models...	
	3.4	**Techniques**	**Relevant Technologies:**
	3.4.1	Representation	**Mobile Applications.**
	3.4.2	Data	**Rich Client Applications.**
	3.4.3	Sociological	**Rich Internet Client Applications (RIA)**
	3.4.4	Statistical	**Web Applications.**

	3.4.5	Mathematical	**Service Applications.**
	3.4.6	Data science	
	3.4.7	Computer based	
	3.4.8	Team	
	3.4.9	Software dev	
	4	**Operations** Operations includes experimentation, and/or observation, collection of data, critical business requirements, and prototyping the model.	**Key Issues**
	4.1	**Methods**	**Quality Attributes (Microsoft, 2009)**
	4.1.1	Existing Data	**System qualities.**
	4.1.2	Survey	**Run-time qualities**
	4.1.3	Experiment	**Design qualities**
	4.1.4	Observation Social Group Attributes: Segmentation and clustering attributes, demographics, psychographics, lifestyle, social media activity, financial information, behavior scores, and crosscutting concerns (i.e. privacy, confidentiality, compliance, sharing of data, communication, media, designing for Issue mitigation), payment processing, refunds, anonymity, reporting, referral, etc.).	**User qualities**
	4.1.5	Prototype	
	.1.6	Beta application	
	4.1.7	Interviews	

	4.1.8	Case studies	
	4.2	**Data collection**	**Crosscutting Concerns (Microsoft, 2009)**
	4.2.1	Data cleanup	**Authentication and Authorization**
	4.2.2	Data transformation	**Caching**
	4.2.3	Data analytics	**Communication**
	4.2.4	Validity & Reliability Validity is the extent to which measurement represents reality, and is considered useful and trustworthy. Reliability is consistency of measurement.	**Configuration Management.**
	4.2.5		**Exception Management**
	4.2.6		**Logging and Instrumentation**
	4.2.7		**Validation**
	4.3		**Designing for Issue Mitigation (Microsoft, 2009)**
	4.3.1		**Auditing and Logging**
	4.3.2		**Authentication**
	4.3.3		**Authorization**
	4.3.4		**Configuration Management.**
	4.3.5		**Cryptography**
	4.3.6		**Exception Management**
	4.3.7		**Input and Data Validation**
	4.3.8		**Sensitive data.**
	4.3.9		**Session Management**
	5	**Reporting**	**Candidate solutions**
	5.1	**Assessment Types**	**Baseline and Candidate Architectures**

	5.1.1	Validation	succeed without introducing any new risks?
	5.1.2	Verification	mitigate more known risks than the previous iteration?
	5.1.3	Evaluation	meet additional requirements?
	5.1.4		enable architecturally significant use cases?
	5.1.5		address quality attribute concerns?
	5.1.6		address additional crosscutting concerns?
	5.2	**Assessment Forms**	**Architectural Spikes (Microsoft, 2009)**
	5.2.1	Structural	
	5.2.2	Component	What to Do Next
	5.3.3	Operations	Reviewing Your Architecture
	5.3	**Assessment Methods**	**Scenario-Based Evaluations (Microsoft, 2009)**
	5.3.1	SRs	**Software Architecture Analysis Method (SAAM).**
	5.3.2	Quantitative data operations	**Architecture Tradeoff Analysis Method (ATAM)**
	5.3.3	Qualitative data operations	**Active Design Review (ADR)**
	5.3.4		**Active Reviews of Intermediate Designs (ARID)**
	5.3.5		**Cost Benefit Analysis Method (CBAM)**
	5.3.6		**Architecture Level Modifiability Analysis (ALMA)**
	5.3.7		**Family Architecture Assessment Method (FAAM)**
	5.4	**SSA Methodology** Report your SSA methodology, its success and failures, and its applicability as a case study for future development.	
	5.5	**Writeup-Presentation** Give clear documentation to software developers. Show gained knowledge. Ask	**Representing and Communicating Your Architecture Design**

		more questions for future development.	
	5.5.1		**4+1**
	5.5.2		**Agile Modeling**
	5.5.3		**IEEE 1471**
	5.5.4		**Unified Modeling Language(UML).**
	5.6	**Replication** Can results be replicated?	
	5.7	**Generalizability** Can findings and conclusions be generalized?	
	5.8	**Future Development** Recommendations, future features, versions, etc.	

Table 26 Synthesized Concurrent Checklist ("SCC")

9.2. CCDM Case Study: Discovery

The first science methodology phase is discovery. It is subdivided into three sections: questionnaires for owner (client), questionnaires for research, and answers (or identification) sections.

IMPORTANT NOTE: There are two synthesized and mirrored columns for all phases, sections, steps, and processes for both SSA and MSDN SA methodologies. This case study is targeted at experienced, knowledgeable, and trained architects. It focuses on SSA training and methodology. It is intended to teach, train, and explain SSA phases, steps, and processes. Hence, we cover SSA phases, steps, and processes with great detail, instructions, teaching, training and explanation. On the other synthesized and mirrored side, we cover SA methodology briefly with overviews and summaries when useful. We aim to do it enough to familiarize the architect with the synthesis and concurrence of both methodologies. We avoid consuming unnecessary architect resources with uncalled-for elaboration on familiar SA methodology. Concurrent SSA and SA development aims to optimize the processes by merging them together, allowing for greater fit, and increasing collaboration.

9.2.1. Questions for owner (client)

The owner (client) is not necessarily the material, title, or equity owner of the project. The owner is the team or person charged with leadership and ultimate decision making on the project. This section starts with subsection 1.1.1: Goals and objectives. We start by preparing questionnaires for the purpose of discovering the owner's SSA and SA goals and objectives. Architects can start preparing owner questions using templates similar to the following: "Software Development Client Questionnaire – 10 Questions To Ask When Developing Software" (Tripathi, 2019) and "20 Questions To Ask Your Client Before You Build Their Mobile App" (Kmulos, 2015). We edit, add, change, and modify questionnaires based on project differences. We also integrate SSA questionnaires regarding steps and processes outlined in the "Table 5.1.2: Synthesized Concurrent Checklist ("SCC")" above (i.e. material, intellectual, and sentimental goals and objective and SSA requirements). For optimization, we merge and unite sections that are the same. Furthermore, we discover and resolve conflicts whenever possible.

9.2.1.1. CCDM's SSA goals and objectives:

CCDM's SSA goals and objectives are divided into three: material, intellectual, and sentimental. We start laying the foundation for them by discovering the owner's and project's history. We discover the project's genesis. We learn how the project was initially started, what was its vision and mission, what are the initial goals and objectives, and what is the vision for the future. We collect all documents already developed for the CCDM project, review them, prepare questions, and interview the owner (client). After the interview is completed, we gather our notes and develop a CCDM goals and objectives document. For the CCDM project, the owner is a fintech startup company referred to as "Startup;" it is lead by company CEO and patent inventor.

The inventor and project visionary history includes a strong academic and business background, and experience with financial markets, technology development, and sociology of technology studies. The CCDM project genesis was envisioned and started by contemplating solutions for the financial markets crisis that caused the Great Recession of 2008. In 2008, the financial markets dived into a financial crisis due to the accumulation of large funds with toxic debt assets, especially non-performing subprime mortgage loans. Toxic assets are debts with an unknown but significant percentage of non-performing debt. Toxic assets undermine financial ratings agencies' abilities to rate and price large debt funds. Hence if toxic assets cannot be priced, they cannot be traded. The financial markets inability to trade, liquidate, and recycle toxic assets leads to financial crisis. A fast collapsing subprime mortgage/real estate market brought a domino effect economic downturn and a tidal wave of economic dysfunction and subsequent unemployment. The financial crisis domino effect hit many sectors in the economy including the credit card debt markets.

When a credit card debt becomes delinquent for 90 to 180 days, it is charged-off by the creditor. Charge-off means it is removed from the creditor's assets and declared a loss. The value of the credit card debt falls from 125% for a performing debt to 5% for a non-performing debt. Charged off debt is sold or moved wholesale to debt recovery and asset liquidation departments and third party debt recovery agencies. Debt recovery agencies use coercive methods, especially legal threats to garnish wages and assets, and credit denial, to coerce debtors into paying back delinquent and defaulted debt. The debt recovery industry has one of the worst consumer approval ratings in the U.S.A.

Charge-off rates (FRED, 2019) skyrocketed nearly 300% (from about 4% to nearly 12% annually of the trillion dollar credit card debt market). Consumers were fast defaulting on credit cards, losing access to affordable financing, and buying less. Non-performing debt in many financial markets was accumulating rapidly. This begs the question: How can fintech (financial technology) help resolve non-performance in the debt markets? What is a good solution? Which non-performing debt market is a good candidate to test and scale up a novel and innovative solution? The CCDM inventor contemplated a novel and innovative solution that calls for a third party non-partisan digital mediation solutions and chose the credit card debt market to prove the concept. In 2010, two patent applications were filed. The first patent application titled “Method and system for restructuring debt.” The second patent application titled “Method and system for anonymously matching debtors with debt holders to facilitate resolution of non-performing debt” (Kassir, 2013). Additionally, the inventor partnered with a software company to develop a software solution. In July 2013, the patent application titled “Method and system for restructuring debt.” was granted (Kassir, 2013).

The inventor’s vision was to bring efficiency to the dysfunctioning non-performing debt recovery and asset liquidation market, to disrupt inefficient market agents and intermediaries, to create a fintech platform that recycles non-performing and toxic assets, to proactively prevent its accumulation, and to increase banking liquidity and mitigate banking risks. Asset liquidation is an important function in financial markets. The international banking system and credit issuers must conform to the Basel III international regulatory framework to insure sufficient liquidity to mitigate financial risks (Went, 2010).

The inventor’s vision was to partner and build a fintech startup, develop the right software platform, test it, tweak it, then scale it up in the credit card debt market. A successful CCDM market solution was envisioned as a Phase I proof of concept, and a prelude to further scale up into other non-performing debt and international markets.

CCDM’s SA goals and objectives were to build a limited function prototype (referred to as “DebtorSoft Prototype”), a prelude to embarking on a long-running, customized, and optimized architectural development process. The prototype was to be a web assembly, framing, and integration of off-the-shelf market available and compliant SAAS component applications. This included a payment processing and account management component, an esign contract generator, a crm solution, and web access credentials. The prototype had a limited budget and required limited scalability and use. The goal was a successful market test and proof of concept that attracts investor funding and allows for “embarking on a long-running architectural process.” There were more than one potential path that can be tested. The prototype aimed to test one path on a limited scale with consumer agencies (instead of directly with consumers), and in real market conditions. The optimal and targeted path solution required a customized, robust, and very scalable consumer centric market solution.

9.2.1.2. SSA and SA Requirements

The second subsection of discovery (1.1.2) focuses on SSA requirements (SRs and SDRs) and SA requirements (TORs). Since this is an SSA case study, we focus primarily on SRs and SDRs and give a brief summary on SA requirements.

SSA requirements consists of two parts: SRs (sociological requirements) and SDRs (SSA developer requirements). SRs consists of four components: sociological stakeholders, environment (social system), interface (social interaction), and behavior (social role/action). Stakeholder Types: RIOTU Model. We divided stakeholders into "user," "technologist," "owner," "influencer," and "regulator." (Kassir, 2019, Chapter Three, Figure 3.4.13)

This case study is targeted at experienced software architects. It is not intended to cover and teach TORs in detail. How do we report on and incorporate TORs' side? We will use an IBM model for SA requirements, cover CCDM's TORs with a brief overview, and highlight important CCDM's TORs' issues. We will use three IBM templates: "Capturing Architectural Requirements" (Eeles, 2004), "Appendix B: Architectural Requirements" (Eeles, 2004), and "Appendix C: Sample Architectural Requirements Questionnaire" (Eeles, 2004). For further reference, we use Carnegie Mellon University's "Requirements & Specifications" (Tran, 999) and AltexSoft's "Technical Documentation in Software Development: Types, Best Practices, and Tools" (Altexsoft, 2019).

SA requirements consists of two parts: TORs (technical and operational requirements) and identification of "who will consume your architecture," hereinafter referred to as SA consumers. SA consumers have been synthesized above with SA technologist stakeholders.

Here is a brief summary of CCDM’s TORs: The CCDM project was a long-running architectural process broken into three phases. Phase I was named DebtorSoft.com. It was planned to service debtor agencies positioned as a backend debt resolution processing system. It was not targeted directly at consumers. The consumer didn’t have any direct access to the software. Phase II was named digital mediation.com. It was planned to add direct consumer interface. And Phase III was named DigitalMediation.Solutions. It was planned to add automation, third party integration, and artificial intelligence.

The patent application had three flowchart/schematic figures (Kassir, 2013). These were the initial diagrams to use for architecture. Phase I (“DebtorSoft”) was a web based platform that incorporated and integrated few off-the-shelf and compliant SAAS cloud solutions. One component was for esign contract management, a second was to integrate with an account management and payment processing solution, and a third component was a crm solution for customer service. DebtorSoft controlled user authentication and access to the platform.

9.2.1.3. Resources, budget, and constraints

There were no company technology development resources. All resources were outsourced through an offshore service provider. The first DebtorSoft V1 prototype budget was $10,000. The second DebtorSoft V2 prototype was tentatively budgeted for $100,000. It included further customization of the platform, the development of an automated bidding process, and the development of a processing interface. Following stages of development budgets to be determined after initial discovery and research are completed.

9.2.1.4. Timeline, Milestones, Scope, and Time

Phase I, DebtorSoft V1 prototype, was scheduled for completion in 30 days. The first milestone was the acceptance of ten debtors through debtor agencies. The scope was limited to part time architect/database consultant, one part time project manager, one single developer, a part time interface designer, and a single hosted server. The estimated total time spent on it is nearly 200 hours.

9.2.2. Questions for research

What kind of questions should we ask for research?

How do we proceed with SSA questions, research, and answers?

SSA research questions should be focused on the previous section of discovery. We focus especially on sociological requirements: sociological stakeholders, environment, interaction, and behavior. We aim to clearly define, qualify, and quantify CCDM’s sociological requirements. We research related literature and collect related and relevant data. The SSA developer should explore and discover all previous research done by the inventor and/or owner to make the business case and develop business planning and financing. Such business information is very helpful in researching answers for questions of research. In the following, we ask the questions and answer them. We start with the most obvious and most relevant questions. As we research them, we proceed with more questions and continue our rolling process of questions, research, and answers until we reach a satisfactory discovery of all the knowledge needed to conjecture SSA solutions.

9.2.3. Answers to research questions

In the following, we ask research questions and seek answers in literature review. We also discover and examine existing data and ponder desired data that can either be acquired with additional research or budgeted for acquisition with additional resources.

9.2.3.1. Literature review

CCDM’s literature review focuses on consumer and credit card debt markets and the Great Recession of 2008. We investigate market segments, sizes, and trends. This includes the history of credit card market, of non-performing debt, of debt recovery/collections, and the coercive market environment and related issues they create. Our aim is to understand the bottlenecks of dysfunction and inefficiency in the marketplace and their sociological requirements. It also includes government regulatory and legal environment literature. Our aim is to survey government statistics, reports, recommendations, regulations, enforcement actions, and how government agencies, especially the CFPB, envision solving the challenges in the marketplace.

Why are we studying the debt market?

The world's economy is built on capital lending. Global debt has reached $217 trillion dollar rising to 325% of World GDP (Durden, 2017). According to the U.S. Federal Reserve, U.S. "domestic nonfinancial debt outstanding was $47.5 trillion at the end of the first quarter of 2017, of which household debt was $14.9 trillion (over $1 trillion in unsecured credit card debt alone), nonfinancial business debt was $13.7 trillion, and total government debt was $18.9 trillion" (BGFRS, 2017) Debt markets form the backbone of all economic activities. A dysfunctional debt market leads to a dysfunctional economy and social crisis. The term non-financial debt is used to refer to the aggregate of debt owed by households, government agencies, non-profit organisations, or any corporation that is not in the financial sector. This can include loans made to households in the form of mortgages, or amounts owed on credit cards.

Why is this relevant?

If you experienced the last 2008 debt crisis and consequent "Great Recession of 2008," (Verick and Islam, 2010) you already have parts of the answer. A percentage of all debt falls in default becoming "non-performing debt." The percentage of debt falling in default ranges from near zero on U.S. government debt to over 12% on U.S. credit card debt during times of economic crisis and high unemployment. The higher the default risk, the higher the cost of lending. Spiraling lending costs can have devastating economic consequences from severe to great recessions, to economic depressions. This problem is the Achilles' Heel of capitalism. If the capital markets become dysfunctional, the entire economy suffers, economic progress is reversed, businesses experience market challenges, millions of people become unemployed, poverty increases, and social progress reverses its direction.

Capitalism thrives on free market economics and competitive market forces. As long as the borrower has good credit standing and not in default, the free market forces of competition between lenders keeps the economic engine going; the borrower has choices and can refinance debt, and lenders compete with "optimal pricing." But as soon as the borrower loses good creditworthiness and access to financial markets, the borrower (now becomes debtor in default) is stuck in a legally binding financial obligation that gives the lender strong legal protection and remedies (otherwise lenders would stop lending). The relationship between the debtor and debt collector becomes a coercive relationship. Without free market economics at work, capitalism begins to fail. To repair the system, we need to transform the coercive relationship into a collaborative, agreeable, and free market options relationship.

What happens to charged-off non-performing debt?

Due to government regulations, revolving and non revolving debt must be charged-off and removed from the creditor's assets after 120-180 days delinquency. After charge-off, the non-performing debt (paper) ownership remains in the free market domain. The real value for non-performing credit card debt falls dramatically to a single digit cents on the dollar at charge-off time, and dramatically to as little as one tenth of a fraction of a penny on the dollar within three years. Charged off debt stays on the credit report for seven or more years. But the debtor obligation under contract remains the face value of the non-performing debt. The difference between the real value and the face value of non-performing debt can reach one thousand times (as old debt is traded wholesale at 1/10 of a penny and keeps its nominal face value 100%). This makes the debt recovery/collection market the most conflict driven market in the U.S.A. with the lowest consumer satisfaction. Conflict invites market intermediaries who thrive on conflict resolution creating serious market inefficiencies. The cost (difference between what the debtor pays and what the debt owner of non-recovery debt paper receives net for resolving the debt) of market intermediaries in debt recovery often exceeds 60%. It is 1000% the 6% or less a home seller pays for selling a real estate property. The non-performing U.S. consumer credit card debt market is dysfunctional. This is a problem. If this problem is solved, it can become a model for other debt markets, especially the U.S. household non-performing debt market.

Is the non-performing consumer debt market a "Broken System"?

In July 2010, the FTC issued a report declaring the non-performing consumer debt market a "Broken System" that demands repair; the same month President Obama signed the Dodd-Frank Wall Street Reform and Consumer Protection Act (Leibowitz, *ed.*, 2010). This chapter examines the non-performing debt markets since the year 2000 (with a special focus on unsecured and non performing U.S.credit card debt recovery market).

The U.S.markets suffered a severe financial crisis in 2008; it is now known as "The Great Recession" (Margalit, 2013). The primary cause for this market failure was the rapid growth of subprime lending in a rapidly growing household indebtedness market; when real estate values collapsed, hundreds of billions of dollars in subprime debt became toxic assets; their real market value and risk ratings became unclear; their market screeched to a halt. The domino effect on other debt markets was formidable. When debt markets don't perform, financial markets feel the jitters.

From 1999 to 2008, for nine successive years, household indebtedness grew at an average of 13% a year (more than 4 times GDP growth rates), then, as a result of the "Great Recession," retreated by a total of 10% from 2008 to 2013. As the financial markets collapsed and the economy went into a "Great Recession," GDP shrunk, bankruptcies increased, unemployment skyrocketed to over 9%, millions of households lost their creditworthiness, delinquencies tripled and quadrupled, and credit card debt charge-offs more than doubled (McElvaine, *ed*., 2008).

How significant is the U.S. household non-performing debt market?

The U.S. household ("HH") debt market (Federal Reserve, 2011) has expanded at historic rates during the decade preceding the 2008 Great Recession; HH debt grew at an average of 11% per year from $4.4 in Q2, 1998, to $12.5 trillion at its peak in Q2 2008. The HH debt market retreated in the following 6 years and approached $11.75 trillion at the end of Q2 2014; but had the Great Recession not happened and the market continued its historic 11% annual growth, the HH debt market size in 2014 would have exceeded $25 trillion (more than double actual 2014 size). Meanwhile, U.S. GDP was growing at an average 2.23% annual rates; hence, HH debt growth rates were five times faster than GDP growth rates; this is an unprecedented and alarming development (Kilian and Vigfusson, 2000).

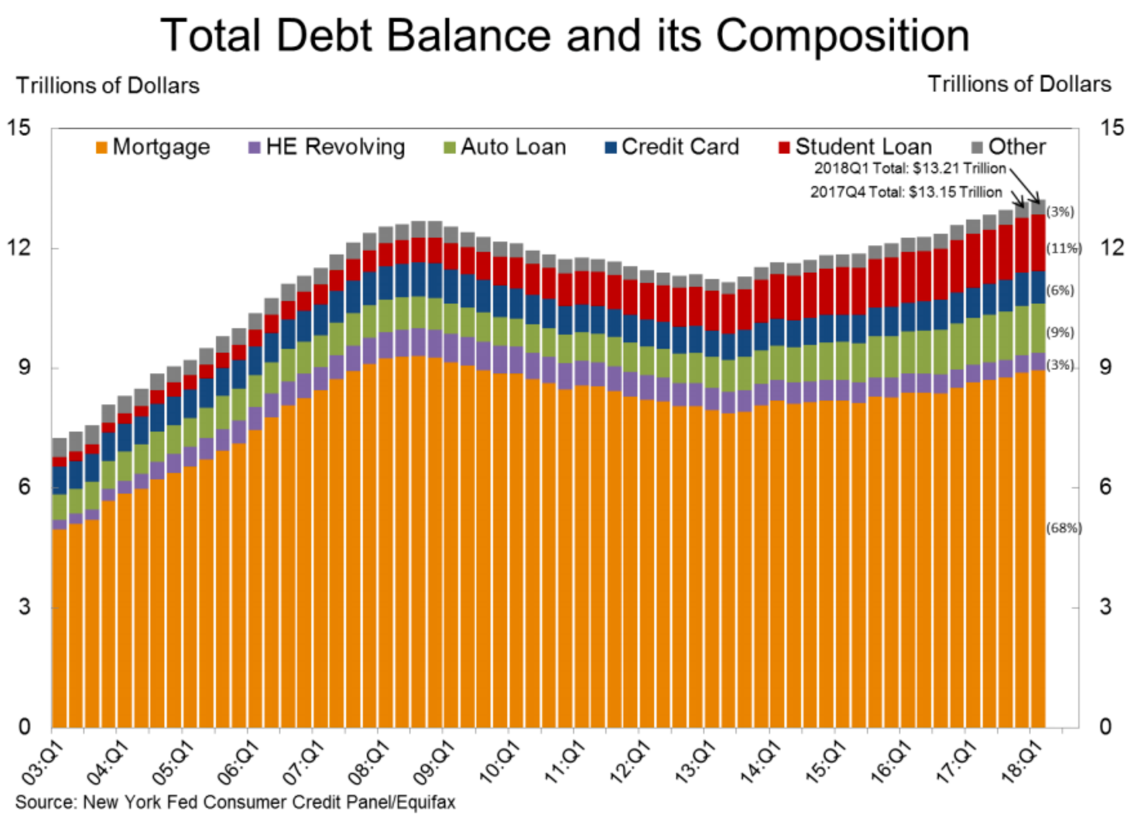

Figure 20 Total Debt Balance and its Compositions

The rapid growth of the subprime mortgage market represented a significant segment of the overall HH debt market and was the driving engine behind its growth; mortgage debt grew more than 300% from a little over $3 trillion in Q2 1998 to nearly $9.25 trillion in Q2 2008. Since HH debt market segments are closely interrelated, the expansion of one segment affects the entire market. For example, the student loans segment of the market grew from nearly $100 billion in the year 2000 to over $1.1 trillion in year 2014; This is more than 1100% in 14 years. Besides house mortgage, home equity, and student loans, other HH debt segments included credit cards, auto loans, non-revolving debt, personal loans, and others.

Many households also carry the burden of other unsecured personal debt such as utilities, municipal, and medical debt.

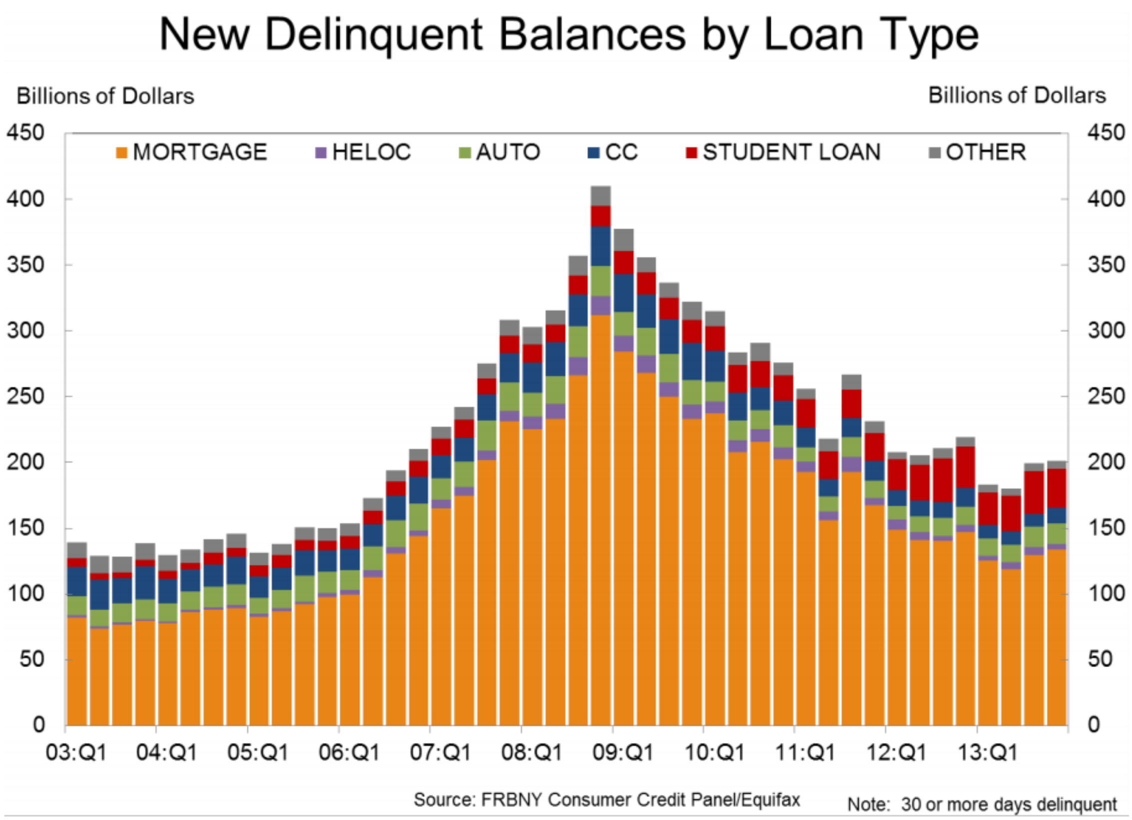

Figure 21 New Delinquent Balances by Loan Type

In good economic growth times, HH debt default rates are manageable; they averaged at nearly 4% from the year 1998 to Q2, 2008. However, when the economy goes into a recession, default rates grow rapidly. By Q1 2010, HH debt delinquency rates nearly tripled to over 12%. “New Delinquent Balances” went up from nearly \$70 billion in 1998 to nearly \$420 billion (a 600% increase) in 2008. High default rates undermine the viability, sustainability, and profitability of the financial markets; if they change too fast, as happened in 2008, this could cause the collapse of financial markets, and therefore the economy.

