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THE STAKEHOLDER-PROFILE FRAMEWORK FOR TACIT KNOWLEDGE
ACQUISITION IN REQUIREMENTS ELICITATION INTERVIEWS

A Thesis Presented to

The Faculty of the Department of Software Engineering and Game Development

by

Rasha Eltigani

In Partial Fulfillment

of Requirements for the Degree

Master of Science in Software Engineering

Kennesaw State University

May 2022

THE STAKEHOLDER-PROFILE FRAMEWORK FOR TACIT KNOWLEDGE
ACQUISITION IN REQUIREMENTS ELICITATION INTERVIEWS

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THE STAKEHOLDER-PROFILE FRAMEWORK FOR TACIT KNOWLEDGE
ACQUISITION IN REQUIREMENTS ELICITATION INTERVIEWS

An Abstract of

A Thesis Presented to

The Faculty of the Department of Software Engineering and Game Development

by

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Bachelor of Science in Computer Science,
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In Partial Fulfillment

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Master of Science in Software Engineering

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May 2022

Abstract

The stakeholder's tacit knowledge is a key crown jewel of requirements elicitation, and in turn software development at large. This critical element holds significant leverage in determining the outcome and the quality of the requirements, and therefore the development endeavor holistically. Due to its very nature of being tacit, it is innately covert and deeply hidden within the stakeholders' minds, so it is extremely difficult to articulate and relay, as well as even harder to elicit and utilize. Additionally, the literature reports that there is a scarcity of available theorizations and solutions for addressing this challenge, posing a key and recurrent challenge in its successful attainment, functional utilization, theoretical understanding and synthesis, as well as successful harvesting. The thesis presents a theoretical knowledge management framework for tacit knowledge acquisition, the Stakeholder-Profile, in the spirit of contributing to the body of knowledge. The framework offers a theoretical vision of tacit knowledge acquisition of the stakeholders as individuals, and a conceptual vision of its application in the context of a specifically designed requirements elicitation interview process model. In view of this context, the framework offers a holistic conceptual solution vision, including an analysis of the mitigating factors for tacit knowledge acquisition in view of an interview, the theoretical makeup, synthesis, and acquisition of the stakeholder's tacit knowledge as individuals, an integration of the vision into an interview-specific process model, and an interview process outcome conceptual assessing quality metric.

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Master of Science in Software Engineering

Advisor: Dr. Nasrin Dehbozorgi

Kennesaw State University

May 2022

To God the Almighty all the Glory, Unparalleled Supremacy, Unwavering Goodness
Resolute, and Resolve Absolute and Ultimate, in all things matter and fact.

To my most beloved, exceptionally wonderful children, the light and purpose of my life,
to your long trail of endless, selfless sacrifice, for always believing in me, loving me
unconditionally, encouraging me relentlessly, supporting me fiercely in every way
possible, at every turn, through thick and thin. Without you, this work may have never
seen the light of day. We have all made it here together.

To my wonderful, beloved Mom and Dad, who dedicated their whole lives for us. Your
rock-solid generosity, love, support, and encouragement have always propelled me
assuredly forward.

To my beloved sister, brother-in-law, nephews, nieces, and many family and friends
everywhere.

To my many teachers and professors everywhere, who always believed in me, never
doubted me, supported me, gave me the room, and showed me the way.

Table of Contents

CHAPTER ONE – THEORETICAL BACKGROUND	5
Introduction	5
Chapter One Overview	7
Requirements Engineering Definition.....	7
Requirements Definition	8
Requirements Significance.....	9
Requirements Categories.....	11
Requirements Activities and Phases	12
Requirements Elicitation Definition.....	12
Requirements Elicitation Methods	13
Requirements Elicitation Interviews	14
Requirements Elicitation Challenges	15
Requirements Elicitation Interviews’ Challenges	18
Tacit Knowledge Significance	19
Knowledge Management (KM) Perspectives	21
Literature Review Analysis.....	24
Literature Critique	26
Conclusion.....	27
CHAPTER TWO – THE STAKEHOLDER-PROFILE THEORETICAL FRAMEWORK FOR TACIT KNOWLEDGE ACQUISITION IN REQUIREMENTS ELICITATION INTERVIEWS	29
Introduction	29
Literary Selected Views of Tacit Knowledge in Light of Knowledge Management (KM).....	30
Goals, Rationale, & Supporting Theories and Perspectives.....	33
Goals	33
Rationale	34
Supporting Theories and Perspectives.....	34
The Stakeholder-Profile Contributions	36
The Stakeholder-Profile Definition.....	37
Conceptual Solution Vision	38

Mitigating Factors	42
People	43
Communication	46
Knowledge.....	49
Tacit Knowledge Acquisition Theory	54
Overview	54
Tacit Knowledge Domain Theory	54
Theoretical Considerations	55
Domain Sets.....	57
The Conceptual Sliding Scale for Tacit Knowledge Acquisition	61
The Stakeholder-Profile Interview Process Model	62
The Theoretical Process Model Metric	67
The Stakeholder-Profile Framework Critique.....	69
Recommendations for Future Works	74
Conclusion.....	75
References	77

LIST OF FIGURES AND TABLES

Figure 1. Conceptual overview of the stakeholder's tacit knowledge within the grand scheme of software development.	24
Figure 2. Contributions of the Stakeholder-Profile framework for tacit knowledge acquisition in requirements elicitation interviews.	37
Figure 3. Illustration of the three key mitigating factors and their interactions in an interview scene.	51
Figure 4. Depiction of communication as a vehicle for facilitating knowledge transfer..	52
Figure 5. Depiction of knowledge conversion, key factors, and framework's solution vision in an interview scene.....	53
Figure 6. Breakdown of a person's capacities for tacit knowledge acquisition.....	58
Figure 7. Illustration of the conceptual sliding scale, a predictive analysis gauge for tacit knowledge concentrations, unique per stakeholder.	61
Figure 8. Illustration of the framework's interview process model.	65
Table 1. Abstract inner mechanisms of the interview process model.....	64
Table 2. Detailed outline of the activities, entry and exit criteria for the interview process model.	66

CHAPTER ONE – THEORETICAL BACKGROUND

Introduction

The stakeholder's tacit knowledge is one crown jewel of software requirements elicitation, as well as software development at large for that matter. This is because it is a key caveat for successful requirements elicitation, Requirements Engineering (RE), and in turn the entire Software Development Life Cycle (SDLC) at large. This is the case, as successful software project/product development is primarily dependent on the successful capturing and satisfaction of the stakeholder's needs, which in turn is premised on successfully harvesting and factoring in the stakeholders' tacit knowledge. This intricate notion is largely affirmed and echoed in the literature. However, the stakeholder's tacit knowledge does not exist or operate in vacuum. In fact, in peeling back the layers of where it conceptually stands, in relation to the surrounding concepts of requirements elicitation, RE, and SDLC consecutively, it is found to be right at the heart and center of all three activities. The stakeholder's tacit knowledge is intricately located at the heart of the already volatile and critical phase of RE. As such, it has enormous potential and leverage in failing the entire project/product development effort, if not addressed properly. Furthermore, it is so intimately laced within requirements engineering's how-to mechanism, requirements elicitation, and all its different levers. Positioned there, it faces an outstanding number of challenges and impediments. The notion that eliciting the stakeholder's tacit knowledge seems to be in the nucleus as a key, coveted goal, is echoed throughout the literature in various works.

The stakeholders' tacit knowledge is reported as one of the most significant elements that makes it all happen successfully or otherwise unsuccessfully, in reference to a successful requirements elicitation process and outcome, and project/product development at large. The related issues faced in addressing the stakeholder's tacit knowledge are mainly addressed under Knowledge Management—also known as KM—frameworks presented in various works, including Jiang-ping et al. (2009) and Basir & Salam (2015), among others.

However, there are still outstanding, unmitigated issues with respect to available, individualized theorizations of people's tacit knowledge as individuals, in lieu of the literature reviewed. The literature widely calls for solutions and innovation to address some of the key outstanding issues. This creates the necessity to address the existing gap by developing and contributing an appropriate solution.

To this end, this thesis presents a theoretical framework for tacit knowledge acquisition as an original contribution, focused on the stakeholder's individualized tacit knowledge, in the specific context of requirements elicitation interviews. The framework captures a holistic, methodical vision for tacit knowledge acquisition within a uniquely designed interview process model. The thesis offers two chapters in fulfillment of its intended goals. Chapter one will present the theoretical background necessary to illuminate the topic's background; examine the related overarching factors and underpinnings that influence tacit knowledge in the contextual, practical terms of the interview scene; and provide a literature review and analysis. Chapter two will detail the Stakeholder-Profile theoretical framework for tacit knowledge acquisition in requirements elicitation interviews.

Chapter One Overview

Chapter one presents a comprehensive theoretical background and the conceptual discussion necessary to adequately illuminate the context of the topic: the stakeholder's tacit knowledge in view of requirements elicitation. This background highlights its significance and the role it plays contextually within the grand scheme of software development, requirements engineering, requirements elicitation, and more pointedly, requirements elicitation interviews.

Requirements Engineering Definition

Requirements Engineering is the very first phase of the Software Development Life Cycle (SDLC).

Saiedian & Dale (1999, p.420) state that “the first step in any software developmental effort is to determine exactly what the software system shall do.” According to the authors, software requirements engineering is defined as the dedicated set of comprehensive activities of identifying, applying full-scope analysis for furtherance of the requirements, documenting as specification, and finally validating the documented requirements in reference to the real user's needs.

Furthermore, and as an integral part of this developmental synthesis, the authors explain that collectively, requirements elicitation is defined as the precise process where software requirements are exposed or unearthed, surfaced, determined, extracted, collected, and established.

Saiedian and Dale (1999) identify the key elements governing the quality of attributes and outcome of the elicitation process as the key players involved, namely the users and the developers. They explain that from the users' standpoint, quality elicitation equips them with the ability to better understand their boundaries and needs, such that they are more efficiently able to weigh their options and their respective consequences. From the developers' standpoint, quality elicitation affords a crystalline overview of the specification of the challenges at hand, from a high-level vantage point. It further emphasizes that the right challenges at hand are the actual ones being addressed and that the proposed solution/s is/are doable.

In summation, Saiedian and Dale (1999) cite that the most significant aspect of a quality elicitation process is one where the developer and the user have a mutual understanding and a shared perspective and vision of the challenge at hand.

Requirements Definition

The IEEE defines a requirement as follows:

(1) a condition or capability needed by a user to solve a problem or achieve an objective; (2) a condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document; (3) a documented representation of a condition or capability as in definition (1) or (2). (Jiang-ping et al., 2009, p.3)

According to Leffingwell and Widrig (2010, p.19), two key elements denote requirements, namely problem domain and stakeholders needs. The authors maintain that the "most successful requirements journey begins with a trip to the land of the problem.

This *problem domain* is the home of the real users and other stakeholders, people whose needs must be addressed in order for us to build the perfect system” (Leffingwell & Widrig, 2010, p.19).

Requirements Significance

Software projects, products, and systems development endeavors are primarily undertaken to address people and society’s needs, in order to offer solutions to outstanding challenges and problems within time, budget, and other specified constraints.

Basir & Salam (2015, abstract) confirm that “the most cited reason for software failure is the inability to fully capture and implement the exact user requirements in a timely, operationally and financially expected manner.”

Notably, Friedrich and Poll (2007) and Chikh (2011) denote that “project failure is mostly an outcome of the challenges associated with the clear articulation of user’s personal knowledge and expectation in the requirements specifications” (as cited in Basir & Salam, 2015, p.573). This clearly implies the personal, individual, tacit knowledge of people is a precursor for requirements elicitation and project success.

Leffingwell and Widrig (2010, p.5) similarly echo and assert this very position, stating that “the goal of software development is to develop quality software-on time and on budget-that meets customer real needs.”

Requirements is the very first phase of the Software Development Life Cycle (SDLC); this phase is dedicated to discovering and gathering the stakeholder’s needs. Consequently, it is the phase upon which the rest of the SDLC phases are dependent.

Therefore, requirements hold the highest volatility and most risk out of all of the SDLC phases.

Pfleeger (1998, p.135) asserts that “our understanding of system intent and function starts with an examination of requirements.” Requirements are simply major determinants of the success or failure of the entire developmental effort. If the stakeholder’s real needs are not accurately identified, captured, and reflected in the requirements phase, the erroneous outcome will then bleed into the rest of the SDLC phases. This in turn produces the wrong design and product specification, ultimately failing to meet the required stakeholder and societal needs, and consequently rendering the entire endeavor a failure. This failure also incurs a vast waste of invaluable human, capital, societal, and environmental resources.

Leffingwell and Widrig (2010, p.5) stress that “project success depends on effective requirements management. Requirements errors are the most common type of systems development error and the most costly to fix.”

Abbas et al. (2017, para.1) also contend that requirements are of huge, key value in any software development endeavor. So much so, that it is extremely hard in the end to attain user satisfaction if the requirements have not been properly validated in the initial phases.