These HH debt market facts prompt the following important questions: What happens to non-performing (“NP”) debt during normal economic times and during crisis? How does the market recover, reform, and resolve NP debt? Where do inefficiencies cause the most damage and how can we reduce them? Most importantly, for this research, how can technology help enhance market performance, increase productivity, reduce non-performance, and resolve financial disputes? It is clear the challenges are mammoth in complexity and size; hence, the opportunities for efficient and productive solutions are equally promising.

What is the role of the household debt market in the U.S. economy?

The HH debt balance can be broken into 2 categories: mortgage secured and "Consumer Credit G.19." In the five years between 2003 and 2008, the market size increased from nearly $7 to over $12 trillion, more than 70% increase. In the following five years (after the Great Recession of 2008), the market adjusted back down by nearly 15%. Ten years after the Great Recession of 2008, the market is less than 10% above the 2008 levels (BGFRS, 2017).

The U.S. federal reserve issues quarterly statistics dividing this (G.19) category into revolving and non-revolving consumer debt. How NP HH debt is treated depends on whether it is secured or unsecured, its statute of limitation ("SOL"), if guaranteed (i.e. federal guarantee) or not, its credit reporting laws, rules, and regulations, the authority of the holder (government vs private), and state and federal laws. Secured debt (i.e. mortgage, home equity, auto) has a different process allowing the debt issuer to eventually seize the underlying security (if the debtor doesn't cure default in a predefined default cure period); thus recover more money than in unsecured debt. Federally guaranteed student loans don't have a SOL, can't be wiped out through bankruptcies, and allow the federal government to garnish wages and seize assets without a court order. Unsecured medical debt is very challenging to recover if the debtor doesn't have significant assets or income. Unsecured municipal debt gives the municipalities some leverage to collect. Utilities debt gives the utilities companies the power to shut your utilities services if you default, therefore leverage service to collect. On the other hand unsecured NP credit card debt must be charged off after 180 days of default and has a SOL that varies from three to seven years depending on state laws. Charged off credit card debt is often sold in large wholesale portfolios to debt buyers for collection at less than 5% of its book value (less than five cents on the dollar).

As the below Figure 22 shows, consumer credit increased from nearly $750 million in 1991 to nearly $3,750 in 2016. This represents nearly 500% increase over 25 years or 6%+ growth per year. This is more than twice the average economic growth of an average 2.23% over the same period.

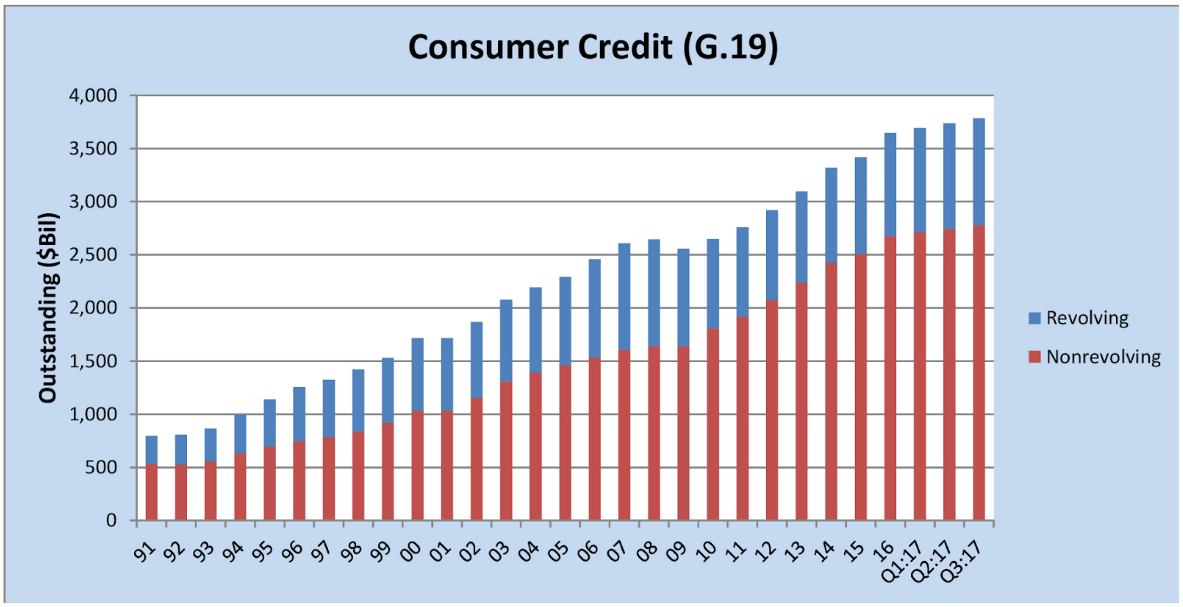

Figure 22 Consumer credit market: revolving and non-revolving debt

What are debt delinquency and default rates during such economic crisis?

The following chart shows that "household Debt Service Payments as a Percent of Disposable Personal Income grew from nearly 11.5% in 1999 to over 13% in the third quarter 2008, then dropped down to under 10% in 2013. "Delinquency had grown from its previously stable 4-to-5 percent of outstanding debt to 11.9 percent. Severe delinquency peaked in first-quarter 2010 at 8.7 percent of outstanding debt, despite having never reached 3 percent for the entire 1999-2006 period. Put differently, delinquency and severe delinquency rates roughly tripled and quadrupled, respectively, over a period of three-and-a-half years" (Brown, *et al.*, 2013, p. 4). With a shrinking debt market, increasing delinquency and default rates, creditworthiness decreases, debt markets suffer, financial markets can't perform, and the economic impact is mammoth.

The below Figure 23 shows a rise of household debt service payments as a percent of disposable income rising to an all time high (above 15%) in 2008 (FRED, 2019).

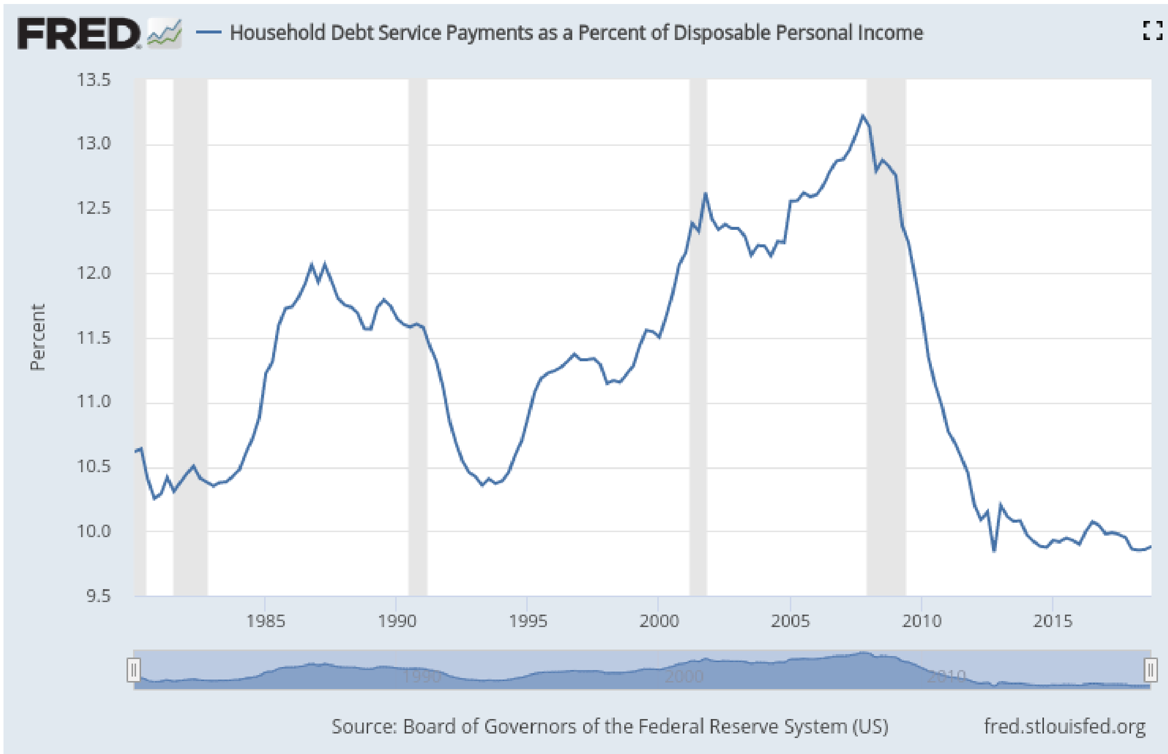

Figure 23 Household Debt Service Payments as a Percent of Disposable Personal Income

How significant is the non-performing credit card debt market?

This CCDM case study focuses on the revolving debt portion of the Consumer Credit (G.19); this is primarily credit card debt. The timeline is divided into two periods: from 1993 to 2008 (market growth period) and from 2008 to 2017 (market downturn and recovery period). Many of the lessons learned from this market segment's challenges and solutions are applicable to other HH debt markets; and some lessons also apply to other than HH debt markets. This research aims to define the market, stakeholders, dynamics, challenges, and opportunities; it also aims to evaluate technologies that can be applied to this market segment to decrease non-performance, increase efficiency, facilitate transactions, increase solutions yield, accelerate market activities, reduce costs, and increase productivity.

What are CCDM's history, statistics, performance, and non-performance since the year 2000?

The CC debt market grew more than double from $561 billion in 1998 to $972 billion in 2008, and charge off rates averaged 4.9 from Q2 1998 to Q2 2008. After the 2008 financial crisis, similar to other HH debt markets, this market shrunk by more than 20% down to under $800 billion by Q2 2011 while charge off rates climbed to over 11% in Q2 2010, then they went back down to under 3.5% in Q1 2014. More than $160 billion dollars in credit card debt were charged off in 2010 and 2011 alone; since a significant portion of this debt has up to seven year SOL and some is extended through debt collection processes, the total floating charged off credit card debt exceeds $300 billion. The size of other similar unsecured and NP HH debt is double the credit card market size. The total size of charged off or equivalent HH debt could exceed $1 trillion. The largest third party debt buyer and collector, Encore Capital, claims to manage over $130 billion in HH debt with more than 60 million individual accounts.

The NP CC debt market is our case study and focus. This research aims to investigate and study what triggers the charge off process? What happens after charge off? What are the market bottlenecks and inefficiency factors? How does it get resolved? What challenges can technology solve? And how to resolve them?

Who are the CCDM's primary stakeholders?

This market has four primary and multiple supporting stakeholders. The four primary stakeholders are:

1. the government (market regulators and enforcement agencies)
2. the sellers (debt holders, creditors, debt buyers),

3. the buyers (debtors, debt buyers), and
4. the referees (credit reporting agencies or “CRAs”).

The debt buyers on the seller’s and buyer’s sides are wholesale debt traders; they buy debt portfolios from credit originators (creditors) and either resell them wholesale to other debt buyers or place them with debt collection agencies to demand and collect debt from debtors.

Government regulations mandate that unsecured credit card debt must be charged off 180 days after the start of default (FDIC, 2014). Charge Off means the debt is not collectable and the creditor can no longer claim it as an asset on its books. The immediate benefit of charge off is tax write off. Some creditors keep the charged off debt and move it over to collections; some sell it to third party debt buyers in large debt collection portfolios. There are more than 500 debt buying companies and more than 5,000 debt collection companies.

“The Commission acquired and analyzed an unprecedented amount of data from the studied debt buyers, which submitted data on more than 5,000 portfolios, containing nearly 90 million consumer accounts, purchased during the three-year study period. These accounts had a face value of $143 billion, and the debt buyers spent nearly $6.5 billion to acquire them” (FTC, 2013, p. ii) This is an average of 4.5 cents on the dollar. As a result, debt collectors demand the full book value for the debt while the real value is less than 5%; the margins are huge; the opportunities are very promising; however, this seller buyer market is not a normal “able, ready, and willing” buyer market. The seller of the debt (creditor or debt collector) is demanding (under threat of legal action) through its agent (debt collection agencies) that the buyer (consumer debtor in default) buy back his/her NP debt at full market value; and the buyer fights back. Therefore, The buyer/seller engagement, for the most part, is hostile and conflicted.

Consequently, the intermediaries (mostly legal help and credit counselors) flock in to cash in on the opportunity. A market test conducted by this researcher finds that, on average, a debtor pays nearly 75 cents on the dollar to resolve NP debt; and the debt holder receives nearly 25 cents on the dollar; the difference (nearly 2/3) goes to market intermediaries and inefficiencies. In 2012, about 30 million consumers (14% of Americans) had debt that was or had been subject to collections process, averaging approximately $1,500 (CFPB, 2013, p. 2).

The buyer in default is, in most cases, under economic duress and fighting off debtors. Debt collectors use litigation (threats of asset seizure and wage garnishment) and derogatory credit reporting to pressure the buyer into buying back their IOU debt notes/papers. The role of the CRAs is very critical since they score creditworthiness and therefore strongly influence a debtor's ability and cost to access the credit markets therefore either enhancing or curtailing purchasing power and affecting credit pricing. In addition to litigation and other debt market enforcement mechanisms, CRAs play a powerful role in the debt market seller/buyer engagement and dynamics.

Additional market stakeholders are the agents (intermediaries) on both sides (debt collection agencies, credit counseling agencies, and legal representatives). The secondary supporting market stakeholders are the service providers including payment processors and software solutions.

The size of the market is significant:

1. "An alarming 77 million Americans—35 percent of adults with credit files—have debt in collections reported in their credit files, with an average debt amount of nearly $5,178" (Ratcliffe, *et al*. 2014, p. 7).
2. 2,000+ credit counseling agencies
3. 20+ primary credit originators (plus hundreds more small ones)
4. 500+ debt buyers
5. 5,000+ collection agencies
6. Thousands of legal representatives and law firms

Because of the current market inefficiencies, hostility, and conflict driven nature of debt collection, the level of litigation is very high jamming the U.S.court system and consumer complaints to federal agencies have exceeded 200,000 complaints in Year 2012. This is why the 2010 FTC report titled "Repairing a Broken System" called for market reforms and technological innovation to remove market inefficiencies and enhance productivity. (Leibowitz, ed., 2010)

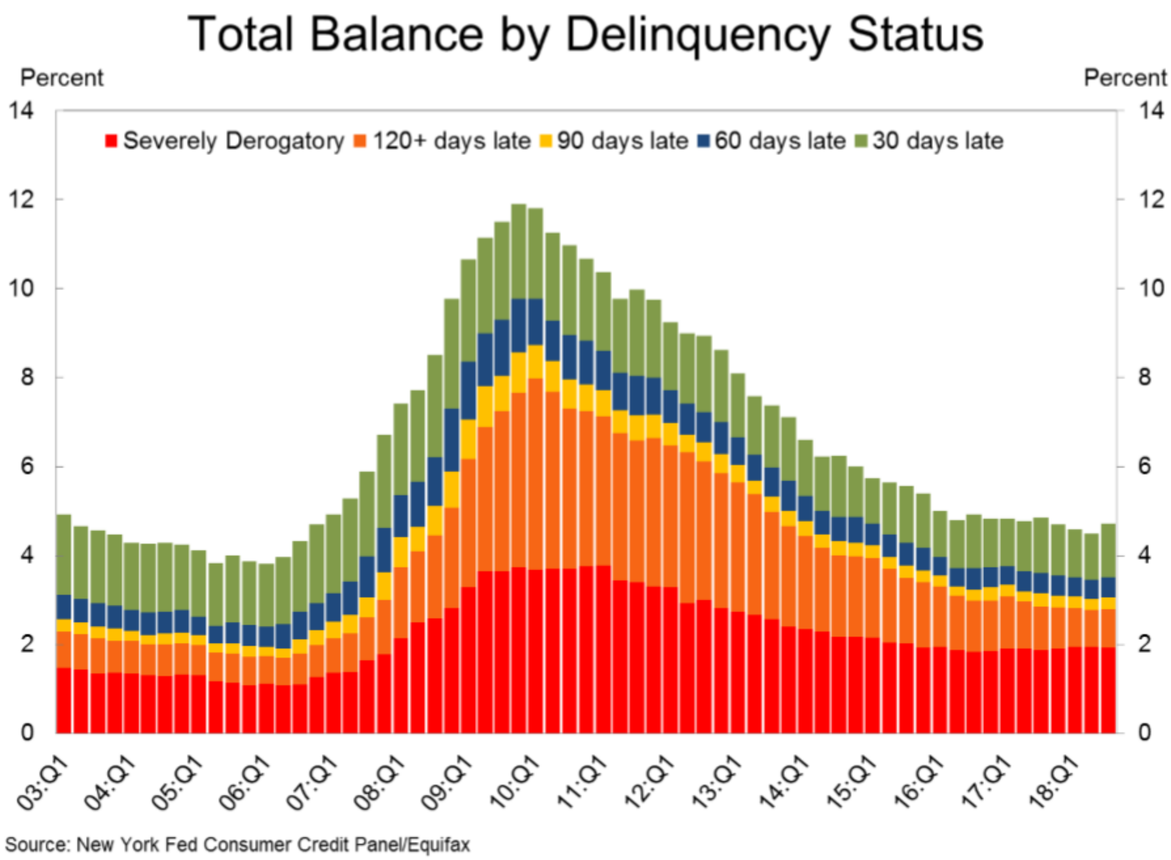

Figure 24 Total Balance by Delinquency Status

In sum, the market stakeholders are many, the market size is very significant, the market environment is hostile and conflicted, and the impact on the economy is huge. The challenges are formidable and the opportunities for technological innovations and solutions is inviting.

Is the CCDM market dysfunctional? Is it a broken system?

The FTC's Roundtables Report: Repairing Debt Collection Litigation and Arbitration was the result of roundtables held in 2009 by the Commission. In 2010, the Commission issued its report with recommendations to improve efficiency and fairness to consumers. Here are the main findings and recommendations:

1. **Consumer Participation in Litigation**: Without knowing why, the study showed that few consumers appear or defend themselves in debt litigation. It recommended improving notice and service of process.

2. **Evidence of Indebtedness**: the study found that complaints were filed against the wrong people or for the wrong amounts, and lacked sufficient information. It recommended that complaints include more evidence (i.e. original creditor) and encouraged the courts to enforce this.

3. **Arbitration**: It recommended more meaningful arbitration choices and a fairer process.

Additionally, the FTC introduced strong enforcement rules through the TSR (Telesales Marketing Rules) to curb abusive practices by the debt resolution industry from harming vulnerable consumers seeking help to resolve their debt.

How did congress act to repair the broken system?

The collapse of the subprime mortgage market, the subsequent financial market crisis in 2008, the skyrocketing increase in defaults of the HH debt market, the mounting consumer complaints to the FTC documented in its "Repairing a Broken System" 2010 report, and other market non-performance factors drove the U.S.Government and Congress' efforts to reform the financial markets. The result was the Dodd-Frank Wall Street Reform and Consumer Protection Act (referred to as "The Dodd-Frank Act"). In addition to financial market reforms, the Dodd-Frank Act authorized the formation of the Consumer Finance Protection Bureau (referred to as the "CFPB") with broad authority to regulate and enforce laws, rules, and regulations designed to protect consumers. For the purpose of this research's focus, the Dodd-Frank Act introduces three significant elements to the challenges and solutions desired; these are:

1. Consumer protection laws, rules, regulations, and enforcement applied to multiple market stakeholders. Most notably is the TSR (Telesales Marketing Rules)
2. Financial information protection and privacy
3. A call to reform and innovate this market with post internet technologies.

These CFPB elements complicate the challenges but also give some direction to market reform and solutions.

What are the market challenges and opportunities?

These are the primary market challenges:

1. **Market Hostilities**: NOT "ready, able, and willing" buyer. Most markets are built on the principle of free trade and a "ready, able, and willing" buyer. "I owe you" is a free commitment from borrowers who are "ready, able, and willing" to pay back (buy back their debt). However, when the debtor falls in default, suffers economic hardships and decreased access to credit market due to lower credit scores and worthiness, and feels unable to meet debt obligations, the debtor continues to be willing, but feels not-able and not ready. As a result, the market becomes compulsory, adversary, conflicted, and hostile. This makes it a unique market for any solution.

2. **Heavy Regulations**: Federal and state laws, rules, and regulations, and data security and privacy, etc. vary from one market to another. But due to the hostile nature of this non-performing debt market, consumer abuse and government regulations increase. This complicates the environment under which a technology market solution is deployed.

3. **Large Spreads** between debt book value and real market value demonstrates a strong need for price transparency and removal of barriers to entry to debt trading market.

What fintech challenges, opportunities, and solutions are there?

An effective market solutions requires a platform that overcomes parties hostilities and government regulations, invites 3rd party market players, investors, and mediators, and matches debtors, creditors, and 3rd party stakeholders while keeping financial data privacy, security, and anonymity. The following technology criteria are needed in any solution:

1. PCI compliance (data security and privacy): this complicates market transactions, creates barriers to entry, slows integration, increases costs, and increases risks.
2. Federal and state laws, rules, and regulations can be arbitrary and discriminate often causing unintended harm by erecting barriers to entry and increasing risks.
3. Data anonymity for 3rd Party Market stakeholders (intermediaries): demands anonymity of transactions, introducing new intermediaries and removing inefficient intermediaries.
4. Online Auctions: bidding in open market transactions demands transparency and scoring
5. Optimization of processes
6. Disruptive technology: causes market resistance especially amongst technology averse stakeholders (i.e. debt buyers and attorneys).
7. Technology Aversion (debt buyers and attorneys)

The U.S.Credit Card market grew from nearly $560 billion in 1998 to $1 trillion in 2008 (BGFRS, 2017). Charge Off rates, mandated by federal law on unsecured revolving debt, grew from 2.5% (a little less than $15 billion per year) to over 12.5% (nearly $130 billion in 2010), more than 8 times (BGFRS, 2019). Charged off debt continues to trade in secondary debt buyer, debt collection markets for up to 15 years. The cumulative charged off credit card debt exceeds $500 billion. Since credit card debt represents nearly 20% of the debt collection market, the market for charged off or similar unsecured debt in default exceeds $2.5 trillion. This market involves more than 500 creditors and debt buyers, more than 4,000 debt collection agencies, more than 1,000 debt counseling agencies, more than 1,000 law firms, and more than 50 million consumers.

The debt market is growing at rates much higher than U.S. GDP and inflation rates; hence, the above numbers are likely to grow rapidly. Because of its conflict and hostile nature involving litigation, harassment, and abuse, customer complaints are at an all time high. Over the past 40 years, the federal and state government bodies have introduced many laws and regulations to reform, regulate, and police this market; in 2010, the FTC declared it to be a “Broken System” that needs repair. Since software technology has been the leading solution provider in this information society, all stakeholders in this market appeal to more promising solutions.

What is the history and evolution of the CCDM?

The leading questions asked by this research are focused on:

How did the NP CC debt market develop and grow in recent history? What happens when this debt goes to debt collection? How do debtors and debt collectors resolve the conflict due to debtor’s not being “able” to pay (buyback) NP debt? What is the impact of this conflict driven hostile market on the legal system? How does congress and government regulators respond to consumer harassment?

The U.S.banking system issues monthly statistics and periodic reports (quarterly and annual) on the status of the industry. The Federal Reserve System categorizes this debt under revolving debt, a segment of the Consumer Credit - G.19. "Consumer Revolving Credit Outstanding" increased from $40.5 billion in Q2 1978 to over $1 trillion in Q2 2008 (25 times increase in 30 years). Charge-off rates increased from 2% in 1984 and 3.5% in the year 1990 to 12% in the year 2010. (BGFRS, 2017) In sum, NP CC debt annual charge-off amounts increased from nearly $1 billion per year in 1978 to over $100 billion per year in 2010 (100 times). This mammoth growth demonstrates the scale, impact, and magnitude of this market on the economy and people's creditworthiness, purchase ability, and economic health. Recent years statistics shows the market slowing down and downsizing by 20% and charge-off rates down to nearly 3.5%, a sustainable level. However, the market is beginning to grow again in year 2014. Surviving the latest financial crisis encourages CC creditors to be more aggressive in coming years; CC debt growth rates could return to or even supercede recent historic levels; and if another financial crisis occur, the magnitude of suffering can quadruple. There is a strong need and demand for market mechanisms and systems that allow for more efficient recycling of NP CC debt to minimize financial and economic damage, to increase market efficiency, and to decrease costs and prices.

Mathew Ruben, in a paper titled "Forgive Us Our Trespasses? The Rise of Consumer Debt in Modern America," observes that between 1975 and 2007, "total household debt in the U.S.has grown by a factor of 4 1⁄2 when adjusted for inflation" (Ruben, 2009, p. 1). In 4 parts, Reuben investigates in detail the credit market, then it characteristics (with a focus on its poverty "debt trap"), then discusses the supply side of the credit market (with emphasis on deregulation and the "Democratization of the Credit Market" and how the elimination of usury laws helped expand the market). At last, in Part IV, Reuben discusses "The Credit Crunch" of 2008 and suggest policy recommendations for reforming the market. Although Ruben sheds light on the history and development of the industry and suggest ideas that can moderate the impact of a "Credit Crunch," he doesn't address this research central question: How can more efficient market systems (and technology) resolve NP CC debt and decrease market inefficiency, debt collector - debt consumer conflict, jamming court system, consumer harassment, and economic and financial damage?

A Census Bureau report titled "Household Debt in the U.S.: 2000 to 2011" examines how the composition of HH debt changed in those years. Although all HH debt grew significantly, it points out that CC debt share in unsecured debt decreases from 47 percent in 2000 to 31 percent in 2011 (Gottschalck, Vornovytskyy, and Smith, 2013). However, those younger than 35 experienced an increase in their share from 26 percent in 2000 to 67 percent in 2011. The decrease in overall share is due to more Americans using secured HELOC loans to replace or payoff credit card debt; since younger than 35 Americans are less likely to own a home, this explains their increased reliance on credit cards. However, since the younger generation use of credit cards is increasing so much, this suggests that in the next economic expansion cycle, credit card use can grow much faster than the last cycle.

In a widely cited study by Lawrence M. Ausubel titled "The Failure of Competition in the Credit Card Market," Ausubel explains that credit card rates have been unusually sticky when compared to the cost of funds (Ausubel, 1991). This study shows evidence that even when cost of funds are low and charge-off rates are low, the cost of credit cards remains high despite the presence of 4,000 competitors. This study is relevant to our research in explaining two issues: how creditors survive despite a 12% charge-off rate in years 2010 and 2011 and that the excessive demand for credit cards is not deterred by excessive pricing. The high profitability due to sticky high prices encourages creditors to expand the supply of credit cards; the ever increasing demand for credit card by consumers (especially the younger generation) can be due to increased perceived need (strong marketing / consumerism culture) or the economic pressure to make ends meet. This suggests that an ever larger and larger number of debtors are vulnerable in economic downturns, and more so in an economic crisis; and that creditors are well positioned to reap significant profits in most years with a strong resistance to losses in bad years.

When charged off, debt goes into debt collection cycles. Several studies show that the debt collection industry has flourished with the rapid growth of NP debt. Other studies show a sharp increase in personal bankruptcies due to defaulting on debt (Gross and Souleles, 2002). Additionally, multiple regulatory agencies studies show a sharp increase in consumer harassment and abuse; “The Federal Trade Commission (FTC) received over 200,000 complaints about debt collection in 2013—second only to complaints regarding identity theft (FTC, 2014a)” (Stifler and Parrish, 2014, p. 2).

“Why should economic scholars study the consumer debt collection process?” asks Rob Hunt, a senior economist in the Research Department of the Philadelphia Fed (Hunt, 2007, p. 11). “First, the cost and effectiveness of the collections process has implications for the pricing and availability of consumer credit. Second, changes in technology and the structure of credit markets have transformed the collections industry.” Rob shows the exponential growth of the debt collection market how the federal government entered the regulation of this market with the Fair Debt Collection Practices Act. This article supports this research argument for the need to address the challenges of debt collection and consumer complaints. Interestingly, this article shows that medical debt collections is a larger share of the market (28%) than financial institutions share (17%). This clearly demonstrates that solutions for the NP CC debt market can be applied to similar unsecured NP debt markets (nearly 5 times larger). “The FTC considers debt buying to be one of the most significant changes in debt collection in recent years. revenue in the debt-collection industry has increased by more than six times the levels of the early 1970s” (Stifler and Parrish, 2014, p. 4).

Ernst & Young conducted a study titled “The Impact of Third-Party Collection on the US National and State Economies in 2016” (ACAI, 2017). The study was commissioned by ACA International, the primary debt collection industry organization. The study shows that the debt collection industry collects in medical debts 2.5 times what it collects for credit card debt (which represent ⅕ of debt collections). This demonstrates the value and application of this research solution goal.

“Currently, more than one in seven adults is being pursued by debt collectors in the U.S., for amounts averaging about $1,500 (Federal Reserve Bank of New York, 2014)” (Stifler and Parrish, 2014, p. 2). Additionally, there are more NP debt accounts that are not in active collection status.

How do debtors and debt collectors resolve the conflict due to debtor's not being "able" to pay (buyback) NP debt?

"Communities of color, older Americans, and low- and moderate-income communities experience higher rates of debt buyer lawsuits and abuses. In addition, military service members also face abusive debt collection practices" (Stifler and Parrish, 2014, p. 18). One way consumers could fight back was bankruptcy. "From 1980 to 2004, the number of personal bankruptcy filings in the United States increased more than five-fold, from 288,000 to 1.5 million per year" (White, 2007, p. 175). In 2005, the debt industry was able to push a new law through congress: The "Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA)." With bankruptcy becoming a more challenging solution, debt collection agencies have nearly doubled their litigation in recent years to nearly double. This has overwhelmed the court system. "The majority of cases on state court dockets on any given day are debt collection cases" (FTC, 2009). Due to financial hardship, the vast majority of debtors are not able to retain legal representation and judges are approving debt collectors default judgements without much investigation. In some courts, more than 80% of default judgements are debt collection judgements. Default judgements increase the life of debt collection beyond the statute of limitation; hence, debt collection conflicts and harassment increase and consumer complaints rise.

How does congress and government regulators respond to consumer harassment?

The government has reacted to the debt market challenges with several laws. Michelle White discusses the BAPCPA Bankruptcy Abuse Prevention and Consumer Protection Act (bankruptcy reform) of 2005 (White, 200). Schulman discusses "The Effectiveness of the Federal Fair Debt Collection Practices Act (FDCPA)" (Goldberg, 2005, p. 711). In "Regulating Wall Street," in addition to developing "the New Architecture of Global Finance," this law also established the CFPB (Consumer Finance Protection Bureau) (Scholes, 2010). Other important laws apply:

What are government reforms, regulations, and enforcement since the credit card market inception?

Industry regulations started in 1970 with the Fair Credit Reporting Act ("FCRA"). A 2004 Harvard University study (Staten and Cate, 2004) concludes that FCRA has been very successful. "The 1971 federal Fair Credit Reporting Act (FCRA) was intended to promote greater accuracy in credit reporting in the United States. Inaccurate credit reports can lead to overpricing on accepted loans, if not outright rejection" (Staten and Cate, 2004, p. 1). The FCRA was amended in 1996 by enhancing consumer control and privacy, and information accuracy. "Given the dramatic changes that were taking place in technologies, credit, and the uses of credit reports, Congress built into the statute an opportunity to revisit its performance by providing that these preemption provisions would expire on January 1, 2004" (Staten and Cate, 2004, p. 17). This study concludes that "The current system in the United States under which furnishers voluntarily report information to competitive credit bureaus has proved to be extraordinarily successful." Furthermore, it cautions against new changes that might cause more harm than good and discourages participation. FCRA is a relevant component to any technology mediation solution between creditors and debtors; FCRA violations give the debtor a strong hand in mediation. According to CDIA (Credit Data Industry Association), only 46% of consumer disputes are verified.

The FDCPA (Fair Debt Collection Practices Act), first passed in 1977, was the first federal regulation to address the increasing rampant issue of debt collection abuse and harassment. Previously, this issue was addressed at the state level (Goldberg, 2005). The FDCPA sets the rules of engagement between debt collectors and debtors. Again, FDCPA violations are subject to federal and state fines. The FDCPA law was reformed in 1996. Greenberg's examination of the FDCPA experience...

In summary, the 2008 financial market crisis highlighted the critical necessity of a performing market for non-performing debt. Unlike performing debt, non-performing debt market price can vary significantly (up to 1000% of real value). Therefore it increases risk, confuses pricing models, and causes market dysfunction. The absence of timely and meaningful price information and electronic trading mechanisms aggravates the problem leading, as happened in 2008, to an accumulation of non-tradable toxic assets. This causes financial markets to tighten up and slow down significantly therefore collapsing dependable markets (i.e. real estate and auto industries). It also decreases consumer credit worthiness and purchase ability. This causes chokes in economic activity and brings down financial and economic organizations. Consequently, it increases unemployment, and hurts a lot of people.

9.2.3.2. Existing data

We are looking for data that enhances our knowledge of our sociological requirements. We want data about our sociological stakeholders, environment, interaction, and behavior. In the above investigation and review, we identified existing and relevant data, especially government statistics and sources. We collect much general data, such as market size about our stakeholders. But we have collected little specific data (such as contact information and attributes). Most of this data is available only for purchase through industrial and commercial sources. We list it under desired and missing data. However, there is significant data about the sociological environment (social situation, market conditions, government regulation, statistics, and enforcement, legal system, etc.). Although we acquire a lot of general data about social interaction, most of the specific data is privileged to the creditors. As we offer our services to creditors, we will be able to acquire much data that could be very useful to enhance our interaction model and design. Behavior data comes from several points of interaction: marketing, transactions, agency relationships and communication, and the legal system. Again, general information is available. But the more useful and specific information, such as transactional data, is privileged and regulated, and should be negotiated in market partnerships.

9.2.3.3. Desired and missing data

What kind of desired data is missing?

What type of data are we looking for?

We have identified in the above research the size of our market to include 77 million Americans, 2,000+ credit counseling agencies, hundreds of credit originators, hundreds of debt buyers, thousands of debt recovery/collection agencies, and thousands of legal representatives and law firms. These are primary stakeholders about whom we should be collecting/acquiring as much information as possible. These databases are available at a cost from industry and commercial sources. To enhance debtor data, there are thousands of attributes available through commercial sources. This data is very useful for analytics, segmentation, targeting, pricing, behavior, location, propensity, and elasticity. The creditors database includes banks, credit unions, credit card issuers, online lending, etc. We discovered through interviews with transactional services companies that there are more than 30,000 companies active in debt recovery. Such data is not available commercially. Access to such data will have to be negotiated through business partnerships.

In addition to commercially and industry available data at a cost, the most important, and possibly the most valuable, data collection will be the data we collect through our interaction and behavior management of our own future debtors, creditors, communications, and transactions. We can also collect much data from business partnership.

9.2.3.4. Identify SRs and TORs

Our literature review and existing and missing data discovery, we are focused on identifying SRs and TORs. Our literature has clearly identified the primary sociological stakeholders, environment, interaction, and behavior requirements. In the next section, we conjecture their classification under our RIOTU model.

9.3. CCDM Case Study: Conjecture

The second science methodology phase is Conjecture. It is subdivided into four sections: analysis and conclusions, challenges, problems, and solutions. In our analysis and conclusions, we ponder above knowledge and data developed in the discovery phase and conjecture hypotheses and scenarios. We start by reevaluating CCDM's goals and objectives. We follow by defining CCDM's SRs within the RIOTU model. This gives us the foundation upon which we can conjecture priorities. Challenges relates to knowledge and data desired but not easily acquired through research. This includes expert knowledge and enhanced data. We have identified above desired and missing data. We should develop a plan on the priority, cost, and value of acquisition of such knowledge and data. Problems relates to issues that are currently market bottlenecks and dysfunctions we aim to resolve. This includes issues of conflict, collaboration, communication, interactions, transactions, stakeholders' driving interest, competing interests, federal, state, and local regulations, social sensibilities (such as gender, race, language, ethnicity, socioeconomic status, style, fashion, current political and social issues and currents, etc.), and competition. Solutions are the scenarios or hypothesis we develop to resolve problems. This includes resolution methodology, promising use case, product development, user engagement, and user response.

9.3.1. Analysis and Conclusions

In our analysis, the principal CCDM problem examined by discovery is the following: In debt markets, when the debtor falls in default, the debt, regulated by the government, is charged off and sold to debt recovery parties. The relationship between the debtor and the debt recovery party becomes a coercive market relationship: "either you pay or we take you to court." Unlike free and competitive markets, coercive markets don't work efficiently. For example: a debt recovery party demands full payment on debt even if it purchased the debt for less than one cent on the dollar. Asking a price one hundred times or more the cost of acquisition does not happen in free and competitive markets. Coercive markets are conflict driven. Social conflicts generate much damage to the material, intellectual, and sentimental assets of the parties involved.

The two original counterparts in this coercive market conflict are the debtor and the creditor. The creditor is in demand (plaintiff) position armed with legal and financial resources to press demand for payment coupled with legal threats to seize wages and assets.

The debtor is in default due to financial challenges. The debtor is the defendant with little or no legal and financial resources to resolve the demand for payment or fight back in court. The legal system favors the creditor; hence the debtor, in most cases, avoids the court system. Technology has lowered the cost of litigation and increased the creditors' ability to file complaints by the thousands. The legal system is jammed with creditor complaints. The creditor obtains easy default judgements. On the other hand, government regulations and enforcement favor of the debtor. The creditor and/or his debt recovery agency press the debtor with intimidating communications. Most debtors run away. The debt recovery industry has one of the lowest industry approval ratings in the U.S.A. The creditor-debtor conflict is an opportunity for intermediary agents to serve either party. This includes creditor and debtor agencies and attorneys. The cost of intermediaries is nearly two thirds of all monies recovered or collected. On average, the consumer pays nearly 75 cents on the dollar to settle debt; about 50 cents go to intermediaries and only about 25 cents go to the original creditor. Only a fraction of debt is collected. The system is inefficient, dysfunctional, and needs repair. The CFPB (Consumer Finance Protection Bureau) calls for innovative technology solutions. The CFPB states: "Our mission is to promote innovation, competition, and consumer access within financial services. We're aiming to fulfill this statutory mandate by: updating policies and creating sandboxes through which we provide regulatory relief, engaging with entrepreneurs and the innovation community, and collaborating with regulators" (CFPB, 2019). The CCDM project aligns itself with the CFPB mission, goals, and objectives.

9.3.1.1. Goals & objectives achievable?

Section 11.2.1.1 above outlined CCDM's material, intellectual, and sentimental goals and objectives.

The following is CCDM's achievable goals and objectives summary:

➢ **Material goals and objectives**: Since the Startup became the owner of the project, it developed preliminary fintech, financial planning, and business development to:

- reach company financial timelines, milestones, goals, and objectives,
- be first to markets and maintain a leading position in the non-performing debt recovery and asset liquidation markets,
- reduce the consumer cost and pain of resolving non-performing debt,
- increase debt recovery and asset liquidation,
- lower the cost of financing, especially essential financing (i.e. housing and auto financing) to consumers,
- expand financial and consumer markets,
- build a robust and scalable model and software system, and
- scale up into other financial and international markets.

➢ **Intellectual goals and objectives**: The Startup aimed to produce and lead intellectual property development in its markets. It also supported and promoted consumer empowerment, distributed and networked capital markets, and increased compliance with federal, state, local, and industry laws and standards.

➢ **Sentimental goals and objectives**: The Startup aimed to replace coercive debt recovery market operations with collaborative, amicable, voluntary, and agreeable digital mediation, reduce conflict, promote resolution, and increase market and social cohesion.

9.3.1.2. SR Components: hypothesize them

CCDM's sociological stakeholders (based on the RIOTU Model) include the following:

- **User**: this includes:
  a. **Debtor** (consumer): credit card holder

b. **Debtor agency** (consumer credit and debt counseling, resolution, repair, and settlement agencies). Debtor agencies are companies with an organizational hierarchy and multiple roles users.

c. **Creditor** (initial creditor, its debt recovery department or arm, or debt buyers). Creditors are companies with an organizational hierarchy and multiple roles users.

d. **Creditor agency** (debt collection agencies). Creditor agencies are companies with an organizational hierarchy and multiple roles users.

e. **Third party financial transaction facilitators and credit reporting and monitoring agencies**. These are companies with an organizational hierarchy and multiple roles users.

f. **Proxy debt buyers**. These are companies with an organizational hierarchy and multiple roles users.

- **Technologist**: it included the following:
  a. Architects
  b. Developers
  c. Testers
  d. Operations staff
  e. Management

  Please note that SSA technologist list mirrors the MSDN SA list of "who will consume your architecture." The SSA developer should attempt to mirror as much as possible between SSA and SA development.

- **Owner**: The owner is Startup. The leader of CCDM project development was the company CEO and patent inventor.

- **Influencer**: it includes:

a. Debt recovery industry organizations
b. Industry media
c. Consumer protection organizations
d. Credit card industry
e. Banking industry

- **Regulator**:
  a. Federal: CFPB and court system
  b. State
  c. Local

CCDM's environment is the social situation or system that surrounds, contains, and rules the stakeholders. It includes the sociological, technical, and operational elements of the following industries and related media and regulatory environment (federal, stae, and local regulatory agencies and courts):

- Credit card
- Banking
- Debtor agency
- Debt recovery
- Debt recovery agency

CCDM's interface is the social interaction of its stakeholders. It is the exchange, competition, conflict, cooperation, and accomodation of knowledge, sentiments, products and/or services, and monies between stakeholders. Non-performing debt markets are caused by delinquencies and defaults of debtors on terms and conditions of financial obligations to creditors. Therefore, by its nature, it is a conflict driven market. CCDM's interface includes the following:

- **Relationships**: adversarial and conflict driven
- **Roles**: creditors, creditor agencies, regulators, courts, debtor agencies, debtors, transactional intermediaries and service providers.

- **Status**: counterparts in conflict
- **Communications**: coercive and adversarial
- **Transactions**: highly regulated, confidentiality, privacy, debtor vulnerability
- **Disputes**: legal and financial in nature
- **Resolution**: agency driven through legal and financial threats and adversarial negotiations

CCDM's behavior is the social role/action of the stakeholders. It includes the following:

- **Transformation of relationships**: CCDM envisions a less adversarial and conflict with more collaboration, arbitration, resolution, and settlement driven relationship
- **Changing of roles**: CCDM envisions softening the roles creditors, creditor agencies, regulators, courts, and debtor agencies, empowering debtors, and advancing digital mediation through optimized transactional intermediaries and service providers.
- **Repositioning of status**: instead of counterparts in conflict, CCDM envisions participants in an exchange marketplace where third party intermediaries with novel solutions can mitigate everyone's risk, lower costs, lower compliance risks, and increase market activity.
- **Response to communications**: in conflicted relationships, roles, and statuses, communications tends to be more negative, avoidance increases, and response decreases. CCDM envisions a collaborative exchange market environment to be more positive with decreased avoidance and increased response.
- **Optimization of transactions**: CCDM's solution aims to disrupt inefficient market activities and replace it with fintech processes that increase market optimization, lower prices, increase transactions, decrease costs, decrease compliance risks, increase liquidity, and increase profits.

- **Mitigation of disputes**: CCDM envisions its third party non-agency digital mediation platform to invite novel third party solution providers to mitigate the disputes and bring efficiency to the market.
- **Promotion of resolution**: CCDM promotes a platform that decreases coerciveness, increases collaboration, encourages social cohesion, and promotes resolution.

SDRs focuses on SSA team skill development (Bika, 2018). We use this "Software Architect Interview Questions Template - Hiring | Workable" to develop SDRs' template. We add sociological requirements knowledge and training. In addition to architectural skills, we desire SSA knowledge, training, and skills.

TORs include the following:

- ➢ Web application platform with user control and authentication
- ➢ Framing of three compliant SAAS components:
    - Esign contract generator
    - Account management and payment processor
    - CRM
- ➢ Financial information privacy and security compliance insured through off-the-shelf framed and compliant component applications
- ➢ API integration with third party software components
- ➢ Posting and collection of contract data
- ➢ Easy to use and friendly UI/UX
- ➢ English only in U.S. market
- ➢ Database is SQL

- ➢ Microsoft .NET platform
- ➢ The system will run 24/7
- ➢ No online help system is required in Phase I

In order to discover and define the real problem in this market, we employed multiple and mixed research methods including doing a literature survey and review, gathering of statistical and other data (especially government and industry statistics), conducting a historical analysis of the evolution of this market and the formation of its principal problem, and a using ethnography (participant observation) where we entered the market as a consultant then became a distributor of technology solutions to consumer credit agencies. We concluded discovery with a clear definition of all SRs and TORs.

9.3.1.3. Resources/Budget/Constraints: Can you meet them? Manage expectations.

Our preliminary budget was to produce a DebtorSoft V1 prototype as described above with a $10,000 budget. This was a reasonable budget for this prototype. An outsourced solution was available for implementation. The prototype was developed within 30 days. Other than the prototype budget, the Startup resources at the early stage were very limited. The goal was to attempt a live market test with the prototype, develop the next phase budget, and plan accordingly.

9.3.1.4. What are your priorities?

Our priority is to execute a real market test with the DebtorSoft V1 prototype. If the test is successful, it might generate sufficient revenues for Phase II development. Otherwise, the Startup will have to raise capital to fund Phase II. More importantly, the DebtorSoft V1 prototype market test helps us scope the project for long term sustainable and customized software development. The test should favor development scenarios.

9.3.2. Challenge(s)?

The challenges to this CCDM project are many. The targeted financial market is mammoth. It can be subdivided into more than ten vertical sub-markets. The approach to each of these sub-markets is different. The scenarios are many. Amongst the challenges are discovered, cost effective, beneficial, and desired knowledge and/or data that can be acquired if and when the project has the necessary resources. Expert knowledge is key to not re-inventing the wheel, to better exploit opportunities, to gain quick assessment of product development, and to avoid pitfalls. Expert knowledge can be acquired through two primary compensation packages: stock options and/or money. Data acquisition is key to enhancing collected data and developing operations algorithms, scoring, and predictive models based on acquired data attributes.

9.3.3. Problem(s)?

Problems are dysfunctional interactions that disrupt and/or prevent communications, exchange, and/or transactions. Problems require solutions. CCDM’s problems are many.

Regulations: Over the past four decades, government regulators and enforcement agencies have developed an extensive body of laws and regulations to manage the dysfunctional interactions of the debt recovery market. These include regulating communication, exchange, data protection, privacy, and security, and transactions. Regulations are not the problem; they are guidelines to help resolve the problem. Any proposed solution needs compliance with federal, state, and local laws and regulations.

Conflict: As discussed above, the debt recovery market is one of the most conflicted markets in the U.S.A. The nature of the conflict is deep and fundamental. It arises from the nature of legal ramifications of default on debt. The relationship between the creditor and debtor becomes coercive. Consequently, the normal free market forces applied in capitalism lack a mechanism to collaborate and compete for a solution. Solving this conflict requires transforming the coercive creditor-debtor relationship into a tri-lateral collaborative market relationship in which 3rd party innovative solution and free market force providers offer novel market solutions and free trade.

Collaboration: Because the debtor is in default and the court system favors the creditor with legal and financial resources, because consumer financial protection laws and regulations favor the debtor, and because there are strict regulations on financial information protection, privacy, and confidentiality, direct collaboration between the creditor and debtor is very challenging. Any communication between the creditor and debtor can generate more information that benefits the creditor against the debtor. This is why debt collectors are required to disclose to debtors that any information collected can be used by the creditor against the debtor. Turning a coercive relationship into a collaborative and agreeable relationship is the most challenging problem for the CCDM project.

Interaction: All creditor-debtor communication and/or interaction is heavily regulated. Parties are obligated to maintain strict financial information protection, confidentiality, and privacy. Any business interaction between solution providers demands exchange of data. Parties have to negotiate carefully any sharing and/or use of data.

Driving interest: The social epistemology of the marketplace has existing market players boxed into a mental frame, position, vision, and mission to drive revenues and profits to the participating enterprise. Some market players, especially ones feeding on market dysfunctionality and inefficiency, have strong driving interest to fight back any solutions. Others, who can benefit from novel solutions, require much learning to understand novel solutions and reorient their driving interests for a better, functional, and more efficient marketplace. The problem for Startup is how to deal with the different driving interests in the marketplace.

Competing interests: The two most competing interests in the CCDM market place are the creditor and debtor. There are also competing interests between creditors and market intermediaries who are taking the bigger slice of recovered debt. If the competing interests of the two primary parties, creditor and debtor, are mitigated and transformed from a coercive relationship to a collaborative and agreeable relationship, the cost of debt resolution can decrease by 30-50% and the creditors returns can increase by 20-40%. Lower debtor costs and higher creditor revenues expands the marketplace, generates more debt resolution, increases consumer creditworthiness, opens up financial markets to more buyers, and increase economic activities. The problem of mitigating and transforming the competing interests of the creditor and debtor is pivotal to a good market solution.

Sensibilities: There is much sensibility and hostility in the marketplace between creditors and debtors. Such sensibilities affect creditor's branding and customer attachment. This is more visible in membership driven credit unions. Brand erosion is a problem that most creditors wish to resolve. More importantly, the debt recovery image, with the lowest consumer approval ratings, needs recovery.

Competition: Any CCDM solution introduction to the marketplace must proactively prepare and develop a strategy to compete with alternative solutions. Competition is a perception that could be real or false. For example, debt recovery agencies may perceive the CCDM solution to be competition. The CCDM problem is how to position itself to be a tool that helps instead of completes with debt recovery agencies. If the CCDM solution is not an agency of either party and offers automated third party non-partisan solutions, it becomes a tool that helps debt recovery agencies recover more at a lower cost and less compliance risk. Similarly, debtor agencies can use the CCDM solution to automate their debt resolution negotiations with creditors and/or their agencies. This reduces costs and optimizes revenues and profits.

9.3.4. Solution(s), Scenario(s), and/or Hypothesis(es)?

Solutions can be developed through novel resolution methods, development of use cases (new products and/or services), enhanced interaction and engagement between buyers and sellers, and optimized response. They should also take into consideration the above problems and their solutions.

What is the core problem and its solution?

The core problem is the coercive relationship between the creditor and the debtor. The core solution is the transformation of the coercive relationship into a collaborative, agreeable, and resolution driven relationship. How can this be achieved? The following are some guidelines for an optimal CCDM solution:

1. The CCDM solution should be a 3rd party non-partisan, non-agency, and very compliant solution.

The three biggest red flags that trigger consumer protection regulation and compliance are: (a) charging the consumer any kind of fees, (b) management of consumer's financial data protection, privacy, and confidentiality, and (c) demand for payment communications. Consumer agencies' biggest compliance challenges are charging consumer fees and marketing communication. Debt recovery agencies' biggest compliance challenge is demand for payment communications. All parties have to comply with financial information compliance. To achieve a 3rd party non-partisan, non-agency, and very compliant solution, the CCDM solution can not charge any fees to the consumer. To achieve this goal, the marginal cost of the CCDM solution should be near zero. This can be achieved through near 100% software automation and intelligent communication and transactions. The CCDM solution should never issue demand for payment communication. It should also avoid consumer agency like risky marketing communication. Furthermore, customer acquisition cost should be exceptionally low. For example, if the CCDM solution can be offered to membership benefits organizations as a free giveaway to their membership, customer acquisition costs drop significantly.

2. To gain the debtor's collaboration, the CCDM solution should be consumer centric. It should protect the debtor's financial information, privacy, and confidentiality. More importantly, it should lower costs and expand resolution options.

In the current debt recovery marketplace, the following table is descriptive of the debtor debt recovery demand response segments based on consumer recovery attributes: consumer debtors are either able, think not able, or not able to resolve debt. “Think not able” means they have poor information on resolutions options; hence they think they are not able to resolve the debt when in reality there are options including, for example, discounting the debt or arranging for termed payments. On the other hand, consumer debtors are either willing, willing but afraid, or not willing to communicate or collaborate with creditors or their debt recovery/collection agencies to resolve debt. This breaks the table into four debt recovery demand response segments: (a) debt recovery collaborative response space, (b) sceptical response space, (c) very sceptical response space, and (d) averse response space. This is a good example of data acquisition, analytics, and modeling to give us a propensity score (“Debtor Segmentation Score”) for debtors to belong to one of the four segments. Based on the score and a media propensity score, we can communicate the right message through the right media to best influence and change the debtors behavior towards collaboration, debt resolution, and social cohesion.

<table>
<tr><th>Consumer debtors</th><th>Willing</th><th>Willing but afraid</th><th>Not willing</th></tr>
<tr><td>Able</td><td>Debt recovery collaborative space</td><td>Sceptical</td><td rowspan="2">Very sceptical</td></tr>
<tr><td>Think not able</td><td>Sceptical</td><td>Sceptical</td></tr>
<tr><td>Not able</td><td colspan="3">Averse</td></tr>
</table>

Table27 Debt recovery demand response segments

If the CCDM solution is free to consumers, lowers the cost of resolution, improves the terms of resolution, is compliant with financial information protection, privacy, and confidentiality, offers novel resolution options, and educates the consumer on the benefits of an affordable debt resolution solution, the CCDM solution promises to expand debt recovery into the “sceptical” and “very sceptical” spaces.

The following is a CCDM consumer debtor pricing model:

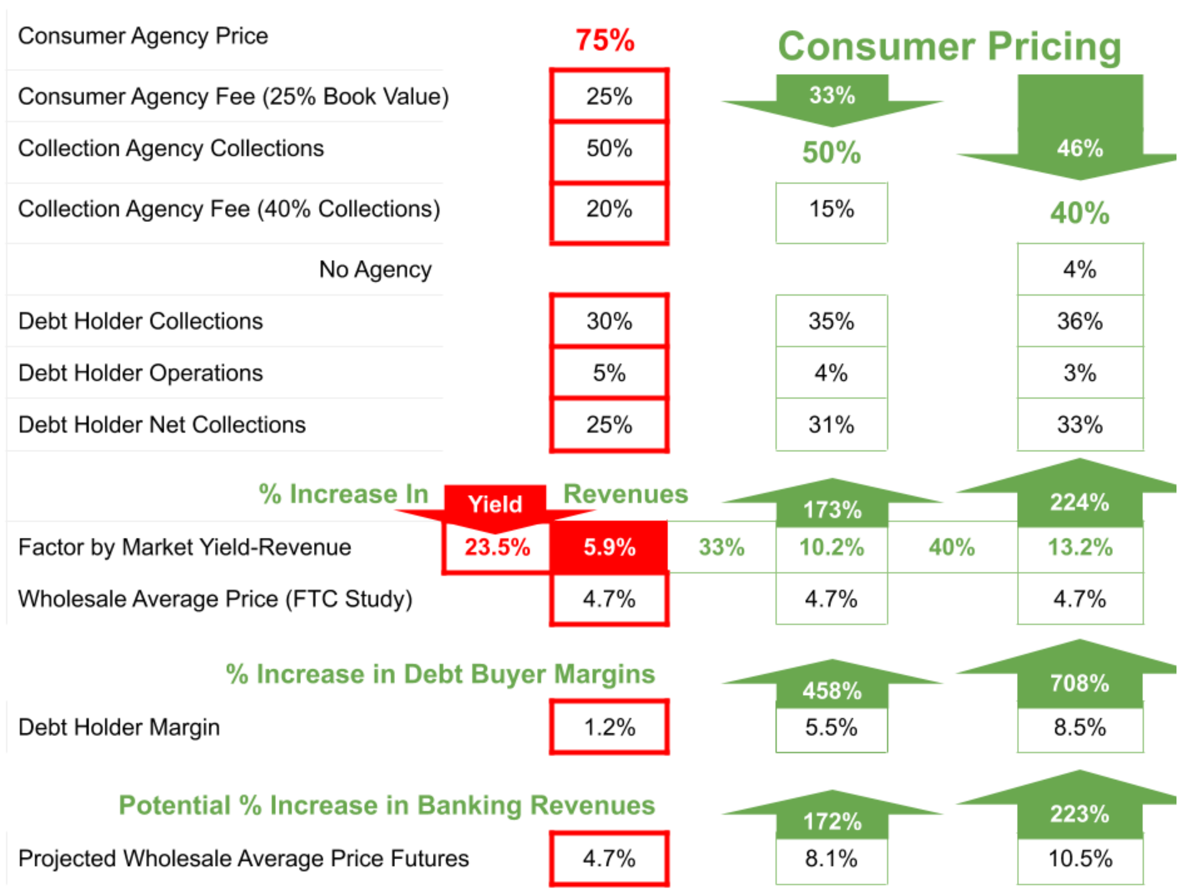

Figure 25 CCDM consumer debtor pricing model

The above model is based on a case study of the consumer agency fee model and the debt collection agency fee model. This CCDM model predicts a consumer price 33% to 46% lower than current market prices. It also predicts a significant expansion of debt resolution market.