Additionally, Weigers (2006) asserts that “if you don’t get the requirements right, it doesn’t matter how well you execute the rest of the project” (as cited in Abbas et al., 2017, para.2).

Friedrich and Poll (2007, abstract) warn that “building software from requirements that are incomplete and not fully understood” leads to “products that are either faulty or ultimately not being used at all.”

Similarly, Basir & Salam (2015, abstract) confirm that “the most cited reason for software failure is the inability to fully capture and implement the exact user requirements in a timely, operationally, and financially expected manner.”

Requirements Categories

Researchers in the literature categorize requirements into two main categories: explicit and implicit, or tacit.

Basir & Salam (2015, abstract) echo this dichotomy. According to the authors, explicit requirements denote clearly articulated, easily expressed, and well-established requirements, laying the bounds within which the system must function. However, implicit or tacit requirements are those covertly and deeply hidden, embedded requirements that must be captured properly to avoid major and consequential setbacks.

Jiang-ping et al. (2009, para.6) contend that explicit requirements are those precise requirements that can be easily and mutually relayed and understood by the stakeholders and the software developers. This is in terms of “speech, character, or multimedia.”

Tacit requirements depict the more elusive, difficult to articulate and relay requirements, and they are difficult to precisely target, surface, and elicit. This is because tacit requirements reside deeply within people’s (the stakeholders and developers) minds, and therefore are not readily reachable nor articulable.

Jiang-ping et al. (2009, para.7) highlight key attributes depicting tacit requirements. They explain that tacit requirements are difficult to articulate, put into code, relay, state, or convert in genre from tacit to explicit. Tacit requirements frequently relate to the “application domain” and are often the “user’s tacit knowledge” (Jiang-ping et al., 2009, para.7). They are experience-based requirements that are accrued incrementally and cumulatively over time by the development team.

Requirements Activities and Phases

The requirements phase includes several activities and processes and is denoted by two major transformative phases. According to Pfleeger (1998, p.136), these phases are requirements elicitation and analysis, and requirements definition and specification. The requirements elicitation and analysis phase involves problem analysis, problem description, prototyping, and testing transformatively, leading to the requirements definition and specification phase, where documentation and validation occurs.

Requirements Elicitation Definition

Requirements Elicitation is the very first stage of the requirements engineering phase. It is the stage dedicated to discovering and gathering the needs of people. The people referenced are referred to as users or stakeholders in this context, whose lives are going to be impacted by using the system/product being developed, either through direct use or through indirect societal impact.

According to Abbas et al. (2017, para.3), requirements elicitation is the phase dedicated to grasping the full range of existing issues with accuracy.

Sajjad and Hanif (2010) characterize requirements elicitation as the process where systems and users' requirements are filtered and specified, and the information regarding the proposed system's behavioral attributes, functionality, and boundaries is established (as cited in Basir & Salam, 2015, p.572).

Requirements Elicitation Methods

Requirements elicitation methods depict the how-to mechanisms and the various methods through which the function of requirements elicitation is to be carried out. According to Abbas et al. (2017, pp. 2-7), available elicitation methods include the following: Interviews, Observation, Card Sorting, Brainstorming, Prototyping, JAD [Joint Application Design], Mind Maps, Questionnaires, and Ethnography.

Sutcliffe and Sawyer (2013, abstract) report on emerging and more creatively oriented trends in requirements methodology and show that there are possibilities for providing advanced simulations with respect to areas of “domain knowledge modelling.”

The authors reference NL and IR—most likely referencing Natural Language and Information Retrieval respectively in this context—and text mining tools as all aiding in the disambiguation and categorical organization of requirements. The authors cite that these tools exhibit more development and progressive growth in comparison to model checking tools which exhibit more evolution and intricacy.

The authors additionally report a comparably novel area in requirements elicitation referred to as collaborative social support. This area, according to them, aides in the ranking, categorical sorting, and grouping of requirements collections for what is referenced as genres or “product line versions” (Sutcliffe & Sawyer, 2013, p.92).

Maiden and Rugg (1996) further highlight more specialized techniques rooted in knowledge engineering, such as “... (AHP) Analytic Hierarchy Process and laddering” (as cited in Sutcliffe & Sawyer 2013, p.92).

According to Knauss (2012), new surfacing trends are also emerging for requirements methodology via “social media and netography (Internet logging and requirements capture)” (as cited in Sutcliffe & Sawyer, 2013, p.92).

Requirements Elicitation Interviews

Leffingwell and Widrig (2010, p.101) define interviewing as “a simple and direct technique that can be used in most circumstances.”

Ferrari et al. (2016, p.2) illustrate that an interview usually “involves two roles: a customer and a requirements analyst.”

Abbas et al. (2017, para.5) state that “an interview is a verbal method for sharing ideas of different stakeholders. It is a face-to-face meeting between the client and expert who ask questions and discuss different solutions for that problem.”

Furthermore, Abbas et al. (2017, para. 6-8) define interviews in terms of three main categories: Unstructured, Semi-structured, and Structured interviews.

Unstructured interviews depict an informal setting where a free range of undetermined questions are asked. These settings exhibit inadequacies in the range of gathered knowledge. This is because while certain topics are comprehensively covered by questioning, others are left out.

Semi-structured interviews depict a proportionally flexible setting. An interviewer prepares a predetermined set of questions but accommodates additional spur-of-the-moment ones as they arise during the interview.

Finally, Structured interviews depict a stricter setting where requirements analysts prepare their questions ahead of time. Analysts must strictly adhere to gathering information solely from the prepared questions. The information gathered in this setting is further compiled in matrix form or other “visualization notations” (Abbas et al., 2017, para. 6-8).

Requirements Elicitation Challenges

This section presents an overview of the overarching issues and contributing factors to the challenges exhibited in requirements elicitation holistically, and the next section covers requirements elicitation interviews more pointedly.

Leffingwell and Widrig (2010, p.89) characterize requirements elicitation as plagued by what they call the “Three endemics; the ‘Yes, But’, the ‘Undiscovered Ruins’, and the ‘User and the Developer’ syndromes.”

According to the authors, the “Yes, But” syndrome is one rooted in the essence of human nature, as well as the lack of opportunity for the users to be able to interact with the software product in real time in the same capacity as a touchable solid device.

The authors liken the quest of capturing the requirements to that of the “Undiscovered Ruins,” eluding clearly to their tacit element as they do so. This notion depicts what

seems to be a bottomless phenomenon, where no matter how much you think you have gathered, much more still remains.

Finally, there is the “User and the Developer” syndrome. This syndrome depicts the extreme range of dissimilarities between the user and the developer, as a result rendering key communication challenges.

Abbas et al. (2017, abstract) reveal that efficient communication, especially with respect to tacit knowledge, poses a key challenge between analysts and users in elicitation settings.

Notably, Abbas et al. (2017, abstract) assert that tacit requirements are those that remain deeply hidden within experts’ minds such that they are not easily or readily expressible or articulated to others. This leads to ambiguities and misunderstandings that consequently result in system failures.

For clarity, the stakeholders are considered experts with knowledge in their own domains.

Additionally, Saiedian and Dale (1999, abstract) report that based on their experience, “many projects fail even before they reach the formal specification stage...because too often the developer does not truly understand or address the real requirements of the user and his environment.”

Moreover, dissymmetry in knowledge levels between stakeholders and developers is also cited as a major challenge faced in requirements elicitation, a strong sentiment echoed often in the literature. For instance, Jiang-ping et al. (2009, abstract) maintain that

“the bottleneck of requirement eliciting is the knowledge dissymmetry between clients and developers.” Furthermore, that the struggle to reconcile this knowledge dissymmetry and bridge its gap is ultimately “the driving force of software requirements elicitation and the foundation of their cooperation” (Jiang-ping et al., 2009, abstract).

Noteworthy to report, Sutcliffe and Sawyer (2013, para.1) reveal that although requirements elicitation is characterized in the literature as a “relatively mature area of RE,” requirements elicitation “still remains problematic; missing or mistaken requirements still delay projects and cause cost over-runs.” Additionally, “no firm definition has matured for requirements elicitation in comparison to other areas of RE” (Sutcliffe & Sawyer, 2013, para.1). Despite consensus on what it entails, “elicitation and requirements analysis share an ill-defined boundary, necessarily so since to gather information involves understanding it to determine its worth” (Sutcliffe & Sawyer, 2013, para.1).

Saiedian and Dale (1999, p.421-422) further highlight challenges affecting requirements elicitation, including “Poor communication” and “Resistance” to innovative ideas on the client’s part. This is an aspect that the requirements engineer must be critically able to “recognize and mitigate because it highlights issues to the customer that are not being addressed adequately.”

Furthermore, Saiedian & Dale (1999, p.421-422) highlight that there are “articulation/expertise problems” involving heavy use of technical jargon with which either the client or the developer is unfamiliar; the sophistication and “complexity of modern software systems;” and finally, “problem perspective differences.”

Requirements Elicitation Interviews' Challenges

People are complex beings, and Interviews are complicated by just this very personal trait and factor. Interviews are also the most people-centered elicitation setting. As Leffingwell and Widrig (2010, p.101) put it, it is the setting where people are “up close and personal,” with the analyst and the stakeholder face to face with one another. Consequently, the process is further compounded by the complexity aspect of people’s nature, as it often interferes with the proceedings and outcome of the elicitation process. Potentially, aspects such as personal biases, beliefs, predispositions, and idiosyncrasies can all interfere with and influence the quality and outcome of the elicitation process.

Leffingwell and Widrig (2010, p.101) reflect just this very notion and affirm that “... one of the key goals of interviewing is to make sure that the biases and predispositions of the interviewer do not interfere with a free exchange of information.”

The authors further explain that this is a particularly thorny issue to tackle, as according to the teachings and science of sociology, “it is extremely difficult to truly understand others because each of us is biased by our own conceptual filter, one that results from our own environment and cumulative experiences” (Leffingwell & Widrig, 2010, p.101).

Moreover, Ferrari et al. (2016, abstract) cite that ambiguity in oral communication poses a major challenge by impeding the effective knowledge exchange in requirements elicitation interviews, potentially leading to requirements that lack clarity or completeness.

Distanont et al. (2012) cite further contributing factors that may impact the quality of the elicitation process to include “the trustworthiness and motivation of the customer, to the absorptive capacity of the requirements analyst” (as cited in Ferrari et al., 2016, p.2).

Additionally, Abbas et al. (2017, para. 10-11) present a critique of issues faced in interviews. The authors explain that interviews have an extremely limited number of participants, as well as a prohibitive expense factor that further discourages additional interviewing. Interviews are time demanding and may require intermittent following-up for elucidation and validation purposes. The quality of the gathered information in interviews is contingent upon the professional expert level, efficiency, and experience of the interviewer.

Tacit Knowledge Significance

Considering the comprehensive theoretical discussion presented thus far on the contextual whereabouts of tacit knowledge per stakeholders in context of elicitation, and with respect to the conceptual, spatial relationship of requirements, requirements elicitation and requirements elicitation interviews, two main takeaways can be determined. Firstly, requirements are the most important and most volatile phase of the entire Software Development Life Cycle (SDLC) phases. This is primarily due to its determinant potential and ability to fail the entire project.

Secondly, the stakeholder’s/user’s tacit knowledge is one key goal to elicitation and project success. This element is highly impactful in the qualitative outcome of the requirements and consequently project development at large.

The stakeholder's tacit knowledge reflects and mirrors their real tacit needs and requirements. Jiang-ping et al. (2009, para.7) confirm that "tacit requirements are often user's tacit knowledge." As such, it is one of the most important goals in arriving at a successful elicitation and development outcome, irrespective of the elicitation method used.

This notion is especially critical in the context of requirements elicitation interviews, particularly as they are cited as the most effective and most widely used elicitation method. Interviews are also where the personal-people's element is most pronounced in comparison to other settings.

It is especially imperative that we arrive at the stakeholder/user's tacit knowledge to achieve successful elicitation and development outcomes, bearing in mind that arriving at what is tacit comes with its own slew of particular difficulties. This is due to the nature of what is tacit as being covert, deeply hidden within, difficult to articulate and express, and even harder to elicit, whereas what is explicit is easily and readily expressed, retrieved, and relayed, as has been established in our prior discussions on requirements categories.

Notably, the quality of the elicitation underway is dependent upon eliciting not just what is explicit, but more so importantly on what is tacit.

Basir & Salam (2015, p.573) stress that to ultimately satisfy the end user, and produce quality software, both the explicit and tacit components of requirements must be fully attained and upheld by the development team.

Knowledge Management (KM) Perspectives

This section offers a presentation of the conceptual definitions of knowledge and Knowledge Management, and an example of knowledge models. The discussion serves to illuminate and enlighten the upcoming contextual presentation of the literature review.

Markus (2001) divided knowledge into two distinct categories, namely explicit and tacit. Explicit knowledge can be readily codified with ease, as well as documented and catalogued in a formal way, whereas tacit knowledge resides deeply within the brains and minds of people with expert knowledge, such as the stakeholders. Such knowledge may remain covertly hidden and tucked within, until it is appropriately unearthed, surfaced and captured using the right method (as cited in Abbas et al., 2017, para.13).