3. To gain the creditor’s collaboration, the CCDM solution must demonstrate without any doubt its compliance with federal, state, and local laws and regulations. More importantly, it should lower creditor’s debt recovery cost,

expand resolution options, increase revenues, and increase recovery rates, decrease compliance risks.

4. To expand resolution options, the CCDM solution should open the marketplace to novel resolution solutions especially the introduction of proxy debt buyers. Often times, the creditor's ask price and terms and the debtor's bid price and terms don't meet due to technical obstacles and 3rd party financing needs. Proxy debt buyers can mediate the transaction through innovative acceptance of the ask and bid terms and conditions often by bridging the financing between parties.

Creditors and debt recovery agencies are very elastic on the discount rate of a defaulted debt but inelastic on terms. Debt recovery runs into multiple campaign. Each campaign runs about 3-6 months. Response to marketing campaigns tapers off within 3 months. After the completion of each debt recovery campaign, the debt is resold or transferred to a new enterprise for another round of collection campaign. The cost of debt in default is minimal; however, the cost of marketing campaigns and operations is relatively high. Because of the nature of a collection campaign, debt collectors can accept terms if they are within 90 days. Longer term resolutions require new financing. Compliance with regulations makes it hard to sell new financing while collecting debt. This is why creditors and debt collectors are inelastic on terms. To compensate, and because between the spread between cost of charged off debt and the face value is huge, creditors and debt collectors are more elastic on price discounts. On the other hand, debtors in default are more elastic on discounts and less elastic on terms. Debtors ask for the longest term possible. This incompatibility between the creditor's ask and the debtor's bid aborts attempts at debt resolution. The solution is with a 3rd party proxy debt buyer. The proxy accepts the terms of the creditor and the debtor, gains the spread between the wholesale-cash creditor ask price and the retail-terms debtor bid price, and bridges the difference. Other 3rd party innovative solutions include simultaneous 3rd party financing to resolve debt. With an electronic exchange platforms, we expect many novel solutions to participate in the marketplace and bring efficiency.

5. To optimize transactions, the CCDM solution should be fully automated while keeping a wall of financial information protection, privacy, and confidentiality between parties.

Most creditors offer online automated debt resolution platforms. But since they collect the debtors information data and can use it against the debtor to enforce coercive collection throughs the courts, most debors are averse to using the creditor or debt collector platform. Hence, automation without financial information protection, privacy, and confidentiality is not the solution. On the other hand, debtor agencies, with fiduciary duty to represent the best interests of the debtor versus the creditor or creditor agency counterpart, conduct negotiations through a manual process. This is costly and inefficient. The CCDM solution must provide both: full automation for efficiency, optimization, and lower costs, and financial information protection, privacy, and confidentiality.

6. To optimize pricing, the CCDM solution should develop price elasticity algorithms that take into consideration the profiles of the buyer (debtor), seller (creditor), and debt.

Because of the large spread between the cost and face value of defaulted debt, and because of the nature of coercive markets, the price of debt resolution is artificial. What is a free market reasonable and fair price mechanism? This can be solved with machine learning. The CCDM solution should acquire the data necessary to suggest a fair pricing mechanism that brings the buyer and seller to a quicker resolution. This involves building profiles of the buyer (debtor), seller (creditor), and debt portfolio.

7. To optimize collaboration, communication, and response, the CCDM solution should develop creditor and debtor behavior propensity algorithms.

Similar to the above elasticity pricing solution (6.), the CCDM solution should develop models and algorithms for debtor and creditor behavior based on historical data and acquired profiles.

8. To optimize communication, the CCDM solution should develop media and content response propensity algorithms.

Similarly, the CCDM solution should develop propensity algorithms that improve and optimize communication between the parties. Debt recovery agencies continue to rely heavily on direct mail communication. With the varied technology communication options available today, communication can be optimized by scoring the recipient's media response propensity. Creditors and debt collectors communication starts with a payment demand letter. Demand payment communications are heavily regulated. Since the CCDM solution does not communicate and payment demands, its options to communicate with all parties are expanded. This gives the CCDM solution more room to increase communication and collaboration between the parties.

9. To develop intelligent algorithms, the CCDM solution should acquire necessary creditor and consumer data attributes and scores.

We covered this point in the above Section 12.2.3.3 Desired and missing data.

What is the proposed CCDM solution?

The CCDM solution is a fully automated and intelligent software solution offering neutral 3rd party non-agency and non-partisan digital mediation exchange platform between all parties. The CCDM solution invites proxy debt buyers and other novel 3rd party novel debt resolution service providers to participate in the CCDM marketplace and offer innovative solutions. The platform is fee free to the consumer debtor, charges the creditor a contingent digital mediation fee 70% less costly than normal debt collection campaign and operations costs, and charges 3rd party service providers negotiated fees based on the services provided. The CCDM digital mediation exchange platform targets the 77 million Americans with debt collection accounts and the nearly 25 million Americans derogatory, stressed, or near default credit accounts. This target of 100 million financially underserved Americans are the target of many financial and related products and services. The platform becomes an attractive mall for product and service providers to targeted market.

What are the scenarios for achieving the above solution?

There are two primary scenarios for achieving the above solution.

1. **Scenario I**: enroll debtors and submit bids to creditors, then try to enroll creditors.

2. **Scenario II**: enroll creditors and offer a platform to enroll two types of non-responders to debt collection campaigns: the “sceptical” and the “very sceptical” spaces (see the above Table 5.3.4: Debt recovery demand response segments)

Because this CCDM solution is consumer centric and fee free to consumers, the cost of customer acquisition with Scenario I is much less than the cost of acquisition with Scenario II. Furthermore, because of the regulatory environment, creditors and their agencies are very sceptical to experiment with novel solutions.

What scenarios of debtor enrollment are available?

There are two primary scenarios for enrolling debtors:

1. **Direct enrollment**: this involves expensive and untried marketing campaigns. Because of the early stage development of the CCDM solution, the DebtorSoft V1 prototype, and lack of capital to fund any marketing campaigns, this solution is not practically available.

2. **3rd Party enrollment**: There are two primary enrollment scenarios:

a. **Membership enrollment scenario**: This is a very promising scenario. However, it is novel and requires a unique partnership willing to test the product with its membership. Finding such a partner will require time and resources.

b. **Agency enrollment scenario**: This is a good and easy enrollment solution. Agencies suffer with their manual backend debt resolution negotiations costs and yield. Offering an automated solution with a competitive price and manual backup option opens a relatively easy door to a first test solution.

Hence, the best option has the following attributes: it is a 3rd party agency consumer enrollment. This use case option was tested with nearly 20 agencies. It was well received. The Startup started testing the DebtorSoft V1 prototype with nearly 20 agencies.

What are the optimal steps to reach the above goals and objectives?

Here are the steps:

1. Build, deploy, test, tweak, and redeploy DebtorSoft V1 prototype.
2. Develop an agency enrollment product/service and plan.
3. Train agency team to use DebtorSoft V1 prototype.
4. Monitor and interview agency team regularly to ensure best practices and collect feedback data.
5. Use customer revenues to develop DebtorSoft V2 prototype. It takes six to nine months before enrolled debtors save enough money in dedicated accounts to start bidding on their debt resolution. This time was good for DebtorSoft V2 prototype development including an automated and simulated debtor bidding process.
6. Run a bidding test for nearly one year.
7. Study the results and make recommendations for a future long term

customized platform development.

This CCDM solution proposes the development of an online auction for non-performing debt that serves as a debt clearinghouse. Trading, optimizing, and resolving non-performing debt has significant financial and economic rewards; however, it also has a very challenging environment.

The use case was market positioned to consumer agencies as an automated backend processing system with manual backup, lower cost, and potential higher yield. After successfully signing up the agencies, enrolling debtors, and building DebtorSoft V2 prototype, we had to focus on creditor engagement. Creditor engagement was decided through automated efax bidding. We were looking to measure response for a basic and automated bidding process.

9.4. Conclusion

In this chapter, we introduced concurrent and sequential development methods. Concurrent development means the development of sociological requirements alongside SA's technical and operational requirements. This is best for new development with a strong incentive for SSA methodology. Sequential development means the development of sociological requirements after the completion of SA development. This is best for existing development that seeks to optimize itself with the sociological requirements.

Furthermore, we introduced the CCDM case study with the Discovery and Conjecture stages of development. We have laid the groundwork for CCDM planning and design and operations discussed in the next two chapters.

10. Chapter Ten

CCDM Case Study: Planning and Design

Methods, Approaches, Models, and Techniques

10.1. Planning and Design

The third science methodology phase is planning and design. It is subdivided into four sections: methods, approaches, models, and techniques. The first step in to edit and prepare a step by step checklist. SSA concurrent developers can use the above Table 5.1.2: Synthesized Concurrent Checklist ("SCC") as a template. SSA sequential developers can use the SSA column as a model to develop their own checklist.

10.1.1. Methods

What methods are most appropriate for the CCDM project?

The CCDM's planning and design include the following operation methods:

1. Building the DebtorSoft V1 prototype (see the above section 5.2.1.1)

The first method was to build the DebtorSoft V1 prototype which integrated 3rd party service provider component applications. Its purpose was to create a consumer enrollment platform for agencies. This prototype budge was $10,000. The component applications included an automated esign contract generator, an account management and payment processing service provider, and a CRM module. The DebtorSoft production time was one month.

2. Testing the DebtorSoft V1 prototype's enrollment process with agencies.

The plan was to complete and test the DebtorSoft V1 prototype with consumer agencies. The enrollment process including working with enrollment agents as well as administration and management. Financial reporting was generated by the debtor account management and payment processing service provider. Enrollment data and esigned contracts were auto posted on company cloud storage database. CRM tickets were processed by company staff.

3. Building the DebtorSoft V2 prototype

The plan was to build and complete DebtorSoft V2 prototype during the first six months of agency enrollment process. The budget was $100,000. It was outsourced overseas at nearly one fifth the cost of US development cost. This V2 included and enhanced and more customized agency interface, the building of an automated bidding engine, and the building of a backend customer processing interface. The bidding engine included a first version pricing algorithm. The pricing algorithm uses pricing data collected from discovery and graduates prices over multiple offers. The starting price point was in mid teens percent. This is a relatively low price start.

4. Testing the DebtorSoft V2 prototype's bidding process with creditors

The plan was to enroll at least one thousand accounts and to start an automated bidding process. The platform generated efax bids. If no response, the bid was adjusted upward and resent within 30 days. 30 days is a relatively long time between successive bids. There was no communication with the creditor to prepare the creditor to receive the bid.

5. Market experiment (Chapter II, Section 2.1.3.)/bidding metrics: Experiments are conducted when the researcher has dependent and independent variables and wants to measure the effect of a treatment on independent variables. These experiments can either be done in a laboratory or field environment.

The plan was to test over 1,000 accounts with a bidding process, once per month, over a one year period. The starting price was in the mid teens percent. It was adjusted upwards once a month. We also wanted to evaluate creditor response. The data collected is to be compared to other credit agency performance.

6. Participant observation (see Chapter II, Section 2.1.4): This research techniques is used by researchers who participate and interact in the real world social group setting. The researcher gains membership (or the right to participation) in the group which, in most cases, is an alien group to the researcher. This technique is used when the researcher wants to have direct access to the internal structure, norms, interactions, and dynamics of the group. This helps the researcher better understand social behavior and sociological requirements.

The participant observation study was planned to engage the agency industry, study their practices, examine the environment, investigate its challenges and problems, and contemplate solutions. The Startup founder offered his services as a small business financial technology consultant. Most of the smaller size startups struggled with technology solutions. None of them developed customized solutions. Most licensed online SAAS solutions for contract generation, debtor account management and payment processing, and CRM services. The service offered by the participant observer consultant was to optimize technology integration and deployment, train agents, help optimize the backend debt resolution negotiations process, and collaborate with marketing. Since the consulting jobs had two aims: to provide contracted services to the client agency and to conduct a participant observer study.

A second participant observation study was planned with a larger agency network. The Startup founder role was to serve as a distributor to help build the network. The larger agency network had its integrated software solution using third party component applications. This study was more useful for the development of the DebtorSoft platform.

In the above two participant observation studies, the observer was studying three aspects of the business operations: technology, business, and sociological requirements development. Developing sociological requirements was the uniquely different aspect of this study.

Participant observations, in most cases, gather qualitative data. The participant observer has biases that should be recognized and mitigated beforehand. If the participant observer has stakes in the outcome of the research, the participant observer may intentionally or unintentionally skew the research outcome with participant observer biases.

7. Interviews (unstructured) (see Chapter II, Section 2.1.2): Unstructured interviews are designed to give the interviewer freedom in conducting the interview. But normally, they cover the same topics in mind and seek to identify the sociological requirements for SSA development. There is more room for bias and errors. However, they give the researcher more freedom to understand and report on their participants. Unstructured interviews are more useful in smaller sample studies. If you want to interview the CEO of a company, unstructured interviews are a better tool. The CEO's opinion in forming sociological requirements weighs much more than other company stakeholders.

Unstructured interview studies were planned and conducted regularly by the Startup. This includes interviewing hundreds of people. Continually, DebtorSoft agent users were interviewed to evaluate the performance of DebtorSoft and to improve on it. Debtor agencies, creditors, debt recovery agencies, market experts, advisors, prospective investors, professionals, fintech experts, technologists, and other candidate market partners were regularly interviewed. The interviews were prepared to include a study of the sociological requirements for developing the optimal CCDM technology solution. When sociological requirements were identified, they were subsequently tested with following unstructured interview. For example, when the ongoing study determined that the primary problem in the marketplace is the coercive relationship resulting from the consumer default, and the proposed solution aims to transform the relationship with a 3rd party non-agency and non-partisan solution, these sociological requirements were tested in multiple interviews with many market stakeholders from all sides. Feedback was important in the further development of sociological requirements and software architecture solution.

Unstructured interviews, in most cases, gather qualitative data. The interviewer has biases that should be recognized and mitigated beforehand. If the interviewer has stakes in the outcome of the research, the interviewer may intentionally or unintentionally skew the research outcome with interviewer biases.

8. Case studies (existing solutions, debt resolution industry, debt recovery agency model) (Chapter II, Section 2.1.5.2): Case studies rely on a single case where the researcher has more control of the entire case and data collection. This control allows for detailed observation, testing, modification, and development over extended time periods.

Two important and brief case studies were done. The first one was a study of an existing consumer agency with a manual backend debt resolution negotiation process. The second one was done with a debt recovery/collection agency. The goal was to establish intermediary costs and project market changes with automation. The two studies were repeated many times to ensure data accuracy.

10.1.2. Approaches

In our approach, we study the social epistemology of each stakeholder group and the overall social epistemology of the entire market. We also select a worldview approach to the market's problem identification and proposed solutions. In the CCDM case study, we clearly seek conflict resolution and social cohesion to optimize interaction, behavior, response, and transactions, grow economic activities, and improve people's financial wellbeing. "Social cohesion is the set of characteristics that keep a group able to function as a unit" (Cloud, 2018). We also examine what sociology theory helps us better understand, explain, and construct the social environment, the interaction between stakeholders, and the group behavior attributes of users. Furthermore, we need to plan our approach to empirical data collection, acquisition, and management. DebtorSoft prototype testing and market experiment will yield quantitative data. Participant observation and interviews yield primarily qualitative data. Case studies yield both types of data. Quantitative data is numerical and textual data is primarily textual. We need to plan and prepare for qualitative and quantitative analysis including segmentation, clustering, surveys, profiling, and data science applications.

Five sociology theory frameworks are useful for the CCDM case study: functionalism theory, conflict theory, symbolic interaction theory, structural strain theory, and social phenomenology theory.

- Functionalism theory: “It has its origins in the works of Emile Durkheim, who was especially interested in how social order is possible or how society remains relatively stable. As such, it is a theory that focuses on the macro-level of social structure, rather than the micro-level of everyday life.” (Crossman, 2019) “Functionalism, in social sciences, theory based on the premise that all aspects of a society—institutions, roles, norms, etc.—serve a purpose and that all are indispensable for the long-term survival of the society.” (Setia, 2008)

How does functionalism theory help us understand and explain the CCDM case study?

Functionalism theory teaches us to look at the creditor-debtor coercive relationship the the resulting conflict as social disorder that undermines social stability. It also leads us to focus on the macro-level or social structure of financial markets and how they lead to social conflict and instability. When debtors fall in default, it is easy to make an individual judgement on each one of them and blame the individual debtor of mismanaging their financial affairs. However, when millions of debtors are falling in debt, functionalism theory teaches us to approach the problem from a macro-structure social level. We need to examine the causes for sharp rises in unemployment, financial market dysfunction, and economic down turn. “All aspects of a society—institutions, roles, norms, etc.—serve a purpose and that all are indispensable for the long-term survival of the society." The CCDM case study approaches the problem from a macro-structure social perspective. It aims to restructure the creditor-debtor relationship through novel market mechanisms and innovative financial technology solutions. The 3rd party electronic restructuring of debt creates a new social structure that resolves financial conflicts and promotes social stability.

- Conflict theory: it is "an independent paradigm of sociological theory with a distinct focus on phenomena of power, interests, coercion, and conflict. Basically, conflict theory assumes that societies exhibit structural power divisions and resource inequalities leading to conflicting interests." (Rössel, 2017)

Conflict theory is a good approach to explaining the "phenomena of power, interests, coercion, and conflict." The creditor has resources and the debtor needs resources; they are unequal in their financial power, interest, and social strength. The court system favors the creditor and protects its interests. The CCDM case study focuses on the coercive nature of their relationship when the debtor falls in default. We need to mitigate coercion and conflict while we take into consideration existing power and interests. In capitalism, the owners of capital have more power and interest. The CCDM model is not a social revolution against capitalism. It is a solution within the assumptions and structure of capitalism. Distributed technology allows for redistribution of knowledge and power in ways that allow for optimization of use of power and interests.

- Symbolic interaction theory (Handel, 1977): "In contrast to functionalism and conflict theory, symbolic interactionism emphasizes the micro-processes through which people construct meanings, identities, and joint acts. In doing so it accentuates how symbols, interaction, and human agency serve as the cornerstones of social life." (Fine and Sandstrom, 2014)

This theory explains social interface and behavior (our third fourth type of sociological requirements) in terms of how people interface, interact, and behave with each other using symbols. This individual use of symbols explains the social structure. Digital interface and interaction depends greatly on the use of symbols. Start thinking about the @ and # symbols and the many similar symbols, you realize the value of this theory. When designing a software application interface and user experience, the theory of symbolic interactionism gives us a good approach. The CCDM project is sensible to the symbols and meanings of a coercive creditor-debtor relationship. An online search of symbols and images of debt collectors is a good example. The CCDM case study approaches stakeholders with a goal of protection, collaboration, agreeableness, and resolution. Another example: using symbols to promote debtors financial information safety, protection, privacy, and confidentiality transforms scepticism into collaboration.

- Structural strain theory: “The sociologist Robert Merton argued that deviance (i.e. people breaking social norms/rules) is produced by how that society distributed the means to achieve cultural goals. According to his structural strain theory (or anomie strain theory), deviance is a result of a mismatch between cultural goals and the institutionalized means of reaching those goals.” (Medley-Roth, 2018)

Defaulting on debt can be explained as a structural strain where there is a mismatch between American cultural goal of financial creditworthiness and wellbeing and the financial markets means of reaching the goals.

- Social phenomenology theory: “Social phenomenology is an approach within the field of sociology that aims to reveal what role human awareness plays in the production of social action, social situations and social worlds. In essence, phenomenology is the belief that society is a human construction.” (Crossman, 2018)

In the CCDM case study, the human awareness approach relates to the social epistemology of the group. Epistemology is the study of how do we know what we know. Social epistemology argues that our knowledge is a social product. It plays an important role in the production of social action (behavior), social situations (environment), and social worlds (social system). Social phenomenology is useful to our model. For example, in the above "Table 27 Debt recovery demand response segments," we can educate sceptical and very sceptical debtors to become less sceptical and more collaborative to achieve debt resolution.

Influencing logic and reasoning approach is key to achieving intellectual goals and objectives. Changing logic and reasoning is key to influence thinking. We can change stakeholders logic and reasoning for their behavior by educating them on the options and benefits of debt resolution and credit worthiness. In "Table 27 Debt recovery demand response segments," we study the social epistemology of each segment and the logic and reasoning behind their behavior. Then we educate the debtors to modify their logic and reasoning, influence their thinking, and change behavior towards a more collaborative, agreeable, and resolution driven social interaction and behavior.

10.1.3. Models

We introduced and discussed models in Chapter III, Section 3.3. In the CCDM case study, we use the SSH model and apply it to CCDM stakeholders. We make three applications: Figure 26 with both agency types, Figure 27 with creditor agency type, and Figure 28 direct to consumers. These are three use case models.

The following models help us visualize specific use case models targeted at specific market verticals.

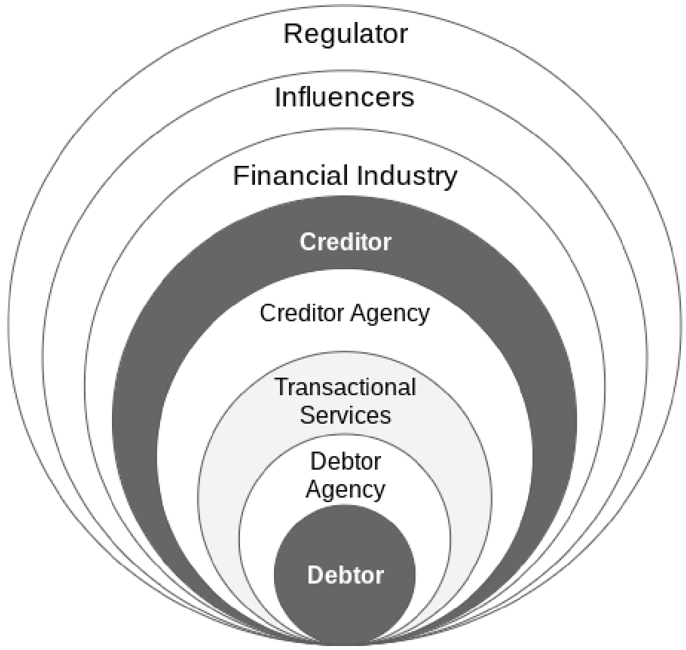

Figure 26 The SSH Model applied to CCDM before solution

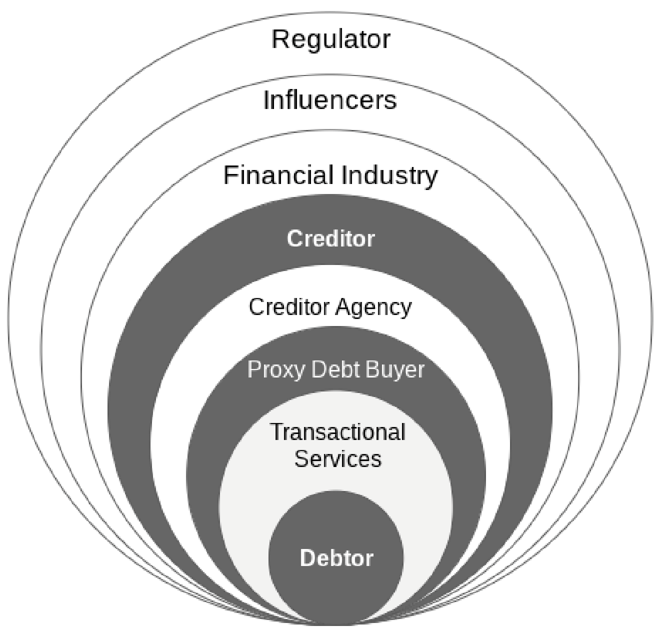

Figure 27 The SSH Model applied to CCDM with creditor agency

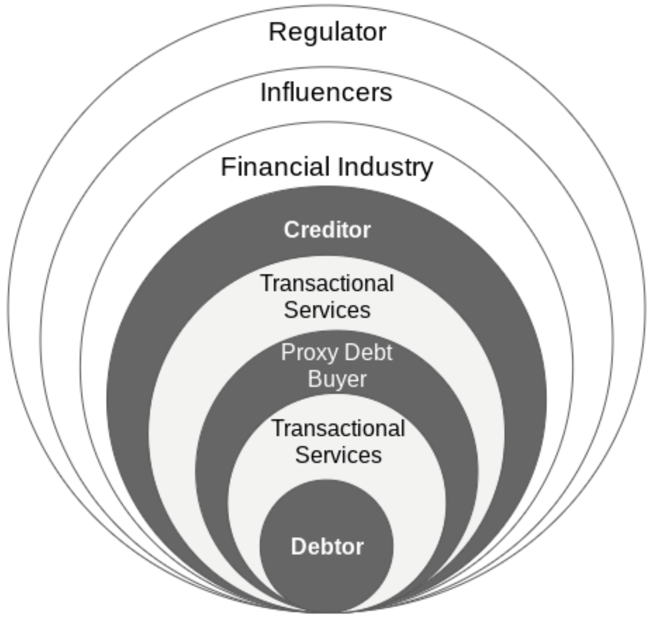

Figure 28 The SSH Model applied to CCDM direct to debtors

10.1.4. Techniques/Relevant Technologies:

How do we determine what SSA techniques are useful for the CCDM case study?

In the above Section 5.4.1: Methods, we discussed eight planned and designed CCDM operation methods. In this section, we discuss the SSA techniques that are useful for executing these operations.SSA techniques were introduced and discussed in Chapter 3, Section 3.5. We only discuss SA techniques only if it is important and relevant to discussing SSA techniques. It is important to discuss the planning and usage of the SCRUM method in software development. This agile methodology was extended to include sociological requirements. How was this done? There was an ongoing interview process along with DebtorSoft testing with the agent users (Section 5.4.1, planned operations 2 and 4). The interview process included techniques to collect the agent users' experience and feedback. It also included interviews regarding the agents' experience with debtors in the debtors enrollment process. Our goal is to get ongoing SSA feedback and incorporate it in the SCRUM process. For example, if we analyze enrolled debtor feedback data and determine the need for stronger symbolism to emphasize the debtor's financial information safety, protection, privacy, and confidentiality, this sociological requirement was communicated to DebtorSoft designers.

In the CCDM case study, we use representation techniques. This includes tables, step by step checklist, templates, schematics, flowcharts, graphs, images, etc. Organized tables and graphic representations facilitate our methods and techniques.

Sociological techniques are useful for operations 5 (market experiment), 6 (participant observation), 7 (interviews), and 8 (case studies). Sociological techniques include planning how to conduct above operations. For example, in interviews and participant observation methods, we are dealing primarily with qualitative textual data. It is important to plan how to do it, plan questions in advance, increase awareness of biased questions and recording of observations and interview responses, proper collection of qualitative data, proper analysis of data including the categorization of meanings, marking of repetitive data, and conjecture of patterns. If the participant observers or interviewers are proactively thoughtful about their biases, outline them, highlight them in their notes and questions, make conscious steps to avoid them, and postactively check for them, then biases can be controlled and minimized. But they may never be eliminated. Qualitative methods and techniques, if applied properly, may generate outcomes with negative impact and repercussions on the participant observer or interviewer. This can be mitigated by teamwork, alternate participants or interviews, and triangulation techniques. Triangulation in qualitative research means the use of multiple methods and/or techniques to collect data on the same sociological requirement. If they agree, it adds to validation.

In operations 2, 4, 6, 7, and 8, the CCDM case study involves the collection of qualitative data. In planning and designing CCDM's qualitative data collection and analysis, we need many of the qualitative data techniques highlighted in Chapter III, Section 3.5.2. Unstructured interviews and participant observation notes are expected to contain much data that remains textual. For qualitative data that can be transformed into statistical data, such as nominal, ordinal, interval, and ratio data, SPSS is a full statistical techniques toolbox for sociologists (Cramer, 2003). We utilize it for SSA development.

With quantitative data, our options expand to many mathematical techniques in sociology (Coleman, 1964) that have advanced over the past fifty years. The following are very well established techniques. we will offer references to apply them:

- Spreadsheets (Fillebrown, 1994)
- Graphs and charts (Triola, 2006)
- Schematics, flowcharts, and tables: SA developers should be skilled with schematics, flowcharts, and tables.
- Regression analysis (Cameron and Trivedi, 2019)
- Segmentation (Peterson, 1992)
- Clustering (Ball and Hall, 1967)
- General research techniques (Myers and Avison, eds., 2002)

Additionally, the exponential evolution and rapid proliferation of data science (Chen, Chiang, and Storey, 2012), machine learning, and BIG DATA analytical tools and applications has generated many useful techniques that can be used effectively in our CCDM's SSA research and development. However, in the first two DebtorSoft version of development, no data science applications are planned or designed.

10.2. Conclusion

Planning and Design is the heart and most critical stage of SSA development. In this stage we capture all the knowledge captured in discovery and novel ideas innovated in the conjecture stage. Furthermore, it is where methods, approaches, models, and techniques are selected for the optimal SSA development. Planning and Design also determines the process of operations and the collection of data.

Chapter Eleven

CCDM Case Study: Operations

Key Issues

11.1. CCDM Case Study: Operations / Key Issues

Operations are methods to apply planning and design for the purpose of testing research generated conjectures, hypotheses, and/or scenarios. In CCDM case study, we are testing SA and SSA requirements (SRs and TORs). This includes observational as well as experimental methods. SA operations include building and testing prototypes. SSA operations include participant observations, interviews, surveys, case studies, and experiments. SSA operations aim to test SRs. This includes the identification and prioritization of sociological stakeholders, the description, understanding, and explanation of the social environment, relationships between stakeholders, social and power structure, and market dynamics, the elements, symbols, functions, and roles of the interface, and the variables that define and affect social behavior and actions.

There are eight CCDM operations. In the following, they will be discussed in terms of purpose, methods used, data collection, preliminary conclusions, and new SRs discoveries that should be included and mitigated in further development. Full reports will be included in the next Chapter 15 CCDM Reporting.

11.1.1. Prototype Building: DebtorSoft V1

The purpose of this operation was to build and test DebtorSoft V1 prototype with a $10,000 software development budge and within 30 days. It included the building an agency interface website for the purpose of enrolling consumer debtors. The website included five components: (a) company content including training material, (b) user credential management, (c) automated esign contract generator, (d) integration with a debtor account management and payment processing service provider, and (e) a CRM module to manage customer relationships. The method of this operation was to build a basic website with company content, manage user credentials, and integrate three SAAS components. The data collection of this operation included all data generated by the debtor application process. The debtor's application included complete debtor's contact information as well as credit card details and banking payment method. Debtor data collection is the most important data collection in the company.

Our preliminary conclusion is that this operation proved to be very successful. It validated its usefulness with agency business. Over the following year, it generated hundreds of debtor enrollments. As we integrated DebtorSoft V1 prototype with SAAS components, we had to reexamine all data fields necessary for the completion of the debtor application and for account management and payment processing. This required re examining some SRs. This process was useful to better define SRS and identify new ones. For example, account management and payment processing required very sensitive banking information and social security number. These are sociological requirements that needed additional assurances of debtors financial information safety, protection, privacy, and confidentiality.

11.1.2. Prototype Testing: DebtorSoft V1

The purpose of this operation was to test DebtorSoft V1 performance in real market conditions with agency users. It also involved training and regular interviews with agency users to collect data on them and their enrolled debtors feedback. This continuous process testing included the testing of sociological requirements. For example, CCDM's SRs included steps towards the transformation of sceptical debtor behavior. Scepticism was due to fear of engagement in a debt resolution process and ignorance of available options to resolve debts. These sociological requirements were addressed in contracts with the debtors. The results were positive. Debtor scepticism was transformed to collaboration. The method for testing was for both SRs and TORs. TORs' testing involved interface and performance testing. SRs testing methodology involved regular focus group study meetings and one-on-one interview with agent users to discuss their enrollment experience. We looked for feedback on existing SRs. We also identified new SRs coming from debtors' feedback. Debtors' objection and questions in the enrollment process was very useful to develop additional SRs. Most of the data collection involved qualitative data collected from meeting notes. There were meeting preparations and presentations. There was a conscious effort to minimize biases and encourage agent users to give truthful feedback. The meetings and interviews were unstructured. Feedback was integrated into the SCRUM process to ensure adjustments and changes required. Our preliminary conclusion was that these operations were very successful. It helped the CCDM team crystalize SRs. Some new SRs were added due to enrollment agent suggestions of enrolled debtor feedback.

11.1.3. Prototype Building: DebtorSoft V2

This operation's purpose was to build and test DebtorSoft V2 in 6 to 8 months. it included the following components: (a) enhancement of content website, (b) enhancement of user authentication and management system to allow multi-tier agency and admin roles, (c) adding a calculator tools that allowed agent users to quickly assess the debtors financial situation and debt resolution options, (d) customization of the esign contract automation engine, (e) building of a bidding engine that simulated debtor behavior, and (f) customization of the CRM component with customer service and processes interface and added features. The method used was building more customization and more tools on a cloud server. It included Microsoft's .NET environment and SQL database structure. It was still restricted to an online web presence. This operation included transactional and customer account management data collection. Transactional data collection comes next in importance to debtor data collection. It involved both sides, the creditor and the debtor. Future transaction data collection should be expanded to include proxy debt buyers and other market stakeholders. The operation also included the acquisition of a creditor database that included nearly 4,000 active debt recovery enterprises. Creditor data was incomplete. It was missing a key data field: efax. A data cleanup and enhancement tool was built for a remote Filipino team. This part of the operation was not clearly anticipated in the planning stage.

Our preliminary conclusion is that most components were completed in 6 months. However, testing and deployment encountered more software bugs and fixes than expected. It took two additional months to complete it. This operation was not as successful as expected. It encountered more technical specifications requirements that anticipated by the software architectects, designers, database developers, and coders. This is partially due to the incorporation of SRs development in the SCRUM process. This operation ran over budget by nearly 30%. While building a bidding engine, the CCDM team had to reevaluate the creditor's sociological requirements. Few creditor SRs were discovered and identified; however, most of them were deferred for future development.

11.1.4. Prototype Testing: DebtorSoft V2

The purpose of this operation was to test DebtorSoft V2 performance in real market conditions with agency, customer service, processing, and admin users. It also aimed to prepare the DebtorSoft platform to conduct an experiment and test creditor behavior with automated bidding, pricing, and market performance compared to competitive models. The method used was to build a bidding engine that simulates debtor bidding behavior. Pricing assumptions and initial algorithms were developed based on data collected from participant observation and case study operations. Data collection was focused on creditor contact information, debt portfolio profiles, and transactional data.

Our preliminary conclusion is that creditor response to automated bidding proved to be the most challenging operation. Addressing creditors' sociological requirements was more difficult than initially anticipated. Creditors' scepticism proved to be more challenging than debtors' scepticism. In the next section, we report on this operation results and the discovery of more sociological requirements that need to be addressed in future development versions.

11.1.5. Participant Observation: Study of existing marketplace

The purpose of these CCDM's participant observation operations was to study the existing market, discover its successful knowledge, identify its challenges, and test new ideas including defining, qualifying, and quantifying sociological requirements. It also aimed to collect qualitative and quantitative data from real market operations. This operation aimed to enter and engage existing debt resolution enterprises in the marketplace. It aimed to observe existing market operations, learn from them, and test novel approaches to debt resolution. There were two participant observation operations with two similar methods. The first operation included offering consulting services to smaller size debt resolution enterprises. The second operation included offering distribution services to a large debt resolution network enterprise. This operation was unstructured.

In addition to learning about existing technology solutions used by debt resolution enterprises and business practices, it tested preliminary conjectures about sociological requirements. For example, acting as a consultant to small and medium debt resolution enterprises, the consultant (participant observer) gets to interview enterprise stakeholders and users, discover and identify enterprise challenges and pain points, collect much data valuable for analysis (for enterprise purposes and for own participant observer purposes), observe operations and individual behavior, and test novel ideas. Acting as a distributor for a large debt resolution network enterprise gives the distributor (participant observer) to observe, interview, and study affiliate teams. It is also an opportunity to get access to large amounts of existing market data. These participant observation operations generated much qualitative and quantitative data.

Data collection included qualitative data from observations and notes. It also included the acquisition of much data from the target enterprise operations. This data was very useful in constructing case studies and creating starting metrics. Our preliminary conclusion was that these operations were very successful and useful. Real market operations give the researcher much better quality data than 3rd party sources. These operations were foundational operations in creating sociological requirements.

11.1.6. Interviews: Investigations of industry's reaction, reception, assessment, and feedback on proposed solution with expert opinion and advisory board.

The purpose of these operations was two fold. The first is to interview and collect data from market experts, advisors, professionals, candidate market partners, and candidate clients. The second is to interview and collect data from DebtorSoft users. We aimed to investigate their reaction, reception, assessment, evaluation, and feedback on novel market ideas especially SRs. There were many interview operations throughout the CCDM case study. These operations's methods included interviewing hundreds of people. It included focus group (agency and affiliate team focus group) studies and people with debt resolution market experience. Many of these interviews were unstructured and unprepared. However, there was a general preparation and readiness for interviews with prepared questions about sociological requirements. These interviews generated much qualitative data. Our preliminary conclusion is that these operations were beneficial for the development and evolution of sociological requirements. These operations were also a good prelude to more structured surveys and interviews to be built, incorporated, and managed through the company website.

11.1.7. Case Study: Examinations of alternative and/or competitive and/or candidate partnership debt resolution market solutions

The purpose of these operations was to build models and metrics to learn from and compare CCDM development. These operations' methods included the collection of data and examination of alternative and/or competitive and/or candidate partnership debt resolution market solutions. For example, we conducted several case studies of debt resolution agencies, enterprises, and networks. The purpose was to create models and metrics case studies. These case studies are used to compare with CCDM's model and metrics. We also conducted several case studies of debt recovery agencies. Data collection included privileged participant observer data, open market data and research reports, government data and statistics, and academic data. It also included sociological requirements data. Our preliminary conclusion was that these operations were crucial for building CCDM's model and metrics.

11.1.8. Experimentation: Digital mediation/debt restructure/real market

The purpose of this operation was to engage and test the creditor's response to an automated bidding process. It also aimed to create transactional metrics and pricing algorithms. The method included the testing of over 1,000 accounts with graduated bids over a year period. It was in a real market semi-automated digital mediation for debt resolution exchange platform. Over 13,000 automated bids were generated and auto sent via efax to debt recovery enterprises. Although an automated online response mechanism was included, a backup manual handling of creditor counterbids and processing was also included. Data collection included creditor information and transactional data. Our preliminary conclusion is that this operation was the most significant of all operations. The results gave us clear preliminary CCDM pricing and creditor response behavior metrics. They also identified and discovered many new sociological requirements needed for the evolution and optimization of the bidding engine. This operation generated good quantitative data that can be compared with the above case studies. It also laid the metrics foundation for optimization and development.

11.2. Conclusion

Operations is the testing ground of our planning and design. In this chapter, we discussed how the CCDM case study prototyped its application with DebtorSoft V1 and V2 prototypes. We also discussed how data was collected using participant observations, interviews, and application data collection. The use of sociological methods (i.e. participant observations and interviews) was crucial to the SSA development process.

12. Chapter Twelve

CCDM Case Study: Reporting

Analysis, Assessment, and Future Development

12.1. CCDM Reporting

The fifth and last science methodology phase is reporting. In the following, we report on each of the eight above discussed operations. We also conduct a data analysis and rediscovery of new knowledge. Furthermore, we do an assessment of our conjectures and operations. This includes assessment types (validation, verification, and evaluation), forms (structural, components, and operations), and methods (SRs, qualitative data operations, and quantitative data operations). The following is SSA component assessment checklist from Chapter IV, Section 4.12.

	SSA Component Assessment checklist				
	SA Software Architecture	Coding Applications	Cost Benefit Analysis	SRs Sociological Requirements	Sociological Data Operations
Validation (building the right solution)			✓	✓	✓
Verification (doing it the right way)			✓	✓	✓

Evaluation (measuring progress relative to G&Os)			✓	✓	✓

Table 28 SSA Assessment checklist

After we report on all eight operations, we discuss the CCDM case study in terms of research writeup-presentation, replication, and generalizability. Writeup- presentation includes the publication of academic papers, industry white papers, presentations, explainer videos, website, marketing material, data charts and graphs, etc.. Publication proliferates new knowledge to the benefit of society. Replication discusses how this scientific methodology is replicable to validate new knowledge by independent researcher, and to apply it to similar software architecture situations. Generalizability is to infer new knowledge methods that can be used in other disciplines and studies. We argue that this SSA methodology is generalizable to other sociology of technology fields of study.

12.1.1. Prototype Building: DebtorSoft V1

DebtorSoft platform is the first CCDM platform developed by Startup based on the debt restructure patent #8489480. V1 is the first prototype purposed and designed to test debtor agency acceptance and demand for the CCDM technology. V1 was an assembly of three SAAS off the shelf component applications similar to the ones already in use by the industry. DebtorSoft platform’s approach was different because it approached the financial problem and its solution from a sociological perspective. It called for developing software architecture using sociological, technical, and operational requirements. Because of its sociological approach, the Startup vision of market structure, relationships, environment, interface, interaction, and behavior differed from existing debt resolution solutions. DebtorSoft platform aimed to develop into a digital mediation market exchange that automates debt resolution through 3rd party debt restructure. It brings efficiency and productivity to the market. It supports social collaboration and cohesion. It promotes economic growth and social progress.

12.1.1.1. Report:

DebtorSoft V1 was a very successful prototype. Build in less than 30 days with a $10,000 budget, it was an instant success with debt resolution agencies. It was positioned as an automated backend debt resolution negotiations solution with a manual backup. It started generating sufficient revenues to support the development of V2. The product proved to be very competitive in the market.

12.1.1.2. Data Analysis:

Agency conversion rates--the rate of successful debtor enrollment from attempted enrollments through marketing leads--was 20-30% better than similar products. The average balance of enrolled debt was $23,700 per debtor. Case studies of competitive products predicted an average of nearly $15,000. The potential gross agency income from each creditor exceeded $5,000. This compares to nearly $3,000 for competitors. The cost of automated bidding operations was exceptionally low.

12.1.1.3. Assessment:

Can we validate the DebtorSoft was the right solution to build? Yes. Agency and debtor acceptance of the product validated that it is the right product to build. Enrollment operations and rates were good.

Can we verify that it was built the right way? Yes. It performed really well. The marginal cost of enrollment and bidding was very low. It was very scalable.

Can we evaluate progress towards CCDM’s goals and objectives with measurable results? Yes. All data showed measurable progress.

How do we assess DebtorSoft V1 structure, components, and operations? The structure proved to be sufficient for initial operations. It was limited in scalability. The SAAS components were operating satisfactory. However, customization was limited. Operations were reasonable. We did not experience any serious operations interruptions or breakdowns. Minor bugs and glitches were easy to fix. The overall solution was simple and working. But it needed much development to reach CCDM's goal of a fully automated digital mediation debt resolution exchange.

How do we assess CCDM's methods? How successful and impactful was the development of sociological requirements? How fruitful were CCDM's qualitative and quantitative data collection and operations?

Results demonstrate that the development of sociological requirements lead to a unique, different, and competitive market solution. It also promised scalability at low cost and more efficient operations. Qualitative data collection and operations were not optimal, but they were pivotal in developing sociological requirements and their value was evident in the outcome. Quantitative data collection and operations were classical, easy, and very useful.

12.1.1.4. What we learned:

The debt resolution market was booming after the Great Recession of 2008. Regulatory and legal loopholes were exploited. Improper financial services practices were increasing. Debtors in default were increasing with unemployment and the housing market crash. Many people were vulnerable. Many debt resolution agencies with poor ethical and moral guidelines exploited many vulnerable debtors. They offered what they can not deliver and charged advance fees for it. This lead to new government regulations and a crack down on debt resolution agencies.

Although debt resolution agencies represented a good opportunity for Startup to test some attributes and sociological requirements of its novel solution, charging debtors any type of fees went against the sociological requirements of CCDM's solution. CCDM's sociological requirements envisioned a solution that is fee free to consumers. A year after the initial launch of the agency product, new federal government regulations outlawed the existing model. The majority of debt resolution agencies went out of business. Some agencies affiliated with the

DebtorSoft were operating with poor compliance. They were investigated by regulatory bodies and enforcement agencies. When the Startup discovered affiliated agency compliance violations, the Startup shut down all agency related operations.

12.1.1.5. Future development:

From the one year experience with debt resolution agencies, there was sufficient results to guide future development. The low cost and scalability of the automated bidding model promised to introduce 100% compliant and fee free debt resolution services to debtors. On the other side, creditors would pay a low digital mediation fee that increases their debt recovery, lowers their costs, lowers their compliance risks, and expands their market.

12.1.2. Prototype Testing: DebtorSoft V1

This testing focused primarily on the value of sociological requirements development.

12.1.2.1. Report:

Although the initial development of sociological requirements happened in participant observations and case study operations, they were evolved and validated in this initial DebtorSoft V1 testing. This was the first time the new products and services can be tested in a real market environment. Holding regular focus group discussions with agent users and collecting their feedback from debtor enrollment experience contributed to evolving and strengthening initial SRs.

12.1.2.2. Data Analysis:

This was primarily a qualitative data collection operation. Analysing data from interviews, observations, and notes helped tweak CCDM’s SRS and integrate them in the software development process. We conducted content, narrative, and conversation analysis. We accounted for biases and minimized them. The resulting analysis was incorporated into company website content, marketing material, and automated enrollment contracts. They were shared with agents to get another round of more feedback data and analysis.

12.1.2.3. Assessment:

This testing validated that we were developing the right sociological requirements. Agency debtor enrollment success verified that we were doing it right. And tangible results measured by quantitative data gave us measurable evaluation of progress towards CCDM's goals and objectives. The structure for developing sociological requirements (with sociological stakeholders, environment, interface, and behavior components) proved to be simple, easy, and powerful. The four components made it easy to communicate them with agencies, their agents, and software developers. The SRs' methodology proved to be productive and valuable. There were little or no quantitative data operations. Qualitative data operations were not optimal but sufficient to produce good results.

12.1.2.4. What we learned:

We learned from interviews with agencies and agent users that small and medium size agencies lack the resources for proper regulatory compliance. Hence, they were a compliance risk. Poor compliance training meant higher risks of regulatory compliance due to agents' poor. This raised an alarm. We attempted to help improve agent regulatory compliance. Success was limited. In the end, with a changing regulatory environment to more stringent regulations, we decided to shut down all agency operations.

12.1.2.5. Future development:

We reevaluated our approach to compliance. We decided to avoid any business partnerships that are not fully compliant.

12.1.3. Prototype Building: DebtorSoft V2

DebtorSoft V2 was a ten times larger development budget. The timeline was six times longer. It was an important phase to achieving automated bidding transactions. An optimal budget would have been closer to $250,000. There were many features that satisfy more sociological requirements that we felt would produce optimal results. However, we stayed within available resources.

12.1.3.1. Report:

V2 was more challenging, faced some development setbacks, and experienced delays and budget overruns. The final version was operational but limited. For example, our sociological requirements called for better communication and interaction with the creditor prior to sending the first bid. We wished to have a person-to-person introduction to manage expectations, interview the creditor, and collect data. The Startup didn’t have the necessary resources for it.

Nonetheless, V2 was completed and readied for an experiment.

12.1.3.2. Data Analysis:

20% to 30% cost increases and time delays were reasonable. The development gave us a good foundation for further customization and development.

12.1.3.3. Assessment:

The V2 buildup partially validated the building of an automated exchange. Technical test results verified that CCDM’s efax to creditor solution was working properly. The cost and time to build gave us measurable progress towards CCDM’s goals and objectives.

12.1.3.4. What we learned:

We learned that automated communication with creditors was much more challenging than originally conceived. We had to build an extra module for an outsourced Filipino team to clean up the creditor’s data. Establishing a person-to-person contact and communication with creditors required skilled U.S. resources and promised low yield. We have to invest more resources in further development of creditor sociological requirements to improve creditor communication.

12.1.3.5. Future development:

DebtorSoft V2 development gave us our first customized real platform. It became the foundation for building more components and more features. We were on a solid track and clear planning to building the next V3.

12.1.4. Prototype Testing: DebtorSoft V2

V2 testing involved three stakeholders: agents, admins, and creditor users. Agents experienced a more customized interface and new tools, especially a financial calculator that helped agents to quickly evaluate debt resolution options for candidate enrollment debtors. Admins experienced a customized customer service and processing component. And creditors experienced automated bids. Creditors were given access to an online response mechanism. However, we had a manual backup process.

12.1.4.1. Report:

Agent user experience improved the most. Although we experienced some bugs with the financial calculator algorithms, they were easy to fix. The continued engagement with agent users through focus group interviews and discussions proved beneficial and valuable. The admin experience was more complex and challenging. Since admins were our company users, we enjoyed more flexibility in testing and adjustments. The creditor experience faced much skepticism and aversion to automation. Most creditors either responded with fax communication and counter offers or called our backup manual processing desk. The creditor experience could have been much better with proactive communication. This required more resources unavailable at the time.

12.1.4.2. Data Analysis:

Qualitative data was continually collected from all groups. The feedback was useful in making changes through our SCRUM development. Our data validated many of our SRs, especially creditor SRs. It also identified and discovered new SRs.

12.1.4.3. Assessment:

Our SRs testing was easy with agent and admin users. It validated we were developing the right components. Creditor testing was more challenging. We could not validate we are building the optimal communication process.

V2's SR development structure, components, and operations were satisfactory with agents and admins, but not with creditors.

Creditor database acquisition and correction was a good start quantitative data operation that built the foundation for our creditor database. Qualitative data operations from interviews, focus group discussions, and observations were valuable but not optimal.

12.1.4.4. What we learned:

We learned that the sociological requirements for creditors were not fully developed. More should be done to expand and clarify them. Having the right creditor CRs is crucial to the CCDM case study success.

12.1.4.5. Future development:

We needed to engage more creditors, interview market experts, attend their industry events, engage them in advisory board capacity, and explore opportunities for market partnerships. This was applied in following the development of V2 and it yielded good results. The company attended the International Debt Buyers show in Las Vegas. This event was very productive. It was an education on the industry and yielded many good expert relationships and partnership opportunities.

12.1.5. Participant Observation: The study of existing marketplace operations

The two participant observation operations (consulting and distributing for debt resolution agencies) were very productive operations that yielded valuable results.

12.1.5.1. Report:

These operations yielded the initial development of sociological requirements, significant information about the industry and market operations, and very valuable quantitative data reflecting real market operations.

12.1.5.2. Data Analysis:

Qualitative data analysis from interviews, observations, and focus group discussion yielded good knowledge of the industry, its practices, opportunities, challenges, and candidate stakeholders. Quantitative data analysis from ongoing operations gave us metrics and trends that formed the foundation of CCDM's products and services. Above data contributed to building case studies that became models and metrics to measure CCDM's progress towards its goals and objectives.

12.1.5.3. Assessment:

The exceptional success of participant observation operations in forming the initial models and metrics for a CCDM model validate they were the right first step towards CCDM development. The outcome verifies that it was done right. These initial participant observations were the foundation for filing the debt restructure patent application. The patent grant is the best measure of progress towards CCDM's goals and objectives.

The structure of participant observation (consulting/distributing) gave CCDM unique access to existing marketing operations at the micro and macro levels. The components (technology and business development services) were the two most important pillars for building the CCDM model. And the experience with client real market operations laid the foundation for building the CCDM operations model.

Participant observation was the most cost effective way to build the initial sociological requirements. The collection of qualitative data from observations, interviews, and focus group discussions built the initial knowledge base for CCDM. And the collection of real operations quantitative data gave CCDM a good metrics foundation.

12.1.5.4. What we learned:

We learned that participant observation was a very powerful and cost effective method for founding new businesses. Many business people do it without being aware of its academic methods and techniques. Training would-be entrepreneurs to apply the methods and techniques of sociological participant observations adds significant value to their ventures. We learned to promote this method and make it easily available to future entrepreneurs.

12.1.5.5. Future development:

It is the purpose of this study to promote the sociological methodology and techniques of participant observation to future developers and entrepreneurs.

12.1.6. Interviews: Investigations of industry’s reaction, reception, assessment, and feedback on proposed solution with expert opinion and advisory board.

There were many types of interview operations throughout the development process. Most people in business conduct these interviews regularly. It is our purpose in this case study to shed techniques on how to prepare for, manage, minimize biases, and collect valuable qualitative data from interviews.

12.1.6.1. Report:

Interview have been an essential element in CCDM development. Most CCDM interviews are unstructured. However, if prepared properly, biases are minimized, and data is collected and analyzed methodically, the value of these interview improves exponentially. One wiseman said: He who consults people becomes their intellectual partner. Intellectual partnerships are fast, easy, and very productive. Another wiseman said: You don’t want to reinvent the wheel. Ask experts and gain their knowledge. You don't want to repeat the mistakes of others. You want to learn from other peoples' experiences.

12.1.6.2. Data Analysis:

For the time invested in interviewing people, we believe we earned the best return on investment.

12.1.6.3. Assessment:

The valuable data collected from interviews validates their rightfulness. If methodical, even unstructured interview are verified with good results. And we can measure their contribution to CCDM's goals and objectives. For example, CCDM regularly invited valuable advisors to the advisory board for a small stock option compensation package. Advisors accept because the relationship opens opportunities for all sides. The value generated from expert advice is exponential compared to the cost. This is a measurable evaluation of interviews.

Several CCDM interview structures were developed and proved beneficial. The advisory board is one structure. The Startup also participated in valuable industry events. Interviews with candidate market partnerships contributes to knowledge and business expansion. Interviews rarely yield quantitative data. With methodical qualitative data collection and analysis operations, interviews yield very valuable knowledge to the company.

12.1.6.4. What we learned:

We learned that methodical interviews with proper preparation, minimization of biases, and proper collection and analysis of data can increase their value exponentially. Many people are interviewing regularly. However, if methodical, the interviews add much more value.

12.1.6.5. Future development:

Our goal for future development is to promote good sociological methods, techniques, and data collection and analysis when conducting interviews.

12.1.7. Case Study: Examinations of alternative and/or competitive and/or candidate partnership debt resolution market solutions

In the course of our research and development, we encounter many business models with which we share interests, compete, discover alternative solutions, desire business partnership, emulate scalability, or admire their market growth. It is very useful to select leading examples, study them and build a case study with a model, metrics, and attributes. The case study does not have to be extensive and resource consuming. It could be simple and limited. For example; if we discover a debt resolution company offering products and services that compete with our products and services, and we discover enough information in their publications to build a case study, we should consider it. The value of these case studies for comparative models and metrics could be invaluable.

12.1.7.1. Report:

We build several case studies from above two participant observation operations and other companies with published data. These case study models, metrics, and attributes proved to be very valuable for our CCDM case study. For example, the two participant observation case studies were used to develop the initial CCDM model, metrics, and attributes for Startup. They were also used to compare for initial market results.

12.1.7.2. Data Analysis:

CCDM data analysis started with data analysis comparisons with the two initial participant observation case studies. We compared our numbers to their numbers. This gave us a measuring stick to evaluate our progress to CCDM goals and objectives. This was repeated with more case studies collected from published data.