Abbas et al. (2017, para.14) further note that reaching in to surface and utilize expertise-type knowledge, which is tacit knowledge held in expert people's brains and minds, poses a critical challenge for most organizations due to its very multiplexed nature.

According to Preece et al. (2001), the term Knowledge Management "in general is about the efforts that have to be applied to capture, store and deploy knowledge using IT to facilitate business process [*sic*] in the organization" (as cited in Basir & Salam, 2015, p.573).

Moreover, according to Ghani (2009), "the central idea of KM is that [*sic*] the work efforts to create, codify and share valuable knowledge to the organization" (as cited in Basir & Salam, 2015, p.573).

Furthermore, according to Alavi and Leidner (1999), Knowledge Management is classified as “a systemic and organizationally specified process for acquiring, organizing, and communicating both tacit and explicit knowledge of employees so that other employees may make use of it to be more effective and productive in their work” (as cited in Basir & Salam, 2015, p.573).

Sagsan (2006) and Sagsan and Zorlu (2010) assert that the primary goal of Knowledge Management is to “capture tacit knowledge which is considered as individual knowledge and convert it to explicit knowledge, in order to complete the rest of the stages of knowledge management” (as cited in Bashir et al., 2015, p.573).

Notably, Andrade et al. (2006) argue that the field of software engineering stands to benefit the most from Knowledge Management because it is centered on the use of knowledge intensive practices (as cited in Basir & Salam, 2015, p.573).

According to Basir and Salam (2015, p.573) and with respect to knowledge models, the literature reports that although several models for Knowledge Management exist, one particular model stands out for its accuracy and quality in achieving its intended goals and reliability of use over time. This top model is known as the Nonaka/Takeuchi or SECI Knowledge Management model, where SECI denotes socialization, externalization, combination, and internalization, respectively.

According to Grzybowska and Gajdzik (2013), the SECI model’s efficacy is precisely depicted in terms of the “representation of knowledge conversion in the process of introducing organizational changes” (as cited in Basir & Salam, 2015, p.573).

Nonaka (1998) denotes a key premise of the SECI model regarding knowledge flow. The author explains that experiential type knowledge held by expertise has the tendency to convert back and forth in a constant state of dynamic flow, from explicit to tacit, either consciously or unconsciously (as cited in Mohamed, 2010, para.5).

Furthermore, according to Mohamed (2010), the Nonaka/Takeuchi or SECI model depicts two key types of knowledge, namely explicit and tacit. The model further establishes four modes of dynamic knowledge conversion and flow among them to define and explain how knowledge is created, captured, stored, and reused, as follows:

Nonaka defined four modes of knowledge conversion, firstly, in the *socialisation* mode (tacit to tacit), knowledge workers acquire new knowledge directly from each other. Secondly, the *externalization* mode represents the articulation of tacit knowledge into tangible form. Thirdly, in the *combination* mode, different forms of explicit knowledge are combined to generate new factual knowledge. Finally, the *internalization* mode (Explicit to Tacit) comes as a result from the three previous modes. (para.5)

Figure 1 is introduced below to illustrate the contextual and spatial view of the stakeholder's tacit knowledge in relation to the grand scheme of software development, requirements engineering, and requirements elicitation, including elicitation interviews. The diagram aims to showcase the central role that the stakeholder's tacit knowledge leverages in all of these activities.



Figure 1. Conceptual overview of the stakeholder's tacit knowledge within the grand scheme of software development.

Literature Review Analysis

The literature surveyed in this thesis depicts a scarcity in the direct identification and availability of prescriptive, dedicated approaches for arriving at a stakeholder's tacit knowledge, in the context of requirements elicitation interviews.

Two main approaches, however, are identified as methods adopted by researchers in addressing the issue. These approaches are ambiguity in oral communication by Ferrari et al. (2016) and knowledge-based frameworks by Jiang-ping et al. (2009) and Basir and Salam (2015).

Firstly, Ferrari et al. (2016) utilize an oral communication approach versus a Knowledge Management approach centered on characterizing ambiguity. They argue that “ambiguity in communication is often perceived as a major obstacle for knowledge transfer, which could lead to unclear and incomplete requirements documents” (Ferrari et al., 2016, abstract). They introduce a framework for categorizing and quantifying ambiguity to arrive at tacit knowledge in elicitation interviews.

Secondly, there is a knowledge-based approach, which falls under the umbrella of Knowledge Management (KM). In this approach, Jiang-ping et al. (2009) and Basir and Salam (2015) used the SECI knowledge model to address the stakeholder’s tacit knowledge. However, they referenced the SECI model in light of different, nuanced processes and contexts.

Jiang-ping et al. (2009, para.6) used the Nonaka/Takeuchi (SECI) model in the context of what is known as requirements elicitation process (REP). REP is defined by the researchers as “a management process of users and stakeholders, in which knowledge can be divided into explicit knowledge and tacit knowledge.”

Basir & Salam (2015), on the other hand, used the SECI model in reference and context of tacit requirements elicitation. The researchers utilize their knowledge approaches in settings that are not necessarily labelled as interviews, although they do not exclude them either. Basir & Salam (2015) more precisely encourage a multi-elicitation approach.

Literature Critique

Ferrari et al. (2016) devised an ambiguity framework for tacit knowledge. This framework references the Gervasi Model and categorizes instances of ambiguity captured in oral communication in requirements elicitation interviews. The researchers stated they discovered ambiguity as a tool for unlocking tacit knowledge. They experimented with their framework in 34 interviews. Potential for wider-scale applicability and how far the framework taps into the tacit domain are thoughts that come to mind.

Jiang-ping et al. (2009) presented a knowledge conversion framework referencing the Nonaka/Takeuchi (SECI) model contextually with the application of Requirements Elicitation Processes (REPs). The framework observes REP as a people and knowledge intensive process, with a dilemma of deep knowledge dissymmetry between developers and clients at its center. It offers a knowledge conversion model, synthesized from studying characteristics of knowledge in REP, SECI model, dissymmetric knowledge flow theory, and knowledge communication. The framework prescribes stringent rules of engagement and communication to drive a successful elicitation outcome. The framework was tested by two case studies.

Some of the framework's rules seem subjective. For example, Jiang-Ping et al. (2009, para.17) cite that "...only most honest, trustworthy, knowledgeable people..." should participate. In this sense, questions arise with respect to the metrics that may govern the enforcement of these rules, in addition to how such metrics might be applied, as well as how any potential conflicts due to the seeming subjectivity of the rules might

be mitigated. It is also unclear if the framework is exclusive and/or specific for interviews. Finally, the potential for wider-scale applicability also comes to mind.