12.1.7.3. Assessment:

Case studies validate CCDM's initial and continuing performance. They are also validated by the benefits they produce. Data analysis and metrics using case study data for comparison verify we building these case studies with little resources and yielding significant value. The resulting metrics give us good measurement of the progress we are making towards CCDM's goals and objectives. The structure of case studies includes three components: the model, metrics, and attributes. The structure and its components proved valuable for CCDM development. Case studies also help us measure the difference due to sociological requirements. If we know the case study model and attributes, if we modify them due to our sociological requirements, and if we can measure the results, we and assess, validate, and measure the value of sociological requirements. Case studies include the collection of qualitative and quantitative data. In the participant observation operations, it was direct acquisition through an internal operations privilege and access. With other case studies, it was through published information. Both methods of data collection operations are reliable and beneficial.

12.1.7.4. What we learned:

We learned that case studies can be emulated for initial models, metrics, and attributes. The emulation must be thoughtful. It must also develop methods and techniques to account for changes. In the CCDM case study, most change is generated from the addition of sociological requirements to the development of technology.

12.1.7.5. Future development:

It is our goal to improve, develop, use, teach, and promote the building of case studies as templates for initial models, metrics, and attributes. We continue to use them. We encourage developers and entrepreneurs to use them. However, it is important that the are done methodically and cost effectively. Spending too much resources on building case studies can waste resources. We experienced great benefits from building case studies based on a company brochure or white paper.

12.1.8. Experimentation: Operating Digital mediation debt restructure bidding platform in real market conditions

This is the most valuable and most quantitative of all above operations. The success or failure of this experiment means the success or failure of the entire CCDM case study. The purpose of this experiment is to test bidding automation and reduce the marginal cost of debt resolution negotiation backend process with creditors to near zero. In a future experiment, we plan to test the frontend debtor enrollment automation process and reduce the marginal cost of customer acquisition to near zero. Front and back end automation create the necessary technology and business conditions to offer products and services that are fee free to consumers (a consumer SR), fully compliant with regulations (a regulator SR), and exponentially scalable (an owner SR). CCDM aims for prices drop significantly, more people afford debt resolution, more people become creditworthy with reasonable cost access to financial markets, markets expand, and the economy grows. This reduces social conflict and increases social cohesion. These are several of the most important social environment SRs.

12.1.8.1. Report:

Comparative case study preface:

As discussed above, we use case studies to compare results. The case study used for comparative model, metrics, and attributes was one of the leading U.S. debt resolution companies (hereinafter referred to as the Debt Resolution Case Study or “DRCS”). DRCS disclosed and published metrics are:

- Average debt resolutions settlement: 50% (50 cents on the dollar of defaulted debt book value). Please note that based on our R&D and CCDM experiment, we estimate it ranges between 20% and 80% (higher settlement typically go to either very freshly charged off debt or debt with judgements).

- DRCS fee: Up to 25% of book value. This equates up to 50% of average settlement value. Please note that our current model projects charging an average 15% of an average 40% settlement = 6% of book value (nearly ¼ DRCS's fees).

- Workout Cycle (the time it takes a single debtor to resolve all defaulted credit card accounts): 24-48 months. Please note that this suggests the average is 36 months. Our R&D and market experience shows the average leaning to 40 months.

Since this CCDM's experiment is only testing backend operations debt resolution, it is important to note that not all creditor interface SRs were deployed. Traditional manual negotiators have the following SR advantages over our the CCDM experiment:

- Proactive Personal Contact (Interface SR): debt resolution negotiators connect on a personal level with debt recovery parties before an offer is sent.

- Personal Follow-up and Negotiations (Interface SR):

- Website (creditor interface SR): We didn't have a website with content to explain our digital mediation offer and process.

- Brand Recognition (creditor behavior SR): in the case of branded debt resolution companies, the market recognition increases debt collector collaboration. We had no brand recognition.

- Debt Data Scrub Services (TOR): debt resolution companies used debt resolution data scrub services; we didn't. This service can increase yield by 10-30%. Our test was too small for data scrub. There also consumer privacy compliance risks with data scrub.

In sum, DRCS front end customer acquisition costs exceed $1,000. The following are known industry front end operations metrics:

- Lead Generation Rates: ranges from $12-$25 per lead.
- Sales Costs: range from $500 - $700 per enrollment.
- Cost of Acquisition after 1st Six Month Dropouts: $1,100 to $1,200.
- Debt Resolution Yield: ranges from 30% to 40%
- Workout cycle: 24 - 48 months (average nearly 40 months).

Backend negotiations and company operations costs are significant. Debtor drop off rates--customers who quit before completion--are high. DRCS has to target nearly $5,000 in revenues from each customer to become economically viable business enterprise. This is why they charge the consumer debtor 25% of debt face value or nearly 50% of debt resolution value. This is the most important obstacle to CCDM's consumer and regulator SRs.

CCDM Experiment Preface:

CCDM's market experiment simulated as closely as possible the above debt resolution process with one exception: CCDM automated 100% the bidding process on the backend. This replaced having live call center retail debt negotiators--an industry bottleneck.

Our CCDM experiment involved 1,085 credit card accounts. It was conducted over a one year period. It auto-generated 13,017 offers to creditors and received 182 creditor counter offers (nearly 1 in 6 accounts). This averages 12 offers per account, one offer per month.

Additionally,

- ➢ Bids were low (ranging from 15-25%);
- ➢ We experienced a high delivery failure rate due to bad data.
- ➢ Creditors changed hands without update: Debt recovery goes through multiple placements. Typically, a debt recovery placement takes about six month and is placed with a different debt recovery group. The debtor is notified. Unless the debtor updates his debt recovery information, the bid goes to the previous placement debt recovery group.

12.1.8.2. Data Analysis:

Our test results were competitive with traditional debt resolution operations rates. CCDM's costs are exceptionally lower due to digitization and automation.

- Delivery Improvement: Half way through the test and as we observed a high delivery failure rate, we implemented a creditor delivery contact enhancement project (verify efax or email) through a Filipino team, we noticed up to 100% improvement in response rates. Delivery can be enhanced dramatically if we can auto-update credit account ownership information through credit bureau.

  Book Value: $2,000 or less and $10,000 or more

- $2k or less: Average counter offer price was 56.50% (much higher than overall averages suggesting that smaller accounts counter price resistance).
- $10k or more: Average counter offer price was 37.63% (much lower than overall averages suggesting that bigger accounts counter price softness).
- Legal Files: 12 out of 182 files all in the upper half of offer price rate.

This may explain why we received more high book value counter offers (since our offers ranged from 15% to 25%).

12.1.8.3. Assessment:

Despite the experiment's failure to satisfy creditor interface SRs and creditor poor data, the experiment validated that automated bidding is competitive with existing and traditional debt resolution operations. Additional SR improvements promise to increase its competitive edge. The experiment verified that efax delivery works well. It didn't give good verification of delivery rates due to poor creditor data. But it gave us good metrics that show necessary progress towards CCDM's goals and objectives.

The structure (auto generation and price graduation of the bids through an efax server) of the experiment was good. Some components (i.e. bidding algorithms, bidding interface, bidding delivery) worked well while others (i.e. creditor response mechanism) worked poorly. The person-to-person backup process and the manual Filipino team data cleanup process saved the experiment from total failure. Some operations (i.e. bidding platform) performed well and some (i.e. delivery platform) didn't.

We discovered new creditor sociological requirements (i.e. interface and communication, creditor response behavior). There was some qualitative data operations regarding the person-to-person creditor response backup mechanism and the Filipino creditor data cleanup team. Most data operations were quantitative and performed very well. We collected very useful transactional data.

Total Offers	13,017
Accounts	1,085
Averag Total Debt Balance	$23,700.00
Average Account	$3,385.71
Counter Offers: All	**182**
Averag Total Debt Balance	$42,567.37
Average Account	$8,171.45
Annual %	16.77%
Monthly Yield Rate	**1.40%**
Average % Settlement	40.59%
Average Settlement	$3,317
Average Fee Rate	15%
Average Fee	$497.55
Counter Offers: 75% or less	**175**
Averag Total Debt Balance	$42,860.44
Average Account	$8,277.70
Annual %	16.13%
Monthly Yield Rate	**1.34%**
Average % Settlement	39.50%
Average Settlement	$3,270
Average Fee Rate	15%
Average Fee	$490.48
Counter Offers: 59% or less	**130**
Averag Total Debt Balance	$44,054.80
Average Account	$9,092.50
Annual %	11.98%
Monthly Yield Rate	**1.00%**
Average % Settlement	33.67%
Average Settlement	$3,061.02
Average Fee Rate	15%
Average Fee	$459.15
Counter Offers: 50% or less	**116**
Averag Total Debt Balance	$44,863.26
Average Account	$9,364.19
Annual %	10.69%
Monthly Yield Rate	**0.89%**
Average % Settlement	32.26%
Average Settlement	$3,021.28
Average Fee Rate	15%
Average Fee	$453.19

Figure 29 Experiment Data Report

12.1.8.4. What we learned:

There are four primary variables that determine platform metrics:

- Deliverability: rates depend largely on accurate and fresh data.

Deliverability Rate	Opt-in Creditor	Fresh Data	Aged Data
Autopull	> 90%	> 80%	< 50%
Manual	N/A	< 50%	< 25%

Table 29 Deliverability Metrics

- Pricing: Our market test gave us the following metrics on pricing

Debt Account Book Value	Average Successful Bid	Optimal Bid
> $10k	37.63%	30% to 40%
< $10k and > $2k		40% to 50%
< $2k	56.50%	50% to 60%

Table 30 Pricing Metrics

Bidding pricing is optimal at 30-50% instead of 15%-25%.

- Terms:

Debtor Pricing	Credit Reporting		# of Accounts	
	Immediate	Delayed	Single	Multiple
Terms	High	Medium	High	Medium

Cash	Low	N/A	Medium	Very Low

Table 31 Terms Metrics

- Workout Cycle

	Average Monthly Yield (If, Then)	Workout Cycle	Workout Cycle Yield
Immediate	1.25% - 2%	24 months	30% - 48%
Intermediate	2% - 3%	15 - 17 months	30% - 51%
Longterm	3% - 5%	10 - 12 months	30% - 60%

Table 32 Workout Cycle Metrics

12.1.8.5. Future development:

SA Optimization: Technical and operational requirements

We identified the following SA technical and operational requirements (TORs):

1. Search Engine: We need to build a search engine that can locate and match debt account, debt holders, and debtor while preserving consumer financial information privacy and anonymity.

2. Debt Tracking: We need to track debt ownership, placement, and history. This is important for establishing debt value. The market is fractured, regulated, and obsessive with trade secret (creditor SRs).

3. Debt Validation: We need to validate debt amount, terms, conditions, etc., and resolve information disputes between parties.

4. Debt Portfolios: We need to bundle and group debt accounts into tradable debt portfolios.

5. Bidding Process: We need to efficiently deliver offers and counter offers between multiple stakeholders

6. Data Science: We need to develop intelligent decisioning algorithms.

7. Arbitrage Pricing: We need an arbitrage engine for wholesale and retail pricing with price graduation and multi-tier pricing.

8. ROI Metrics: We need further development and optimization of our Debt Restructure Rate of Return ("DRRR") model.

9. Document Processing: we need to improve and optimize

10. Payment Processing: we need to improve and optimize

SSA Optimization:

We learned that we need to better prioritize creditor interface SRs (i.e. website, proactive introduction, compliance emphasis, creditor contact information cleanup in advance of test with data scrub services, etc.). We should also add a consumer interface and educate debtors to update creditor information (consumer interface SR). Furthermore, we identified and validated the following SRs:

1. do not charge consumers fees, (important consumer SR)

2. do not force debtors into monthly program payments (consumer SR): Traditional consumer fee based debt resolution model requires that consumers commit monthly payments to a work out period of 24-48 months. Most debtors in default are financially unstable. Many drop out of the program. CCDM's consumer SR requires that the consumer has the freedom to opt-in

and out of the program as they wish. This gives the consumer more flexibility to manage their debt resolution process.

3. promote opt-in digital mediation with all stakeholders (social environment SR),

4. ensure financial information safety, protection, privacy, and confidentiality (consumer SR)

5. give the consumer all the benefits of an agency without fees (consumer SR)

6. communicate the value proposition to the debt holder (higher yield and revenues and lower cost and compliance risk), (interface SR)

7. remove barriers to creditor opt-in, (creditor SR)

8. offer good customer service and payment processing to debtor and creditor, (interaction--interface and behavior--SR)

If we apply the above optimization processes, yield can be increased further, cost can be reduced, and the workout cycle can be reduced in half down to 12-24 months; ultimately, it can be reduced to under one year. This has become a new CCDM goal.

Successes

1. Roadmap to electronic non-performing debt market

Shortcomings

1. Scoring
2. Portfolio Optimization
3. Debt Search

Promising New Related Research Frontiers:
 	
1. Software:
    a. Debt Matching
    b. Data Mining:
    c. Debt Industry Search Engine:
2. Math Finance:
    a. Arbitrage theory and application for non performing debt
    b. Price theory and application for non performing debt
    c. Risk Mitigation: Scoring of debt, debtor, portfolio
3. Application for Other Than Credit Card Unsecured Household Debt
4. Application for Secured Household Debt
5. Application for Other than Household Debt

Model: 1. Procuring Fast Delivery: Sole Sourcing with Information Asymmetry 2. Optimal Bidding in Online Auctions

Table 33 CCDM Model

12.1.9. SSA Methodology: A reassessment and recommendations

SSA methodology applied on this CCDM case study produced sociological requirements that facilitated better solutions and optimized software architecture development. For example, CCDM's vision / DNA became crystal clear: The Startup advocates and supports consumer protection, privacy, information security, confidentiality, mediation, debt resolution, and restoration of good credit life and financial prosperity (core consumer SRs). The Startup's goal is conflict resolution, social cohesion, financial market efficiency, good economic performance and growth, financial prosperity, and social progress (core social environment SRs). And the Startup promoted and supported more efficient debt recovery markets at lower costs, lower compliance risks, higher profit margins, and expanded market operations (core creditor SRs). The Startup also seeks to improve banking liquidity and performance (banking SRs).

12.1.10. Writeup-Presentation

Writeup-presentation includes the publication of academic papers, industry white papers, presentations, explainer videos, website, marketing material, data charts and graphs, etc.. Publication proliferates new knowledge to the benefit of society. This CCDM project has done all of the above including this case study writeup.

12.1.11. Replication

Replication discusses how this scientific methodology is replicable to validate new knowledge by independent researcher, and to apply it to similar software architecture situations. Following this thesis, the SSA methodology can be replicated and applied to most software architecture projects.

12.1.12. Generalizability

Generalizability is to infer new knowledge methods that can be used in other disciplines and studies. We argue that this SSA methodology is generalizable to other sociology of technology fields of study. The SSA methodology can be generalized and applied to nearly every software development project. Since software is becoming the soul of most new generations of products, this methodology should be generalized to other disciplines and studies.

12.1.13. Future Development

The future development of the CCDM project includes the following:

1. We will continue to apply, develop, and improve this SSA methodology.
2. We should develop sociological requirements for market segments (i.e. membership benefits organizations, employee benefits packages, credit union membership, worker union membership, auto club memberships, financial fitness and wellness memberships, etc.)
3. We need to develop the following SA technical and operational requirements:
    a. Apply machine learning to transactional behavior especially retail and wholesale pricing.
    b. Build a decision science engine
    c. Build an arbitrage pricing engine
    d. Build a rating engine to rate individual debts and portfolios
    e. Build the debt buyers exchange
    f. Build a digital mall for CCDM membership and offer financial product stores to businesses targeting the underserved 100 million Americans with low creditworthiness.
    g. Develop blockchain technology to authenticate debt and prevent fraud.

h. Build speedtrace technology to trace the most current information on debt, debtors, and creditors.

4. We need to build a special platform to help banks and other financial institutions increase their liquidity rates to meet international BASEL III standards by liquidating non-performing debt.

5. We need to build a specialized platform for credit card issuers to help them proactively deal with non-performing credit card debt. This solution should be packaged fee free with every credit card issued.

12.2. Conclusion: The Most Important Discovery

We discovered that this CCDM technology solution is a few years ahead of the market. Most fintech innovation has focused on generating new credit and loans. The Startup is a pioneer in thinking ahead to find good solutions for non-performing debt before the next financial market crisis happens. Maybe we can prevent or at least minimize its damage.

PART IV: CONCLUSION

13. Chapter Thirteen

Conclusion and Future Perspectives

Reassessment and Recommendations

13.1. Summary

The entire thesis can be summarized as follows: we laid the groundwork, explained the motivation, and charted the course for the evolution and development of sociology of software architecture. We defined SSA by adding *sociological requirements* to existing software architecture *technical and operational requirements*. We synthesized and developed a novel research methodology and interdisciplinary study with its unique SSA approaches, models, techniques, and ways of assessment. We created and modeled a step-by-step application SSA methodology to apply on most software architecture projects. We included an extensive and detailed CCDM case study to demonstrate SSA methodology application, usefulness, challenges, value proposition, and benefits. And we encouraged and promoted the further and future development of this novel and beneficial interdisciplinary study of sociology of software architecture.

What are sociological requirements?

Sociological requirements (Section 2.7) include four elements: (1) sociological groups or stakeholders (social groups or SSA groups), (2) the social environment (social situation), (3) interface (social interaction), and (4) behavior (social role and action desired). The primary difference between traditional SA development and this novel SSA development is that SA development focuses on the software system's environment and stakeholders while SSA development expands beyond the software system to include the social system. Hence, SA stakeholders by definition are limited to direct groups involved in and interacting with the application. SSA stakeholders are extended to the social groups with their particular and unique sociological requirements.

What are the main benefits of adding sociological requirements?

Software applications are developed by people for the people. They target specific groups of people (stakeholders) with common attributes, interests, demands, problems, desires, and expectations. SA practitioners develop unique interfaces aiming to encourage certain interactions and illicit certain user behavior, response, action, and/or reaction. This includes generating meaningful communication, engagements, leads, reviews, surveys, and transactions. Every SA developer should optimize development and increase user success and proliferation. Hence, it makes sense to study the specific and targeted groups of people. The most developed science for the study of groups of people (social groups) and their behavior is sociology. Therefore, using sociological methods, approaches, models, techniques, and assessment to understand software application social groups attributes, qualities, and behavior is helpful, useful, and beneficial to better understand and target the software application's social groups and/or audiences. The synthesis of sociological and software architecture methodology helps the SSA developer better understand and develop the sociological requirements. The main benefits for adding sociological requirements are, therefore, *to help SSA developers better understand, explain, and define their social groups, social environment, interface, and behavior*. This, in turn, helps SSA developers better target their application, optimize interface, produce more desirable behavior, and expand audiences.

This new knowledge empowers SSA developers to (1) better understand, promote, and empower a consumer (social) centric models, (2) qualify and quantify social stakeholders and their social requirements, (3) proactively consider relevant and influential social elements and variables for the optimization of technology development, and (4) enhance the user experience.

This thesis contains four parts. Part I laid down the groundwork, outlined the goals and objectives, defined main issues, surveyed literature, and developed a scientific method research methodology. Part II applied the new research methodology in the development of SSA approaches, models, techniques, and assessment methods. It also developed templates and methods for their application. Part III discussed SSA case studies and candidate solutions. It also focused in detail on an extensive CCDM case study used to develop this novel interdisciplinary study. And the last Part IV is this Chapter Thirteen focused on the study's conclusion and future perspectives.

In Part I we defined the problem and suggested an organised path to the solution. We stated our motivation and asked pertinent research questions. We also synthesized and developed the concept of sociology of software architecture. This includes relating this interdisciplinary study to the related disciplines including software architecture, sociology, sociology of technology, sociology of knowledge society, sociology of information society, scientific methodology, social epistemology, and epistemology. We reviewed the theoretical foundations and developed new axioms on which we built this novel study. We also reviewed models and frameworks useful for our study. Additionally, we developed a research methodology that regressed both software architecture and sociology methods to their common and scientific methodology tracks. This mirrored them in a parallel fashion along the following five main steps: discovery, conjecture, planning and design, operations, and reporting. This allowed us to synthesize SSA methods in one table. For this synthesis, we used MSDN’s method for software architecture.

Part II focused on SSA toolbox development, application, and assessment. SSA development included the synthesized development of SSA approaches, models, and techniques. SSA approaches included worldview and sociological frameworks helpful, useful, and beneficial for SSA development. SSA models included existing and newly suggested models that can illustrate how the difference SSA parts and components can be constructed into a single system and the relationships defined. SSA techniques included a toolbox of different sociological techniques that can be modified, synthesized, and applied to produce the desired sociological requirements. SSA assessment methodology includes ways to verify, validate, and evaluate SSA methodology and application.

Part III discussed SSA case studies with an extensive and detailed overview of the CCDM case study. Several case studies were used for the development of this novel SSA methodology. The CCDM case study is not how it was done. It is a model to emulate on how to apply the final SSA methodology on the CCDM project.

Part IV summarizes, assesses, evaluates, and concludes the work done.

13.2. Novel Scientific Knowledge: Original, and Creative Elements

This study introduces several novel scientific knowledge contributions with original and creative elements:

13.2.1. Pioneering a new field of interdisciplinary study of science

The most fundamental contribution is the evolution and development of this novel and interdisciplinary field of study namely the sociology of software architecture (Section 2.6.). This novel study is a synthesis of two primary fields of study: sociology and software architecture. The synthesis benefits, learns from, integrates, and emulates other related fields of study including the sociology of technology, sociology of knowledge society, sociology of information society, scientific methodology, social epistemology, and epistemology. At the core of SSA methodology is the development modifying the definition of software architecture to include the development of sociological requirements (Section 2.7.). SSA methodology was the product of SSA synthesis (Section 2.6.2.).

13.2.2. Conjecture of new axioms and theories of science

In addition, this study conjectures new axioms and theories of science that require additional work, development, testing, and assessment. However, these serve as a useful tool to better frame the development of this SSA study and its methodology. These conjectures include:

- SEPYN (Section 2.4.1.) : The Theory of Social Epistemology Network ("SEPYN") Development of Knowledge,
- Proposed synthesis of the unique qualities of IT (Section 2.4.2.),
- SETT (Section 2.5.): The Theory of Sociogenetic Evolution of Technology Development

13.2.3. Innovative research and synthesis methodology

How do you develop a novel and innovative research methodology that aims to synthesize two distant disciplines of science: sociology and software architecture?

This thesis introduces an innovative approach that, with the help and emulation of several other studies, regresses both sciences to their elemental, common, and parallel step-by-step scientific methodology. This meant creating a common track with five steps: discovery, conjecture, planning and design, operations, and reporting (Chapter Three). Furthermore, this was applied using traditional MSDN SA Model synthesis (Section 3.6.): Use of MSDN methods synthesis with sociological methods.

13.2.4. Synthesized SSA toolbox development: approaches, models, and techniques

The synthesis and development of the SSA toolbox represents the heart of this thesis. It applies above research methodology to create SSA approaches (Chapter Four), models (Chapter Five), and techniques (Chapter Six).

In Chapter Five, this thesis introduces novel models useful for SSA development. These include

- SSH Simple Socio-hierarchical Model (Section 5.2.2.)
- Complex Socio-Genetic Model (Section 5.2.3.), and
- RIOTU Model (Section 5.2.12.)

13.2.5. Inventive SSA application methodology

In order to facilitate the application of SSA methodology, Chapter Seven included the development of an inventive application methodology named "Step by Step Checklist ("SSC")" (Section 7.2.). This table creates a road map with the above five scientific methodology steps: discovery, conjecture, planning and design, operations, and reporting.

Furthermore, In Chapter Ten, additional application methodology is created. This includes Concurrent or Sequential Development and Synthesized Concurrent Checklist ("SCC").

13.2.6. Avant-garde SSA assessment methods

Chapter Eight focuses on the development of avant-garde SSA assessment methods. This includes: Validation, Verification, and Evaluation. Validation is assessing if you are doing the right thing. Verification is assessing if you are doing it right, and Evaluation is measuring the value it contributes to the achievement of the SSA project's goals and objectives. This included the development of the following:

- SSA Structural Assessment Checklist (Section 8.1.4.)
- SSA Component Assessment checklist (Section 8.1.5.)
- Assessment of Sociological Requirements (Section 8.2.)

How will we test that we have achieved what we set out to achieve and validate the work?

This researcher suggests two methods for testing this new knowledge:

- Take existing, developed, and tested (with clear metrics) software architecture projects, develop and add sociological requirements, apply changes, and test and measure results.
- Take a test project, give it to two software architecture teams, have one develop it the traditional approach (technical and operational requirements only) and another team develop and add sociological requirements. Then test and measure both solutions under similar conditions.

This thesis predicts the development and application of sociological requirements will cost effectively optimize the solution.

13.2.7. Experimental SSA case studies: models for emulation

This thesis introduced three SSA case studies used for the development of SSA methodology. They include: education technology, local search, and restructuring of debt for credit card debt market ("CCDM"). The CCDM case study was covered extensively and in great detail in Chapters Eleven through Fifteen.

13.3. Successes, Shortcomings, and New Research Frontiers

This study produced successes, was challenged by shortcomings, and opened new research frontiers.

13.3.1. Successes

This study was successful in the evolution and development of a novel interdisciplinary study, the sociology of software architecture. It was also successful in laying down its foundations, developing a powerful research methodology that can be applied in other interdisciplinary studies of science, developing an SSA toolbox (including approaches, models, and techniques), developing a step-by-step SSA application methodology, and presenting SSA case studies that support, teach, and demonstrate the usefulness and benefits of SSA methodology.

13.3.2. Shortcomings

The shortcomings and challenges of this study are many. As a pioneering study, it lays down the minimal foundation necessary for the development and establishment of this novel and interdisciplinary field of study. There is much more work to be done by both sides: SA practitioners and sociologists of technology.

This study is thick with sociological concepts. For the SA practitioner, the information maybe overwhelming and needs much explanation, examples, and applications models. Much work is needed to simplify SSA concepts and to make them easy to use especially be first time SSA practitioners.

As a novel methodology, it needs teaching and training before it becomes a mainstream practice. Furthermore, it can benefit from as much as possible feedback from SSA developers attempting to apply its methods.

13.3.3. Further Research Questions, Frontier, and Suggestions

This study asked many questions but did not adequately answer all of them. Much more work is needed to fully address all the questions asked. Further research questions and suggestions present themselves.

First, we ask about the horizontal development of SSA methodology. This includes more and better methods, approaches, models, and techniques. The horizon is broad, open, and very promising.

Second, we ask about the vertical development of SSA methodology. This includes sub-specialization in categories on software application development. For example, we encourage researchers to study SSA methodology and applications for the sociology of education technology, sociology of search, sociology of financial technology, sociology of social networking, etc. The list is unlimited. Each sub-branch of the study of sociology of software architecture invites further research and study.

We suggest using this thesis research methodology (Chapter Three) in the synthesis and development of other interdisciplinary science studies.

We suggest emulating the sociology of software architecture in the development of sociology of similar and related fields of science such as data science and machine learning. Artificial intelligence is perceived as a fundamental opportunity and threat to social groups. The sociology of artificial intelligence can greatly advance developers ability to predict its social impact, harness the opportunities, and mitigate the risks of any threats.

13.4. Conclusion

Sociology is the science for studying modern societies. Modernity is the byproduct of fast technological, industrial, knowledge, and individual and group lifestyle changes. Since technology is the engine of industrial, economic, knowledge, and rapid social change, studying the sociology of technology is a natural and necessary outcome. And since software development is the heart of modern technology, the evolution and development of sociology of software architecture is timely and beneficial. It promises to and produce software application development optimization and enhancement.

The field of software architecture is growing fast to keep up with the global and exponential growth in software markets and related fields especially artificial intelligence. With the explosion of mobile development, the novel and inventive applications targeting the transportation industry and many other fields, and with the information age exploding with new knowledge development, it is urgent upon the software industry, research foundations, and the scientific community to put more resources into and promote this and similar interdisciplinary studies. Researchers and practitioners should quickly apply and expand this field to harness its benefits for knowledge development, economic progress, better lifestyles, and social harmony.