Basir & Salam (2015) devised a requirements elicitation framework for tacit knowledge in which they highlighted similarities in attributes across the processes of tacit requirements elicitation and tacit knowledge elicitation. The researchers compared the two processes contextually in the light of Knowledge Management (KM) and the Nonaka/Takeuchi (SECI) model. The researchers theorize that tacit knowledge extraction is possible where the two processes converge. The framework suggests usefulness in adopting a multitude of elicitation approaches. Therefore, it is difficult to discern its specific effectiveness and applicability in interviews. The inner workings and how-to mechanisms' areas of the framework exhibit some abstractions and seem more high-level along those areas. The framework is yet to be tested.

Conclusion

In summary, chapter one has presented the comprehensive theoretical background necessary to illuminate and enlighten the thesis' topic, the stakeholder's tacit knowledge in the context of requirements elicitation, with a focused interest in elicitation interviews. The topic has been studied in the grand scheme of software development.

In peeling back the layers of software development, requirements engineering, requirements elicitation, and requirements elicitation interviews, the stakeholder's tacit knowledge is found to be positioned right in the heart and center, at the core of all these phases and activities. Consequently, it leverages an instrumental, key role in the entirety of the process.

The topic's role and significance, in addition to the overarching factors and underpinnings, have also been examined. Finally, a literature review, analysis, and critique have also been presented.

Next, in chapter two, the thesis will present its original contribution and final deliverable: the Stakeholder-Profile theoretical framework for tacit knowledge acquisition in requirements elicitation interviews. The framework presents a holistic, methodical vision for tacit knowledge acquisition within a uniquely designed interview process model.

**CHAPTER TWO – THE STAKEHOLDER-PROFILE THEORETICAL
FRAMEWORK FOR TACIT KNOWLEDGE ACQUISITION IN
REQUIREMENTS ELICITATION INTERVIEWS**

Introduction

In view of the discussion presented in chapter one, two main takeaways can be established. One, the requirements phase is the most important phase of the Software Development Life Cycle (SDLC), and two, the stakeholders' tacit knowledge is one of the most important aspects and crown jewels of successful requirements elicitation, and in turn, software project/product development overall, irrespective of the elicitation method used. Despite the key role that the stakeholders' tacit knowledge plays in calibrating and harvesting successful requirements elicitation—and the overall successful project/product development—the literature is still open to decisively available, established, dedicated and effective methods or models that address this concern. The thesis contribution is to offer one such prescriptive method: the Stakeholder-Profile, a theoretical, knowledge management framework for tacit knowledge acquisition in requirements elicitation interviews. The framework is an original thesis contribution, presenting a holistic, methodical vision for tacit knowledge acquisition within a uniquely designed interview process model.

As a reminder, in chapter one we mentioned that tacit knowledge is an issue primarily covered under the umbrella of Knowledge Management (KM), and we presented just enough content to illuminate the literature analysis and review. Here in chapter two, we revive one of the key definitions that we presented for Knowledge Management in

chapter one, in addition to a number of selected views of tacit knowledge, to provide the adequate, in-depth context for the core content presented hereby in this chapter.

Literary Selected Views of Tacit Knowledge in Light of Knowledge Management

(KM)

Knowledge Management (KM) has garnered much attention in academia and business alike as a highly dynamic, interdisciplinary field that strives to create what is known as “knowledge models and group communication frameworks to manage knowledge creation and reuse” (Mohamed, 2010, para.3).

According to Preece et al. (2001), Knowledge Management “in general is about the efforts that have to be applied to capture, store and deploy knowledge using IT [Information Technology] to facilitate business process [*sic*] in the organization” (as cited in Basir & Salam, 2015, p.573).

According to Mohamed (2010, para.2), the notion of KM has also become incredibly important because knowledge is an asset that is extremely critical to the competitive edge, profitability, and sustenance of many organizations. These organizations principally relied on talent and expertise as assets and knowledge sources. These organizations, however, recognized that not all knowledge could be fully extracted, captured, stored, and reused, particularly tacit knowledge. The organizations realized that expertise really resides within people. Due to this fact, people holding the knowledge are mobile and free to disjoin these organizations or retire at will. This factor, therefore, poses a major threat to these organizations in terms of losing their competitive edge and business, should

people decide to leave, essentially taking the knowledge contained in their heads right along with them.

The term knowledge itself has sparked much debate in the literature on many levels; for instance, what constitutes knowledge versus information; how is knowledge classified; and what constitutes tacit knowledge (Hildreth & Kimble, 2002).

The literature at large has established that there are two types of knowledge: explicit and tacit. Primarily, explicit knowledge is defined as knowledge that is easily expressed, articulated, relayed, and codified. Such is the knowledge found in books, publications, and manuals. In contrast, tacit knowledge is proposed to be the knowledge deeply resident within people's awareness, brains, and experiences. Tacit knowledge is behaviorally-inspired, procedural type knowledge, which is covert and difficult to articulate, relay, and codify. Such definitions are reflected in the works of Jiang-ping et al. (2009), Abbas et al. (2017), Basir & Salam (2015), Mohamed (2010), and Hildreth & Kimble (2002), all citing the perspectives of Nonaka and others.

According to Blandford & Rugg (2002), tacit knowledge is "knowledge which is not accessible to introspection via any elicitation technique" (as cited in Friedrich & Van der Poll, 2007, para.1).

Hildreth and Kimble (2002) offer several unique perspectives on the concept of knowledge itself and how it is viewed across the literature. Despite their independent and unique perspectives, researchers concur on the fact that knowledge is either explicit or tacit, but where they differ is on how they envision the engagement between the two knowledge aspects. Furthermore, according to Hildreth and Kimble (2002), some KM

researchers view knowledge as a dichotomy, while others view it instead as a continuum existing across a spectrum. Yet, others, such as Nonaka, view knowledge as a complementary entity. The view of knowledge as a dichotomy mainly stems from the realization that not all knowledge can be captured or articulated, hence the existence of tacit knowledge and its distinct, covert nature.

Leonard and Sensiper (1998) adopt the view that knowledge is a continuum, with the bulk of knowledge falling somewhere along two extreme edges of a spectrum. On one extreme edge, knowledge is mostly explicit, clearly accessed, and stated, independent of the people that sourced it, and they further describe such knowledge as “objective, rational, and created in the ‘then and there’” (as cited in Hildreth & Kimble, 2002, para.11). On the other extreme, knowledge is mostly tacit, “semiconscious and unconscious knowledge held in people’s heads and bodies...subjective experiential and created in the ‘here and now’” (as cited in Hildreth & Kimble, 2002, para.11).

Polanyi views tacit knowledge as one of which there is an inner awareness but difficulty in articulation, mainly because it has become deeply hardened and entrenched within the subconscious mind. This type of knowledge, according to Polanyi (1967), “represents a level of understanding that cannot be externalized because it is inaccessible to consciousness: put simply we know more than we can tell” (as cited in Hildreth & Kimble, 2002, para.15).

On the other hand, Nonaka views the two types of knowledge, explicit and tacit, not as distinct aspects, but rather as reciprocal ones, engaging constantly with one another

within expressive contexts inspired by human interaction. Nonaka depicts this process as the “knowledge conversion process” (Hildreth & Kimble, 2002, para.17).

Nonaka (1991, p.98) offers an original depiction of tacit knowledge that is often referenced in the literature as follows:

...highly personal. It is hard to formalize and therefore difficult to communicate to others ...tacit knowledge is deeply rooted in action and in an individual's commitment to a specific context ...tacit knowledge consists partly of technical skills [and partly] of mental models, beliefs and perspectives so ingrained that we take them for granted and cannot easily articulate them. (as cited in Hildreth & Kimble, 2002, p.16)

Goals, Rationale, & Supporting Theories and Perspectives

Goals

The stakeholder's tacit knowledge is one key to successful requirements elicitation and in turn software development at large. However, tacit knowledge presents challenges, largely due to its elusive, covert nature rendering it difficult to articulate and relay, let alone to elicit. Because there are still outstanding issues related to the successful harvesting of tacit knowledge, there is a need to devise a solution that identifies and addresses some of the outstanding issues. Notably, the goal of the thesis is to present one such solution: the Stakeholder-Profile theoretical framework for tacit knowledge acquisition in requirements elicitation interviews.

Rationale

The rationale behind the creation of the Stakeholder-Profile considers a deliberate, active scrutiny of a requirements elicitation interview scene, with an eye out for the key players in the scene, their relationship dynamics, and the mitigating factors impacting the successful harvesting of the stakeholder's tacit knowledge.

From observation and scrutiny of the interview scene and analysis of different literary theories, including KM theories, set theory, and other conceptual perspectives, we contribute new knowledge in terms of a unique solution vision to address the stakeholder's tacit knowledge acquisition in requirements elicitation interviews.

Supporting Theories and Perspectives

The framework utilized the following theories and conceptual perspectives to support and synthesize its theory and vision. As we progress through the presentation of the framework's details, we will highlight how we apply the various theories and perspectives to each phase.

The Stakeholder-Profile adopted several conceptual considerations that were echoed by various works in the literature. For instance, the framework posits the notion that we should adopt a people first approach, which entails primarily observing a personable, getting to know you perspective, thereby encouraging a more active and positive cooperation between analysts and stakeholders. Such an atmosphere is key to successful requirements elicitation, and more broadly software development at large, as reflected in the work of Saiedian and Dale (1999).

Most notably, the framework adopts a Knowledge Management (KM) approach for tacit knowledge. This is a well-placed and appropriate approach, as the issue being addressed is a major component of knowledge. It is the tacit knowledge of people that is being addressed here. We rely on foundations of KM principles illustrated in the Nonaka/Takeuchi (SECI) model and the Polanyi theory of knowledge (Hildreth & Kimble, 2002). The emphasis and significance of knowledge management approaches for tacit knowledge is reflected in the works of Basir & Salam (2015) and Jiang-Ping et al. (2009), as covered in the discussions presented in chapter one.

Additionally, we draw from basic set theory and Clark's Common Ground Theory to motivate this framework. By starting the interview process with tacit knowledge probing questions—obtained directly from the domain analysis of the stakeholder's knowledge background—the framework strives to illuminate and streamline the mutual communication space between analyst and stakeholder. Thus, the framework aims to bring their visions closer together and strives to level their shared knowledge. By beginning the interviewing and elicitation process from a place of potentially relevant and shared knowledge, the framework also strives to elevate the quality of the exchanged content. This is explained in detail in the domain section of the framework. In turn, such a people-centric approach aims to bring the analyst and the stakeholder closer together, based on mutual communication, understanding, and objectives. This is an essential element highlighted in Clark's Common Ground Theory (CG), as presented in the work of Sutcliffe and Sawyer (2013), and will be covered in the upcoming discussions.

Ultimately, the framework's primary vision is to develop a creative, holistic theoretical vision of the stakeholder's tacit knowledge by treating them as individuals; to encourage the probing of the ever-so-problematic unknown domain; to go beyond the conventional boundaries of explicit knowledge; and to entertain a look beyond the surface and deeper over the horizon. All are notions echoed and encouraged in the work of Sutcliffe and Sawyer (2013).

The Stakeholder-Profile Contributions

We introduce the Stakeholder-Profile contributions. First, we provide the framework's definition and its conceptual solution vision. Second, we detail the key mitigating factors impeding the flow of tacit knowledge in a requirements elicitation interview. Third, we delve into the synthesis of the theory of the stakeholder's tacit knowledge acquisition; this includes the domain theory and the sliding scale theory, which segues into a specific application in the uniquely designed interview model. Fourth, we present the interview process model, highlighting its three key abstract entities: a questionnaire, a tacit knowledge probing question repository, and a requirements elicited repository. Fifth, we introduce the three-tiered quality metric, designed to assess the interview process outcome's efficacy with some initial parameters. Sixth and last, we provide a critique that identifies areas for further exploration and the practical limitations of our framework.

Figure 2 below captures an overview of the contributions of the Stakeholder-Profile for tacit knowledge acquisition in a nutshell.

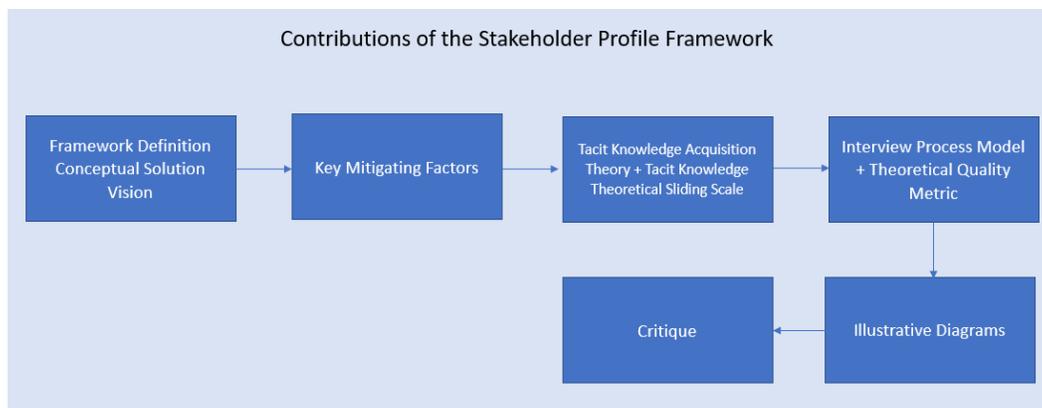


Figure 2. Contributions of the Stakeholder-Profile framework for tacit knowledge acquisition in requirements elicitation interviews.