REFERENCES

Abbot, P. and Sapsford, R., 2006. Ethics, politics and research. *Data collection and analysis*, pp.291-312.

Abrahamsson, P., Salo, O., Ronkainen, J. and Warsta, J., 2017. Agile software development methods: Review and analysis. *arXiv preprint arXiv:1709.08439*.

ACA International (ACAI) (2017) *The Impact of Third-Party Collection on the National and State Economies.* Available at: https://www.acainternational.org/assets/ernst-young/ey-2017-aca-state-of-the-industry-report-final-5.pdf?viawrapper (Accessed: January 15, 2019)

Ackroyd, S., 1992. *Data collection in context*. Longman Group United Kingdom.

Aladdin, M. (2018) *Software Architecture - The Difference Between Architecture and Design.* Available at: https://codeburst.io/software-architecture-the-difference-between-architecture-and-design-7936abdd5830 (Accessed: 20 October 2018)

Al-Nadim, I., 1988. *Kitab al-fihrist*. Dar Al-Massira.

Axelrod, R., 1997. *The complexity of cooperation: Agent-based models of competition and collaboration* (Vol. 3). Princeton University Press.

Altexsoft (2019) *Technical Documentation in Software Development: Types, Best Practices, and Tools.* Available at: https://www.altexsoft.com/blog/business/technical-documentation-in-software-development-types-best-practices-and-tools/ (Accessed: 20 April 2019)

Archives (2019) *The National Archives Catalog.* Available at: https://www.archives.gov/research/catalog (Accessed: 20 November 2019)

Archiveshub (2019) *Home: Archives Hub.* Available at: http://archiveshub.ac.uk/index.html (Accessed: 20 November 2019)

ASE (2019) *Academic Search Engine.* Available at: http://www.refseek.com/ (Accessed: 15 November 2019)

arXiv (2019) *Open Access Search Engine by Cornell University arXiv.* Available at: http://arxiv.org/ (Accessed: 20 November 2019)

Athar, A., Liaqat, R.M. and Azam, F., 2016. A Comparative Analysis of Software Architecture Evaluation Methods. *JSW*, *11*(9), pp.934-942.

Ausubel, L.M., 1991. The failure of competition in the credit card market. *The American Economic Review*, pp.50-81.

Babar, M.A., Zhu, L. and Jeffery, R., 2004, April. A framework for classifying and comparing software architecture evaluation methods. In *2004 Australian Software Engineering Conference. Proceedings.* (pp. 309-318). IEEE.

Ball, G.H. and Hall, D.J., 1967. A clustering technique for summarizing multivariate data. *Behavioral science*, *12*(2), pp.153-155.

Baskerville, R. and Pries-Heje, J., 2010. Explanatory design theory. *Business & Information Systems Engineering*, *2*(5), pp.271-282.

Bass, L., Clements, P., Kazman, R., 2003. *Software architecture in practice*. Addison-Wesley Professional.

Bastian, M., Heymann, S. and Jacomy, M., 2009, March. Gephi: an open source software for exploring and manipulating networks. In *Third international AAAI conference on weblogs and social media*.

Bauchspies, W.K., 2006. Science, technology, and society: A sociological approach.

Becker, H.S., 1995. Visual sociology, documentary photography, and photojournalism: It's (almost) all a matter of context. *Visual Studies*, *10*(1-2), pp.5-14.

Becker, H.S. and McCall, M.M. eds., 2009. *Symbolic interaction and cultural studies*. University of Chicago Press.

Bell, M., and Bell, C. (2019) *Virtual Learning Resources Center.* Available at: http://www.virtuallrc.com/ (Accessed: 15 November 2019)

Bell, K. (2013) *"case study." In Open Education Sociology Dictionary.* Available at: https://sociologydictionary.org/case-study/ (Accessed: October 10, 2018)

Bigelow, J., 1829. *Elements of Technology: Taken Chiefly from a Course of Lectures Delivered at Cambridge, on the Application of the Sciences to the Useful Arts*. Hilliard, Gray, Little and Wilkins.

Bijker, W.E., Hughes, T.P. and Pinch, T.J. eds., 1989. *The social construction of technological systems: New directions in the sociology and history of technology*. MIT press.

Bika, N. (2018) *Software Architect interview questions.* Available at: https://resources.workable.com/software-architect-interview-questions (Accessed: March 20, 2019)

Blumer, H., 1986. *Symbolic interactionism: Perspective and method*. Univ of California Press.

Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release (FRSR) (2017) *Financial Accounts of the United States Flow of Funds, Balance Sheets, and Integrated Macroeconomic Accounts.* Third Quarter 2017. Available at: https://www.federalreserve.gov/releases/z1/current/z1.pdf (Accessed: 10 April 2019)

Board of Governors of the Federal Reserve System (BGFRS) (2017) *Consumer Credit - G.19.* Available at: http://www.federalreserve.gov/releases/g19/about.htm (Accessed: 10 November 2018)

Board of Governors of the Federal Reserve System (BGFRS) (2017) *Financial Accounts of the United States - Z.1.* Available at:

https://www.federalreserve.gov/releases/z1/20170608/html/introductory_text.htm (Accessed: 20 November 2019)

Board of Governors of the Federal Reserve System (BGFRS) (2019) *Charge-Off and Delinquency Rates on Loans and Leases at Commercial Banks*. Available at: http://www.federalreserve.gov/releases/chargeoff/ (Accessed: 27 November 2019)

Boczkowski, P. and Lievrouw, L.A., 2008. Bridging STS and communication studies: Scholarship on media and information technologies. *The handbook of science and technology studies*, *3*, pp.949-977.

Böhme, G. and Stehr, N. eds., 1986. *The knowledge society: the growing impact of scientific knowledge on social relations* (Vol. 10). Springer Science & Business Media.

Bouman, W., de Bruin, B., Hoogenboom, T., Huizing, A., Jansen, R. and Schoondorp, M., 2007. The realm of sociality: Notes on the design of social software. *ICIS 2007 proceedings*, p.154.

Bozarth, J., 2008. The usefulness of Wenger's framework in understanding a community of practice.

Boehm, B. and In, H., 1996. Identifying quality-requirement conflicts. *IEEE software*, *13*(2), pp.25-35.

Boulding, K.E., 1956. General systems theory—the skeleton of science. *Management science*, *2*(3), pp.197-208.

Briggs, C.L., 1986. *Learning how to ask: A sociolinguistic appraisal of the role of the interview in social science research* (No. 1). Cambridge University Press.

Brown, M., Haughwout, A., Lee, D. and Van der Klaauw, W., 2013. The financial crisis at the kitchen table: trends in household debt and credit. *Current Issues in Economics and Finance*, *19*(2).

Brownstein, H.H., 1990. Surviving as a qualitative sociologist: Recollections from the diary of a state worker. *Qualitative Sociology*, *13*(2), pp.149-167.

Buckley, W., 1967. Sociology and modern systems theory.

Bureau, C.F.P., 2013. Fair Debt Collection Practices Act: CFPB Annual Report 2013. *Washington, DC: March*.

Burrows, R. and Savage, M., 2014. After the crisis? Big Data and the methodological challenges of empirical sociology. *Big data & society*, *1*(1), p.2053951714540280.

Busha, C.H. and Harter, S.P., 1980. *Research methods in librarianship: Techniques and interpretation*. Academic press.

Bushkin, L. (2013) *What is the difference between functional and non functional requirement?* Available at: https://stackoverflow.com/questions/16475979/what-is-functional-and-non-functional-requirement (Accessed: 11 July 2019)

Caracelli, V.J. and Greene, J.C., 1993. Data analysis strategies for mixed-method evaluation designs. *Educational evaluation and policy analysis*, *15*(2), pp.195-207.

Cambridge English Dictionary (CED) (2019) *Definition of "assessment" from the Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press.* Available at: https://dictionary.cambridge.org/us/dictionary/english/assessment (Accessed: 22 November 2019)

Cambridge English Dictionary (CED) (2019) *Definition of* "epistemology*" from the Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press.* Available at: https://dictionary.cambridge.org/us/dictionary/english/epistemology (Accessed: 22 November 2019)

Cambridge English Dictionary (CED) (2019) *Definition of "evaluation" from the Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press.* Available at: https://dictionary.cambridge.org/us/dictionary/english/evaluation (Accessed: 22 November 2019)

Cambridge English Dictionary (CED) (2019) *Definition of "validation" from the Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press.* Available at: https://dictionary.cambridge.org/us/dictionary/english/validation (Accessed: 22 November 2019)

Cambridge English Dictionary (CED) (2019) *Definition of “verification” from the Cambridge Advanced Learner's Dictionary & Thesaurus © Cambridge University Press.* Available at: https://dictionary.cambridge.org/us/dictionary/english/verification (Accessed: 22 November 2019)

Carley, K.M., 2001. Computational approaches to sociological theorizing. In *Handbook of sociological theory* (pp. 69-83). Springer, Boston, MA.

Carrington, P.J., Scott, J. and Wasserman, S. eds., 2005. *Models and methods in social network analysis* (Vol. 28). Cambridge university press.

Carter, M.J. and Fuller, C., 2015. Symbolic interactionism. *Sociopedia. isa*, *1*, pp.1-17.

Casey, A., 2005. Enhancing individual and organizational learning: A sociological model. *Management learning*, *36*(2), pp.131-147.

Cramer, D., 2003. *Fundamental statistics for social research: step-by-step calculations and computer techniques using SPSS for Windows*. Routledge.

Cameron, A.C. and Trivedi, P.K., 2013. *Regression analysis of count data* (Vol. 53). Cambridge university press.

Carmines, E.G. and Zeller, R.A., 1979. *Reliability and validity assessment* (Vol. 17). Sage publications.

Charnock, E., Roberts, S.L. and Holsinger, D.J., Cataphorn Inc, 2006. *Method and apparatus for sociological data mining*. U.S. Patent 7,143,091.

Chen, H., Chiang, R.H. and Storey, V.C., 2012. Business intelligence and analytics: From big data to big impact. *MIS quarterly*, *36*(4).

Chung, L., Gross, D. and Yu, E., 1999, February. Architectural design to meet stakeholder requirements. In *Working Conference on Software Architecture* (pp. 545-564). Springer, Boston, MA.

CIRT (2019) *Center for Innovation in Research and Teaching: Analyzing Qualitative Data.* Available at: https://cirt.gcu.edu/research/developmentresources/research_ready/qualitative/analyzing_dat a (Accessed: 15 November 2019)

Clements, P., Kazman, R. and Klein, M., 2003. *Evaluating software architectures*. Beijing: Tsinghua University Press.

Clark, S.C., 2000. Work/family border theory: A new theory of work/family balance. *Human relations*, *53*(6), pp.747-770.

Clark-Ibáñez, M., 2004. Framing the social world with photo-elicitation interviews. *American behavioral scientist*, *47*(12), pp.1507-1527.

Cloud, D. (2018) *What Is Social Cohesion? - Definition & Theory.* Available at: https://study.com/academy/lesson/what-is-social-cohesion-definition-theory-quiz.html (Accessed: November 27, 2019)

Cockburn, A., 1996. The interaction of social issues and software architecture. *Communications of the ACM*, *39*(10), pp.40-46.

Coffey, A. and Atkinson, P., 1996. *Making sense of qualitative data: complementary research strategies*. Sage Publications, Inc.

Cole, J. and Cole, S., 1971. Measuring the Quality of Sociological Research: Problems in the Use of the" Science Citation Index". *The American Sociologist*, pp.23-29.

Coleman, J.S., 1964. Introduction to mathematical sociology. *Introduction to mathematical sociology.*

Collins, R., 1975. *Conflict sociology: Toward an explanatory science*. Academic Pr.

Conger, R. and Killeen, P., 1974. Use of concurrent operants in small group research: A demonstration. *Pacific Sociological Review*, *17*(4), pp.399-416.

Connolly, P., 2007. *Quantitative data analysis in education: A critical introduction using SPSS*. Routledge.

Consumer Finance Protection Bureau (CFPB) (2019) *Innovation. Washington, D.C. Consumer Finance Protection Bureau.* Available at: https://www.consumerfinance.gov/about-us/innovation/ (Accessed: November 27, 2019)

Cottingham, J., 1996. Descartes: Meditations on First Philosophy: With Selections from the Objections and Replies.

Couto, L., Oliveira, J.N., Ferreira, M. and Bouwers, E., 2011, March. Preparing for a literature survey of software architecture using formal concept analysis. In *First International Workshop on Model-Driven Software Migration (MDSM 2011)* (p. 64).

Cox, A., 2005. What are communities of practice? A comparative review of four seminal works. *Journal of Information Science, 31*(6), pp.527-540.

Crabtree, A., 2004, August. Design in the absence of practice: breaching experiments. In *Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques* (pp. 59-68). ACM.

Cram, F. and Mertens, D.M., 2015. Transformative and indigenous frameworks for multimethod and mixed methods research. In *The Oxford handbook of multimethod and mixed methods research inquiry*.

Cramer, D., 2003. *Fundamental statistics for social research: step-by-step calculations and computer techniques using SPSS for Windows*. Routledge.

Creswell, J.W., 2002. *Educational research: Planning, conducting, and evaluating quantitative* (pp. 146-166). Upper Saddle River, NJ: Prentice Hall.

Creswell, J.W. and Clark, V.L.P., 2017. *Designing and conducting mixed methods research*. Sage publications.

Creswell, J.W. and Creswell, J.D., 2017. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications.

Creswell, J.W. and Poth, C.N., 2016. *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Crossman, A. (2018) *What is Social Phenomenology?* Available at: https://www.thoughtco.com/phenomenology-sociology-3026630 (Accessed: 27 April 2019)

Crossman, A. (2019) *Conducting Case Study Research.* Available at: https://www.thoughtco.com/case-study-definition-3026125 (Accessed: 27 April 2019)

Crossman, A. (2019) *Major Sociological Theories: A List of Sociological Theories, Concepts and Frameworks.* Available at: https://www.thoughtco.com/sociology-research-and-statistics-s2-3026650 (Accessed: 20 November 2019)

Crossman, A. (2019) *Understanding Functionalist Theory.* Available at: https://www.thoughtco.com/functionalist-perspective-3026625 (Accessed: November 27 2019)

Davidsson, P., 2002. Agent based social simulation: A computer science view. *Journal of artificial societies and social simulation*, *5*(1).Denzin, N.K., 2017. *Sociological methods: A sourcebook*. Routledge.

Davis, J.A., 1963. Structural balance, mechanical solidarity, and interpersonal relations. *American Journal of Sociology*, *68*(4), pp.444-462.

Davis, K., 1959. The myth of functional analysis as a special method in sociology and anthropology. *American sociological review*, pp.757-772.

Denzin, N.K., 1989. Denzin, Norman K., The Research Act: A Theoretical Introduction to Sociological Methods, Englewood Cliffs, NJ: Prentice-Hall, 1989.

DeSanctis, G. and Poole, M.S., 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organization science*, *5*(2), pp.121-147.

Dictionary.com (2019) *Definition of "Approach."* Available at: https://www.dictionary.com/browse/approach (Accessed: 19 November 2019)

Dix, A., 2009. *Human-computer interaction* (pp. 1327-1331). Springer US.

DLC (2019) *Digital Library Of The Commons Repository.* Available at: http://dlc.dlib.indiana.edu/dlc (Accessed: 15 November 2019)

Dobrica, L. and Niemela, E., 2002. A survey on software architecture analysis methods. *IEEE Transactions on software Engineering*, *28*(7), pp.638-653.

Dobrica, L. and Niemelä, E., 2002, April. Software architecture quality analysis methods. In *International Conference on Software Reuse* (pp. 337-338). Springer, Berlin, Heidelberg.

Dogpile (2019) *search engine by InfoSpace Holdings LLC.* Available at: http://www.dogpile.com/ (Accessed: 10 November 2019)

Durden, T. (2017) *Global Debt Hits 325% Of World GDP, Rises To Record $217 Trillion.* Available at: https://www.zerohedge.com/news/2017-01-04/global-debt-hits-325-world-gdp-rises-record-217-trillion (Accessed: 20 August 2018)

Durkheim, E., Catlin, G.E.G., Mueller, J.H. and Solovay, S.A., 1938. *The rules of sociological method* (Vol. 8). New York: Free Press.

Dzisah, J. and Etzkowitz, H., 2011. *The age of knowledge: The dynamics of universities, knowledge and society*. Brill.

EBSCO (2019) *EBSCO Information Services Inc. Home Page*. Available at: https://www.ebsco.com/ (Accessed: 20 November 2019)

Eeles, P. (2004) *Appendix B: Architectural Requirements.* Available at: https://www.ibm.com/developerworks/rational/library/4708.html (Accessed: 20 May 2018)

Eeles, P. (2004) *Appendix C: Sample Architectural Requirements Questionnaire.* Available at: https://www.ibm.com/developerworks/rational/library/4710.html (Accessed: 20 May 2018)

Eeles, P. (2004) *Capturing Architectural Requirements.* Available at: https://www.ibm.com/developerworks/rational/library/4706.html (Accessed: 20 May 2018)

Eeles, P. (2004) *Characteristics of a software architect.* Available at: https://www.ibm.com/developerworks/rational/library/mar06/eeles/ (Accessed: 20 May 2018)

Eeles, P. (2004) *What is a software architecture?.* Available at: https://www.ibm.com/developerworks/rational/library/feb06/eeles/ (Accessed: 20 May 2018)

Egyed, A. and Grunbacher, P., 2004. Identifying requirements conflicts and cooperation: How quality attributes and automated traceability can help. *IEEE software*, *21*(6), pp.50-58.

Eisenstein, E.L., 1980. *The printing press as an agent of change*. Cambridge University Press.

Elias, N., 1978. *What is sociology?*. Columbia University Press.

Engeström, Y., Miettinen, R. and Punamäki, R.L. eds., 1999. *Perspectives on activity theory*. Cambridge university press.

Ethington, P.J., 1997. The intellectual construction of" Social Distance": Toward a recovery of Georg Simmel's social geometry. *Cybergeo: European Journal of Geography*.

Faiella, G., 2006. *The technology of Mesopotamia*. The Rosen Publishing Group, Inc.

Falagas, M.E., Zarkadoulia, E.A. and Samonis, G., 2006. Arab science in the golden age (750–1258 CE) and today. *The FASEB Journal*, *20*(10), pp.1581-1586.

Falleti, T.G. and Mahoney, J., 2015. The comparative sequential method. *Advances in comparative-historical analysis*, pp.211-239.

Feagin, J.R., Orum, A.M. and Sjoberg, G. eds., 1991. *A case for the case study*. UNC Press Books.

Federal Deposit Insurance Corporation (FDIC) (2014) *FDIC Law, Regulations, Related Acts*. Available at: http://www.fdic.gov/regulations/laws/rules/5000-1000.html (Accessed: 15 May, 2017)

Federal Reserve, N.Y., 2011. Quarterly Report on Household Debt and Credit. *Federal Reserve Bank of New York, Research and Statistics Group*.

Federal Reserve Bank of St. Louis (FRED) (2019) *Charge-Off Rate on Credit Card Loans, Top 100 Banks Ranked by Assets.* Available at: https://fred.stlouisfed.org/series/CORCCT100S (Accessed: 22 November 2019)

Federal Reserve Bank of St. Louis (FRED) (2019) *Household Debt Service Payments as a Percent of Disposable Personal Income.* Available at: https://fred.stlouisfed.org/series/TDSP (Accessed: 22 November 2019)

Federal Trade Commission (FTC) (2013) *The Structure and Practices of theDebt Buying Industry.* Available at: http://www.ftc.gov/sites/default/files/documents/reports/structure-and-practices-debt-buying-industry/debtbuyingreport.pdf (Accessed: 25 September 2018)

Federal Trade Commission (FTC) (2009). *Collecting consumer debts: The challenges of change*. Available at: https://www.ftc.gov/sites/default/files/documents/reports/collecting-consumer-debts-challenges-change-federal-trade-commission-workshop-report/dcwr.pdf (Accessed: January 15, 2019)

FedRes (2019) *Board of Governors of the Federal Reserve System*. Available at: https://www.federalreserve.gov/data.htm (Accessed: 15 November 2019)

Feldstein, M.S., 1986. Supply side economics: old truths and new claims.

Fielding, R.T., 2000. REST: architectural styles and the design of network-based software architectures. *Doctoral dissertation, University of California*.

Fielding, R.T. and Taylor, R.N., 2000. *Architectural styles and the design of network-based software architectures* (Vol. 7). Doctoral dissertation: University of California, Irvine.

Fillebrown, S., 1994. Using projects in an elementary statistics course for non-science majors. *Journal of Statistics Education*, *2*(2).

Fine, G. and Sandstorm, K. (2014) *Symbolic Interactionism*. Available at: https://www.oxfordbibliographies.com/view/document/obo-9780199756384/obo-9780199756384-0061.xml (Accessed: November 30 2018)

Fischer, G., 2004, July. Social creativity: turning barriers into opportunities for collaborative design. In *Proceedings of the eighth conference on Participatory design: Artful* *integration: interweaving media, materials and practices-Volume 1* (pp. 152-161). ACM.

Flink, J.J., 1990. *The automobile age*. mit Press.

Fowler, M., 2002. *Patterns of enterprise application architecture*. Addison-Wesley Longman Publishing Co., Inc..

Freeman, L., 2004. The development of social network analysis. *A Study in the Sociology of Science*, *1*.

Freeman, L.C., 1992. The sociological concept of" group": An empirical test of two models. *American journal of sociology*, *98*(1), pp.152-166.

Fuchs, C., 2013. Capitalism or information society? The fundamental question of the present structure of society. *European Journal of Social Theory*, *16*(4), pp.413-434.

Garlan, D., 2000, May. Software architecture: a roadmap. In *Proceedings of the Conference on the Future of Software Engineering* (pp. 91-101). ACM.

Garlan, D. and Perry, D.E., 1995. Introduction to the special issue on software architecture. *IEEE Trans. Software Eng.*, *21*(4), pp.269-274.

Garlan, D. and Shaw, M., 1993. An introduction to software architecture. In *Advances in software engineering and knowledge engineering* (pp. 1-39).

Gaukroger, S., 2001. *Francis Bacon and the transformation of early-modern philosophy*. Cambridge University Press.

Giddens, A., 1979. *Central problems in social theory: Action, structure, and contradiction in social analysis* (Vol. 241). Univ of California Press.

Giddens, A., (1991). Structuration Theory: Past, Present and Future. In: Bryant, C.G.A. and Jary, D., Eds., Giddens' Theory of Structuration: A Critical Appreciation (pp. 201-221). London: Routledge.

Giddens, A., 1996. Introduction to Sociology. NY.

Giddens, A., 2013. *New rules of sociological method: A positive critique of interpretative sociologies*. John Wiley & Sons.

Giorgi, A., 1997. The theory, practice, and evaluation of the phenomenological method as a qualitative research procedure. *Journal of phenomenological psychology*, *28*(2), pp.235-260.

Goldberg, L., 2005. Dealing in debt: the high-stakes world of debt collection after FDCPA. *S. Cal. L. Rev.*, *79*, p.711.

Goldman, A. (2006) *Social Epistemology.* Available at: https://stanford.library.sydney.edu.au/archives/fall2008/entries/epistemology-social/ (Accessed: 15 August 2019)

Coleman, J.S., 1964. Introduction to mathematical sociology. *Introduction to mathematical sociology.*

Google Correlate (GC) (2019) *Find searches that correlate with real-world data.* Available at: http://www.google.com/trends/correlate/ (Accessed: 10 November 2019)

Gorini, R., 2003. Al-Haytham the man of experience. First steps in the science of vision. *Journal of the International Society for the History of Islamic Medicine*, *2*(4), pp.53-55.

Gottschalck, A., Vornovytskyy, M. and Smith, A., 2013. Household Wealth and Debt in the US: 2000 to 2011. *Press release, US Census Bureau, Washington, DC*.

Granovetter, M., 1978. Threshold models of collective behavior. *American journal of sociology*, *83*(6), pp.1420-1443.

Greene, J.C., Caracelli, V.J. and Graham, W.F., 1989. Toward a conceptual framework for mixed-method evaluation designs. *Educational evaluation and policy analysis*, *11*(3), pp.255-274.

Grimmer, J., 2015. We are all social scientists now: How big data, machine learning, and causal inference work together. *PS: Political Science & Politics*, *48*(1), pp.80-83.

Gross, D.B. and Souleles, N.S., 2002. An empirical analysis of personal bankruptcy and delinquency. *The Review of Financial Studies*, *15*(1), pp.319-347.

GS, (2019) *Google Scholar.* Available at: http://scholar.google.com/ (Accessed: 15 November 2019)

Gullahorn, J.T. and Gullahorn, J.E., 1965. Some computer applications in social science. *American sociological review*, pp.353-365.

Hadnagy, C., 2010. *Social engineering: The art of human hacking*. John Wiley & Sons.

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L., 2006. Multivariate data analysis (Vol. 6).

Hales, D., 2010. An introduction to triangulation. *Geneva: UNAIDS Monitoring and Education Division*, pp.13-17.

Handel, W.H., 1977. *Social psychology: The theory and application of symbolic interactionism*. Boston: Houghton Mifflin.

Harper, D., 1986. Meaning and work: A study in photo elicitation. *Current sociology*, *34*(3), pp.24-46.

Harper, D., 1988. Visual sociology: Expanding sociological vision. *The american sociologist*, *19*(1), pp.54-70.

Harper, D., 2002. Talking about pictures: A case for photo elicitation. *Visual studies*, *17*(1), pp.13-26.

Heick, T. (2015) *100 Search Engines For Academic Research.* Available at: http://www.teachthought.com/learning/100-search-engines-for-academic-research/ (Accessed: 15 September 2018)

Heise, D.R. and Bohrnstedt, G.W., 1970. Validity, invalidity, and reliability. *Sociological methodology*, *2*, pp.104-129.

Hendricks, J. and Breckinridge Peters, C., 1973. The ideal type and sociological theory. *Acta Sociologica*, *16*(1), pp.31-40.

Hines, A.M., 1993. Linking qualitative and quantitative methods in cross-cultural survey research: Techniques from cognitive science. *American Journal of Community Psychology*, *21*(6), pp.729-746.

Hoadley, C., 2012. 12 What is a Community of Practice and How Can We Support It?. *Theoretical foundations of learning environments*, p.286.

Hughes, T.P., 1994. Technological momentum. *Does technology drive history*, *101*.

Hummon, N.P. and Fararo, T.J., 1995. The emergence of computational sociology. *Journal of mathematical sociology*, *20*(2-3), pp.79-87.

Hunt, R.M., 2007. Collecting consumer debt in America. *Available at SSRN 993249*.

Hussein, A., 2009. The use of triangulation in social sciences research: Can qualitative and quantitative methods be combined. *Journal of comparative social work*, *1*(8), pp.1-12.

IBM (2016) *Defining use cases.* Available at: https://www.ibm.com/support/knowledgecenter/en/SSWSR9_11.0.0/com.ibm.pim.dev.doc/pim_tsk_arc_definingusecases.html (Accessed: 17 September 2018)

iSEEK (2019) *iSeek Education.* Available at: http://education.iseek.com/iseek/home.page (Accessed: 15 November 2019)

Jacobson, I. and Bylund, S., 2000. *The road to the unified software development process* (Vol. 18). Cambridge University Press.

Jick, T.D., 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly*, *24*(4), pp.602-611.

Johnson, R.B. and Onwuegbuzie, A.J., 2004. Mixed methods research: A research paradigm whose time has come. *Educational researcher*, *33*(7), pp.14-26.

Johnson, R.B., Onwuegbuzie, A.J. and Turner, L.A., 2007. Toward a definition of mixed methods research. *Journal of mixed methods research*, *1*(2), pp.112-133.

Johnson, R.B., Russo, F. and Schoonenboom, J., 2019. Causation in mixed methods research: The meeting of philosophy, science, and practice. *Journal of Mixed Methods Research*, *13*(2), pp.143-162.

Jones, M.R. and Karsten, H., 2008. Giddens's structuration theory and information systems research. *MIS quarterly*, *32*(1), pp.127-157.

Kassir, H. and Peterson, S. (2002) *US 20020156839 A1 - System for providing localized content information via wireless personal communication devices.* Available at: https://patents.google.com/patent/US20020156839 (Accessed: 20 June 2018)

Karlson, K.B., Holm, A. and Breen, R., 2012. Comparing regression coefficients between same-sample nested models using logit and probit: A new method. *Sociological methodology*, *42*(1), pp.286-313.

Kassir, H., 2013. *US 2013/0159164 A1 Method and system for anonymously matching debtors with debt holders to facilitate resolution of non-performing debt*. U.S. Patent Application 13/328,167.

Kassir, H., 2013. *Method and system for restructuring debt*. U.S. Patent 8,489,480.

Kassir, H., 2019. The Evolution of Sociology of Software Architecture. *Doctoral dissertation, University of East London*.

Kazman, R., Abowd, G., Bass, L. and Clements, P., 1996. Scenario-based analysis of software architecture. *IEEE software*, *13*(6), pp.47-55.

Kelle, U., 1997. Computer-aided Methods for Typification in Qualitative Social Research. In *Classification and knowledge organization* (pp. 342-354). Springer, Berlin, Heidelberg.

Kilian, L. and Vigfusson, R.J., 2013. Do oil prices help forecast US real GDP? The role of nonlinearities and asymmetries. *Journal of Business & Economic Statistics*, *31*(1), pp.78-93.

Kilminster, R., 2007. *Norbert Elias: post-philosophical sociology*. Routledge.

Kimble, C., 2006. Communities of practice: Never knowingly undersold. *Innovative approaches for learning and knowledge sharing*, pp.218-234.

King, A.G. and Amin, S.S., 2008. Social Framework Analysis as Inadmissible Character Evidence. *Law & Psychol. Rev.*, *32*, p.1.

Kirk, J., Miller, M.L. and Miller, M.L., 1986. *Reliability and validity in qualitative research* (Vol. 1). Sage.

Kiser, E. and Hechter, M., 1991. The role of general theory in comparative-historical sociology. *American Journal of Sociology*, *97*(1), pp.1-30.

Kitzinger, J., 1995. Qualitative research: introducing focus groups. *Bmj*, *311*(7000), pp.299-302.

Klein, H.K. and Kleinman, D.L., 2002. The social construction of technology: Structural considerations. *Science, Technology, & Human Values*, *27*(1), pp.28-52.

Kossiakoff, A., Sweet, W.N., Seymour, S.J. and Biemer, S.M., 2011. *Systems engineering principles and practice* (Vol. 83). John Wiley & Sons.

Kramer, G.A. and Vogel, M.B., Encirq Corp, 2001. *Hierarchical models of consumer attributes for targeting content in a privacy-preserving manner*. U.S. Patent 6,327,574.

Kranzberg, M., 1986. Technology and History:" Kranzberg's Laws". *Technology and culture*, *27*(3), pp.544-560.

Kraus, P., 1935. *Selected Letters of Jabir ibn Hayyan: the Book of Khawass*, Gangi Press. P 232. [Arabic book, our translation]

Kraus, P., 1935. *Selected Letters of Jabir ibn Hayyan: the Book of Seventy,* Gangi Press. P 464. [Arabic book, our translation]

Kruchten, P., Booch, G., Bittner, K. and Reitman, R., 2007. Who are the Software Architects and What Do They Do.

Kruchten, P., Obbink, H. and Stafford, J., 2006. The past, present, and future for software architecture. *IEEE software*, *23*(2), pp.22-30.

Kumulos (2015) 20 *Questions to ask your client before you build their mobile app.* Available at: https://www.kumulos.com/2015/12/17/20-questions-to-ask-your-client-before-you-build-their-mobile-app/ (Accessed: 15 September 2018)

Latour, B., 2006. An Introduction to Actor-Network-Theory.

Leibowitz, J. ed., 2010. *Repairing a Broken System: Protecting Consumers in Debt*

Collection Litigation and Arbitration. DIANE Publishing.

Levitas, R., 2010. Back to the future: Wells, sociology, utopia and method. *The Sociological Review*, *58*(4), pp.530-547.

Lewis-Beck, M., Bryman, A.E. and Liao, T.F., 2003. *The Sage encyclopedia of social science research methods*. Sage Publications.

LEXICO (2019) *Definition of Approach by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/approach (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Deductive by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/deductive (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Induction by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/induction (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Epistemology by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/epistemology (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Knowledge by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/knowledge (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Method by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/method (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Model by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/model (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Process by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/scientific (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Scientific Method by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/scientific_method (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Scientific by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/scientific (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Structure by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/structure (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Technique by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/technique (Accessed: 12 November 2019)

LEXICO (2019) *Definition of Threshold by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/threshold (Accessed: 12 November 2019)

LEXICO (2019) *Definition of "Use Case" by Lexico, Oxford.* Available at: https://en.oxforddictionaries.com/definition/use_case (Accessed: 12 November 2019)

Lewin, K., 1947. Frontiers in group dynamics: Concept, method and reality in social science; social equilibria and social change. *Human relations*, *1*(1), pp.5-41.

Lijphart, A., 1971. Comparative politics and the comparative method. *American political science review*, *65*(3), pp.682-693.

Lincoln, Y. and Guba, E.G., 1985. Lincoln, Yvonna, and Egon G. Guba, Naturalistic Inquiry. Beverly Hills, CA: Sage, 1985.

LOC (2019) *Library of Congress.* Available at: http://www.loc.gov/index.html (Accessed: 20 November 2019)

Longhurst, B., 1989. *Karl Mannheim and the contemporary sociology of knowledge*. Springer.

Luhmann, N., 1995. *Social systems*. stanford university Press.

Luhmann, N., Baecker, D. and Gilgen, P., 2013. *Introduction to systems theory*. Cambridge: Polity.

Macal, C.M. and North, M.J., 2005, December. Tutorial on agent-based modeling and simulation. In *Proceedings of the Winter Simulation Conference, 2005.* (pp. 14-pp). IEEE.

Macalester (2019) *All Guides: Data Module #1: What is Research Data?: Qualitative vs. Quantitative.* Available at: https://libguides.macalester.edu/c.php?g=527786&p=3608639 (Accessed: 5 November 2019)

MacKenzie, D. and Wajcman, J., 1999. *The social shaping of technology*. Open university press.

Macy, M.W. and Willer, R., 2002. From factors to actors: Computational sociology and agent-based modeling. *Annual review of sociology*, *28*(1), pp.143-166.

Mahoney, J. and Rueschemeyer, D. eds., 2003. *Comparative historical analysis in the social sciences*. Cambridge University Press

Mall, D., (2016) *Architectural paradigms and research topics.* Available at: http://vwv05.unaux.com/software-architecture-perspectives-on-an-emerging-discipline.html?i=1 (Accessed: 15 October 2018)

Mamma (2019) *Trust Mamma For Business Reviews.* Available at: http://www.mamma.com/ (Accessed: 20 November 2019)

Mansell, R. and Wehn, U., 1998. *Knowledge societies: Information technology for sustainable development*. United Nations Publications.

Marx, M.R.S.L., 1994. *Does technology drive history?: The dilemma of technological determinism*. Mit Press.

MAS (2019) *Microsoft Academic: Research more, search less.* Available at: http://academic.research.microsoft.com/ (Accessed: 15 November 2019)

Margalit, Y., 2013. Explaining social policy preferences: Evidence from the Great Recession. *American Political Science Review*, *107*(1), pp.80-103.

Marr, B. (2019) *Big Data: 20 Mind-Boggling Facts Everyone Must Read.* Available at: https://www.forbes.com/sites/bernardmarr/2015/09/30/big-data-20-mind-boggling-facts-everyone-must-read/#6f708dd517b1 (Accessed: 15 November 019)

Marshall, C.R., 2006. Explaining the Cambrian "explosion" of animals. *Annu. Rev. Earth Planet. Sci.*, *34*, pp.355-384.

Mary, S. and David, G., 1996. Software Architecture: Perspectives on an Emerging Discipline. *Prentice-Hall.*

Martindale, D., 1959. Sociological theory and the ideal type. In *Symposium on sociological theory* (pp. 57-91). Row, Peterson and Company.

Matinlassi, M., 2004, May. Comparison of software product line architecture design methods: COPA, FAST, FORM, KobrA and QADA. In *Proceedings of the 26th International Conference on Software Engineering* (pp. 127-136). IEEE Computer Society.

Mattsson, M., Grahn, H. and Mårtensson, F., 2006, June. Software architecture evaluation methods for performance, maintainability, testability, and portability. In *Second International Conference on the Quality of Software Architectures*.

McElvaine, R.S. ed., 2008. *Down & Out in the Great Depression: Letters from the Forgotten Man*. Univ of North Carolina Press.

McPherson, J.M. and Rotolo, T., 1996. Testing a dynamic model of social composition: Diversity and change in voluntary groups. *American sociological review*, pp.179-202.

Medley-Rath, S. (2018) *Structural Strain Theory and the Baltimore Riots.* Available at: http://stephaniemedleyrath.com/2018/03/10/structural-strain-theory-and-the-baltimore-riots-repost-from-sif/ (Accessed: 15 December, 2018).

Medvidovic, N. and Taylor, R.N., 2010, May. Software architecture: foundations, theory, and practice. In *Proceedings of the 32nd ACM/IEEE International Conference on Software Engineering-Volume 2* (pp. 471-472). ACM.

Meja, V. and Stehr, N., 2014. *Knowledge and Politics (RLE Social Theory): The Sociology of Knowledge Dispute*. Routledge.

Merriam-Webster Dictionary (MWD) (2019) *Definition of "assessment" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/assessment (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of* "approach*" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/approach (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of* “conjecture” *from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/conjecture (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of* “epistemology” *from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/epistemology (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of* “*g*ibberish” *from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/*g*ibberish (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of* “hypothesis” *from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/hypothesis (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of “model” from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/model (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of "scientific method" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/scientific%20method (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of "*sociogenesis*" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/sociogenesis (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of "*techniques*" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/techniques (Accessed: 22 November 2019)

Merriam-Webster Dictionary (MWD) (2019) *Definition of "*technology*" from the Merriam-Webster, Incorporated.* Available at: https://www.merriam-webster.com/dictionary/technology (Accessed: 22 November 2019)

Metacrawler (2019) *metacrawler search engine by InfoSpace Holdings LLC.* Available at: http://www.metacrawler.com/ (Accessed: 10 November 2019)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 1: What is Software Architecture?* Available at:

https://msdn.microsoft.com/en-us/library/ee658098.aspx?f=255&MSPPError=-2147217396 (Accessed: 15 June, 2018)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 4: A Technique for Architecture and Design, Crosscutting Concerns.* Available at: https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ee658084(v=pandp.10)#crosscutting-concerns (Accessed: 15 June, 2018)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 4: A Technique for Architecture and Design, Crosscutting Concerns.* Available at: https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ee658084(v=pandp.10)#crosscutting-concerns (Accessed: 15 June, 2018)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 4: A Technique for Architecture and Design, Designing for Issue Mitigation.* Available at: https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ee658084(v=pandp.10)#designing-for-issue-mitigation (Accessed: 15 June, 2018)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 4: A Technique for Architecture and Design, Quality Attributes.* Available at: https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ee658084(v=pandp.10)#quality-attributes (Accessed: 15 June, 2018)

Microsoft (2009) *Microsoft Application Architecture Guide, 2nd Edition, Chapter 4: A Technique for Architecture and Design, Scenario Based Evaluations.* Available at:

https://docs.microsoft.com/en-us/previous-versions/msp-n-p/ee658084(v=pandp.10)#scenario-based-evaluations (Accessed: 15 June, 2018)

Mills, Albert, Durepos, and Wiebe, editors. Encyclopedia of Case Study Research. (2010) *Organizing Your Social Sciences Research Paper: Writing a Case Study.* Available at: https://libguides.usc.edu/writingguide/casestudy (Accessed: 10 October 2018)

MITRE (2018) *Operational Requirements.* Available at: https://www.mitre.org/publications/systems-engineering-guide/se-lifecycle-building-blocks/concept-development/operational-requirements (Accessed: 20 September 2018)

MMRM (2019) *Types of Data & Measurement Scales: Nominal, Ordinal, Interval and Ratio.* Available at: https://www.mymarketresearchmethods.com/types-of-data-nominal-ordinal-interval-ratio/ (Accessed: 10 October, 2019)

Moen, R. and Norman, C., 2006. Evolution of the PDCA cycle.

Monahan, J., Walker, L. and Mitchell, G., 2009. The limits of social framework evidence. *Law, Probability & Risk*, *8*(4), pp.307-321.

Morse, J.M., 1991. Approaches to qualitative-quantitative methodological triangulation. *Nursing research*, *40*(2), pp.120-123.

Mousa, J. M., (1988) *Research Methodology of Arab Scientists in the Natural Sciences and Astronomy*. Dar Al-Kitab Al-Lubnani. [Arabic book, our translation, pages 126 and 127]

Myers, M.D. and Avison, D. eds., 2002. *Qualitative research in information systems: a reader*. Sage.

Najib, M. Z., 1962, *Jabir Ibn Hayyan*. Maktabat Masr. [Arabic book, our translation]

Nardi, B.A. ed., 1996. *Context and consciousness: activity theory and human-computer interaction*. mit Press.

Nassehi, A., von der Hagen-Demszky, A. and Mayr, K., 2007. The Structures of Knowledge and of Knowledge Production. *Literature Review and Theoretical Framework Report (Part 8). Know & Pol project. URL: http://knowandpol. eu/IMG/pdf/lr. tr. nassehi_al. eng. pdf.*

National Consumer Law Center (NCLC) (2010) *The Debt Machine: How the Collection Industry Hounds Consumers and Overwhelms Courts.* Available at: https://www.nclc.org/images/pdf/pr-reports/debt-machine.pdf (Accessed: 15 August 2018)

Nickols, F., 2003. Communities of practice. *A start-up kit.*

Nico, S., 1994. Knowledge societies. *Sage Publications, London*, p.40.

Noor, K.B.M., 2008. Case study: A strategic research methodology. *American journal of applied sciences*, *5*(11), pp.1602-1604.

OCLC (2019) *Advancing our shared mission.* Available at: https://www.oclc.org/en/home.html (Accessed: 15 November 2019)

Orlikowski, W.J. and Baroudi, J.J., 1991. Studying information technology in organizations: Research approaches and assumptions. *Information systems research*, *2*(1), pp.1-28.

Orth, U.R., McDaniel, M., Shellhammer, T. and Lopetcharat, K., 2004. Promoting brand benefits: the role of consumer psychographics and lifestyle. *Journal of Consumer Marketing*, *21*(2), pp.97-108.

Oxford Islamic Studies Online (OISO) (2019) *Definition of "Asabiyyah."* Available at: http://www.oxfordislamicstudies.com/article/opr/t125/e202 (Accessed: 1 December 2019)

Oxford Learner's Dictionaries (OLD). (2019) *Definition of "conjecture."* Available at: https://www.oxfordlearnersdictionaries.com/us/definition/english/conjecture (Accessed: 22 November 2019)

Oxford Reference (OR) (2019. *Historical determinism*. Available at: http://www.oxfordreference.com/view/10.1093/oi/authority.20110803095938705 (Accessed: 20 November 2019)

Patton, M.Q., 1980. Qualitative evaluation methods.

Patton, M.Q., 1987. *How to use qualitative methods in evaluation* (No. 4). Sage.

Patton, M.Q., 1990. Qualitative evaluation and research methods. SAGE Publications, inc.

Patton, M.Q., 2003. Qualitative evaluation checklist. *Evaluation checklists project*, *21*.

Patton, M.Q., 2005. Qualitative research. *Encyclopedia of statistics in behavioral science*.

Peirson, S.N., Butler, J.N. and Foster, R.G., 2003. Experimental validation of novel and conventional approaches to quantitative real-time PCR data analysis. *Nucleic acids research*, *31*(14), pp.e73-e73.

Perry, D.E. and Wolf, A.L., 1992. Foundations for the study of software architecture. *ACM SIGSOFT Software engineering notes*, *17*(4), pp.40-52.

Peterson, R.A., 1992. Understanding audience segmentation: From elite and mass to omnivore and univore. *Poetics*, *21*(4), pp.243-258.

ProQuest (2019) *Databases: Empowering Researchers with Extraordinary Information provided by ProQuest Libraries.* Available at: http://www.proquest.com/libraries/academic/databases/ (Accessed: 20 November 2019)

Punch, K.F., 2013. *Introduction to social research: Quantitative and qualitative approaches*. Sage.

Rammert, W., 1997. New rules of sociological method: Rethinking technology studies. *British Journal of Sociology*, pp.171-191.

Ratcliffe, C., McKernan, S.M., Theodos, B., Kalish, E., Chalekian, J., Guo, P., Trepel, C., OPPORTUNITY, A. and BRIEF, O.I., 2014. Delinquent debt in America. *Urban Institute Report, Washington, DC, Urban Institute*.

Rehkopf, M. (2019) *Kanban vs Scrum*. Available at: https://www.atlassian.com/agile/kanban/kanban-vs-scrum (Accessed: 12 September 2019)

Rizzatti, L., 2016. Digital data storage is undergoing mind-boggling growth. *EE Times*.

Rizzatti, L. (2016) *Digital Data Storage is Undergoing Mind-Boggling Growth.* Available at: http://www.eetimes.com/author.asp?section_id=36&doc_id=1330462 (Accessed: 17 August 2018)

Rouse, M. (2019) *Definition of "use case" from WhatIs.com*. Available at: http://searchsoftwarequality.techtarget.com/definition/use-case (Accessed: November 20 2019)

Rozanski, N. and Woods, E., 2005. Applying viewpoints and views to software architecture. Open University White Paper.

Rozanski, N. and Woods, E. (2012) *Software systems architecture: working with stakeholders using viewpoints and perspectives*. Addison-Wesley. Available at:

https://www.viewpoints-and-perspectives.info/home/stakeholders/ (Accessed: 17 May 2018)

Roos, H. and Palmér, H., 2015, February. Communities of practice: Exploring the diverse use of a theory.

Rössel, J. (2017) *Conflict Theory.* Available at: https://www.oxfordbibliographies.com/view/document/obo-9780199756384/obo-9780199756384-0035.xml (Accessed: November 30, 2018)

Ruben, M., 2009. Forgive us our Trespasses? The rise of consumer debt in modern America. *Discovery Guide*.

Sack, W., Détienne, F., Ducheneaut, N., Burkhardt, J.M., Mahendran, D. and Barcellini, F., 2006. A methodological framework for socio-cognitive analyses of collaborative design of open source software. *Computer Supported Cooperative Work (CSCW), 15*(2-3), pp.229-250.

Sassen, S., 2002. Towards a sociology of information technology. *Current Sociology*, *50*(3), pp.365-388.

Savage, M. and Burrows, R., 2007. The coming crisis of empirical sociology. *Sociology*, *41*(5), pp.885-899.

Savage, M., Devine, F., Cunningham, N., Taylor, M., Li, Y., Hjellbrekke, J., Le Roux, B., Friedman, S. and Miles, A., 2013. A new model of social class? Findings from the BBC's Great British Class Survey experiment. *Sociology*, *47*(2), pp.219-250.

Schmitt, F. F. (2019) *Social epistemology.* Available at: https://www.rep.routledge.com/articles/thematic/social-epistemology/v-1 (Accessed: 20 November 2019)

Schmitt, T.A., 2011. Current methodological considerations in exploratory and confirmatory factor analysis. *Journal of Psychoeducational Assessment*, *29*(4), pp.304-321.

Scholes, M., 2010. *Regulating Wall Street: The Dodd-Frank Act and the new architecture of global finance* (Vol. 608). John Wiley & Sons.

Scott, E.T.P., 2006. Innovative Approaches for Learning and Knowledge Sharing.

Scott, J., 1988. Social network analysis. *Sociology*, *22*(1), pp.109-127.

Seale, C., 2003. Computer-assisted analysis of qualitative interview data. *Inside interviewing: New lenses, new concerns*, pp.289-308.

Setia, V. (The Editors of Encyclopedia Britannica) (2008) *Functionalism*. Available at: https://www.britannica.com/topic/functionalism-social-science (Accessed: November 30, 2018)

Setterfield, M., 2002. *The economics of demand-led growth*. Edward Elgar Publishing.

Shanmugapriya, P. and Suresh, R.M., 2012. Software architecture evaluation methods-a survey. *International Journal of Computer Applications*, *49*(16).

Shaw, M. and Garlan, D., 1996. *Software architecture* (Vol. 101). Englewood Cliffs: prentice Hall.

Shneiderman, B., Plaisant, C., Cohen, M., Jacobs, S., Elmqvist, N. and Diakopoulos, N., 2016. *Designing the user interface: strategies for effective human-computer interaction*. Pearson.

Simcox, S. (2019) *IPL: The Internet Public Library.* Available at: http://www.ariadne.ac.uk/issue/7/ipl/ (Accessed: 15 November 2019)

Simmel, G., 2011. *Georg Simmel on individuality and social forms*. University of Chicago Press.

Skalicky, J. and West, M., 2008. UTAS Community of practice initiative.

Snyder, C., 2012. A case study of a case study: Analysis of a robust qualitative research methodology. *The qualitative report*, *17*(13), pp.1-21.

Snyder, L.J., 2010. *Reforming philosophy: A Victorian debate on science and society*. University of Chicago Press.

Snyder, L.J. (2011) *The philosophical breakfast club: four remarkable friends who transformed science and changed the world*. Broadway Books. Available at:

https://ted2srt.org/talks/laura_snyder_the_philosophical_breakfast_club (Accessed: 10 November 2018)

Staff (2010) *100 Time-Saving Search Engines for Serious Scholars.* Available at: http://www.onlineuniversities.com/blog/2010/03/100-time-saving-search-engines-for-serious-scholars/ (Accessed: October 10, 2018.

Staten, M. and Cate, F., 2004. Does the fair credit reporting act promote accurate credit reporting. *Joint Center for Housing Studies Working Paper BABC*, pp.04-14.

Stehr, N., 2010. Theories of the information age. *Historical Developments and Theoretical Approaches in Sociology. London: UNESCO-EOLSS*, pp.375-394.

Stehr, N. and Meja, V. eds., 1984. *Society and Knowledge: contemporary perspectives in the Sociology of Knowledge*. New Brunswick: Transaction Books.

Stifler, L. and Parrish, L., 2014. Debt ColleCtion & Debt buying.

Stoddart, J.F., 2009. The chemistry of the mechanical bond. *Chemical Society Reviews*, *38*(6), pp.1802-1820.

Sutton, J. and Austin, Z., 2015. Qualitative research: Data collection, analysis, and management. *The Canadian journal of hospital pharmacy*, *68*(3), p.226.

Swinyard, W.R. and Smith, S.M., 2003. Why people (don't) shop online: A lifestyle study of the internet consumer. *Psychology & marketing*, *20*(7), pp.567-597.

Taylor, R. N. (1999) *Software Architecture.* Available at: https://www.ics.uci.edu/~taylor/Architecture.pdf (Accessed: 15 June 2019)

Techopedia (2019) *What is a Use Case? - Definition from Techopedia.* Available at: https://www.techopedia.com/definition/25813/use-case (Accessed: 20 November 2019)

Thompson, K. (2016) Research Methods in Sociology – An Introduction. Available at: https://revisesociology.com/2016/01/03/research-methods-sociology/ (Accessed: 21 May 2018)

Tran, E. (1999) *Requirements & Specifications.* Available at: https://users.ece.cmu.edu/~koopman/des_s99/requirements_specs/ (Accessed: 10 October 2018)

Triola, M.F., 2006. *Elementary statistics*. Reading, MA: Pearson/Addison-Wesley.

Tripathi, B. (2019) *10 Questions to Ask When Developing Software. Available at:* https://www.synotive.com/blog/software-development-client-questionnaire (Accessed: 22 November 2019)

UCLA (2019) *Research Guides: Choosing and Using Library Databases: Choosing a Database.* Available at: http://guides.library.ucla.edu/databases/choosing (Accessed: 20 November 2019)

USCB (2019) *US Census Bureau Available APIs.* Available at: https://www.census.gov/data/developers/data-sets.html (Accessed: 15 November 2019)

USCB (2019) *US Census Bureau Data Tools and Apps.* Available at: https://www.census.gov/data/data-tools.html (Accessed: 15 November 2019)

Van Der Raadt, B., Schouten, S. and Van Vliet, H., 2008, September. Stakeholder perception of enterprise architecture. In *European Conference on Software Architecture* (pp. 19-34). Springer, Berlin, Heidelberg.

Verick, S. and Islam, I., 2010. The great recession of 2008-2009: causes, consequences and policy responses.

Xu, Y.M. and Jin, S.J., 2014. Application of Computer System in the study of Sociology. In *Advanced Materials Research* (Vol. 926, pp. 1680-1683). Trans Tech Publications.

Wainwright, D., 1997. Can sociological research be qualitative, critical and valid?. *The qualitative report*, *3*(2), pp.1-17.

Wenger, E., 1999. *Communities of practice: Learning, meaning, and identity*. Cambridge university press.

Went, P., 2010. Basel III Accord: Where do we go from here?. *Available at SSRN 1693622*.

White, M.J., 2007. Bankruptcy reform and credit cards. *Journal of Economic Perspectives, 21*(4), pp.175-200.

Wiki2 (2019) *Threshold model.* Available at: https://wiki2.org/en/Threshold_model (Accessed: 15 November 2019)

Williams, A., 1984. Is a radical genre criticism possible?. *Quarterly Review of Film & Video*, *9*(2), pp.121-125.

Williams, R. and Edge, D., 1996. The social shaping of technology. *Research policy*, *25*(6), pp.865-899.

Wikipedia (2019) *List of academic databases and search engines.* Available at: https://en.wikipedia.org/wiki/List_of_academic_databases_and_search_engines (Accessed: 15 November 2019)

Wolfram|Alpha (WA) (2019) *compute expert-level answers using Wolfram's breakthrough algorithms, knowledgebase and AI technology.* Available at: http://www.wolframalpha.com/ (Accessed: 10 November 2019)

Woods, E. and Rozanski, N., 2005, November. Using architectural perspectives. In *5th Working IEEE/IFIP Conference on Software Architecture (WICSA'05)* (pp. 25-35). IEEE.

Woods, E., and Rozanski, N. (2005) *Designing a DSL for Information Systems Architecture: Alternative definition.* Available at: http://www.artechra.com/media/speaking/2007/CG2007-DSLs-For-InfoSysArch.pdf (Accessed: 2 March, 2018)

Woods, E. and Rozanski, N. (2012) *PERSPECTIVES*. Available at: https://www.viewpoints-and-perspectives.info/home/perspectives/ (Accessed: 22 November 2019)

Woods, E. and Rozanski, N. (2012) *STAKEHOLDERS*. Available at: https://www.viewpoints-and-perspectives.info/home/stakeholders/ (Accessed: 22 November 2019)

Woods, E. and Rozanski, N. (2012) *VIEWPOINTS*. Available at: https://www.viewpoints-and-perspectives.info/home/viewpoints/ (Accessed: 22 November 2019)

W3S (2019) *Snoop any website by Bubl.ac.uk.* Available at: https://bubl.ac.uk.w3snoop.com/ (Accessed: 15 November 019)

Yin, R.K., 1981. The case study crisis: Some answers. *Administrative science quarterly*, *26*(1), pp.58-65.

Yin, R.K., 2013. Case Study Research Design and Methods, 5th Revise.

Yin, R.K., 2013. Validity and generalization in future case study evaluations. *Evaluation*, *19*(3), pp.321-332.

Zhu, H., Wang, Q., Yan, L. and Wu, G., 2009. Are consumers what they consume?-Linking lifestyle segmentation to product attributes: an exploratory study of the Chinese mobile phone market. *Journal of Marketing Management*, *25*(3-4), pp.295-314.