The Stakeholder-Profile Definition

The Stakeholder-Profile framework is a new, methodical process for acquiring a stakeholder's tacit knowledge in requirements elicitation interviews. The framework is comprised of several stages that are designed to flow as a cohesive, unified approach; it may be viewed as a system, a solution model, or a blueprint with defined inner-workings, minus implementation-specific data and details. Such data are beyond the scope of this project. For consistency, we will refer to our approach as a framework. To arrive at this framework, we perform problem analysis, identify mitigating factors, derive a new theoretical solution, and design a conceptual implementation setting for applying our solution. We further critique our approach with a proposed, conceptual metric.

The purpose of the Stakeholder-Profile is to focus on the synthesis and accrual of a stakeholder's tacit knowledge, and to then identify tacit knowledge areas that could be probed to extract requirements in an elicitation interview. The framework strives to honor the notion that people play a key role in successful requirements elicitation and software

development by emphasizing a people-first approach. Requirements elicitation—and software development ideally for that matter—is an activity undertaken to address and cater to people’s needs, and it is people who articulate their awareness of these needs by communicating their respective knowledge. It is then true that people’s own knowledge, particularly tacit knowledge, must be accurately captured by requirements analysts during elicitation to facilitate a successful process and outcome. Depending on the elicitation quality and outcome, the entire project could be rendered a success or otherwise a failure, so the framework takes into account all of these aspects in its solution derivation.

Conceptual Solution Vision

The challenge of attaining the stakeholder’s tacit knowledge begins and ends with the stakeholders themselves, as people. Arriving at this framework stems from a vision that holds a few points. The first point is that in principle, people, knowledge, needs, and requirements are conceptually connected elements. The second point is that knowledge, needs, and requirements all emanate from people. Thus, the framework follows an approach centered on people. The third point is that people, knowledge, needs, and requirements all have tacit and explicit components.

The main observation to establish is that requirements are people’s real needs, which they communicate to requirements analysts during elicitation interviews to be addressed, satisfied, and met. Because there is a tacit component to people’s knowledge that cannot be easily articulated, relayed, and documented, and further because this tacit component is often needed, it then becomes especially important to capture it and to further do so accurately, to fully satisfy people’s requirements and needs.

This aspect of capturing the stakeholder's tacit knowledge in elicitation settings is particularly critical and evident. This is especially true in situations where the explicit—which is the more easily and readily expressed, understood, and documented aspect of knowledge—still does not suffice to either fully capture the full and necessary extent of the requirements, or to attain the required levels of quality and satisfaction. This assertion is fully discussed in chapter one per Basir & Salam (2015, p.573).

To this end, this notion clearly establishes that tacit knowledge has importance and volatility, as it is positioned to play a make-or-break role in the success or failure of requirements elicitation and software development at large, situationally. It then becomes highly appropriate, if not necessary, to invest in a dedicated solution approach to investigate and address its whereabouts.

In the light of this view, the thesis' visionary goal is to develop a theoretical solution model that observes and prioritizes the key element of *people* for their tacit knowledge as individuals, within the specific context of requirements elicitation interviews. The goal is to fully adopt an approach that clearly puts people first as the mechanism through which elicitation operates, in order to address people's own needs. From there, the goal is to design the solution model completely around this sole premise—that requirements originate from people—as a foundation. Based on the extensive discussions presented in chapter one, people are the ones who have the knowledge about their unmet needs and a vision on how their needs may be satisfied. It is requirements that have the obligation to satisfy and cater to people's needs, that is if they wish to be successful. This process being centered on people entails addressing the human component, in terms of

appreciating and accommodating the personal element of people and their situations. And finally, this process follows the understanding that the way to gather, extract, and address people's needs and requirements is to directly engage and solicit their knowledge in both of its aspects, explicit and tacit, situationally as needed.

We would like to emphasize that the following trio of elements—knowledge, needs, and requirements—all have explicit and the more critical and elusive tacit components to them. There are no outstanding issues with respect to what is explicit, which, as defined by the literature at-large, is that which is easily expressible, understandable, and codifiable. Therefore, special investment must be made in what is tacit, as tacit is defined by the literature at-large as that which is elusive, difficult to discern in articulation, and inherently resident within people's awareness, such as know-how, procedural and experiential type knowledge, and expertise. This notion is especially critical in requirements elicitation settings where both components qualitatively are needed to address and satisfy the full spectrum of people's needs holistically and accurately.

The thesis's vision manifested in the Stakeholder-Profile's framework, in a nutshell, is on an individual person's tacit knowledge, also known as a stakeholder in our software engineering field. The framework's vision is not one of an eclectic set of fragmented unrelated elements, but rather a conceptually-fluid, cohesive, visionary system, with elements that feed into and complement each other, working together in unison. The framework is centered around putting *people first*, front and center as individuals, together with their needs, getting to know them, and understanding the makeup and synthesis of their tacit knowledge as individuals. The framework also considers how

people acquire and accrue their knowledge over time, during the spans of their lives and through multiple venues. Furthermore, the framework strives to use this sole premise, meaning people's tacit knowledge, to develop a strategy for structuring the interview process in terms of derived interview questions, to further the elicitation process itself. Finally, the framework intends to conceptually measure the efficacy of this approach via a theoretical, three-tiered quality metric, in terms of three parameters: accuracy, relevancy, and completeness.

The framework observes that a person accrues knowledge in a continuum across different phases over the span of their lives. Furthermore, the framework regards a person's cumulative life knowledge to be contained in a cumulative life knowledge domain. This life knowledge domain is comprised of several distinct knowledge domains with varying degrees of overlap among them. Each of these identified knowledge domains consists of key areas of tacit knowledge which can be probed, thus establishing an initial pool of elicitation questions, themes, and categories. The initial yields from this probing process can be further utilized as benchmarks to initialize a repository of elicited tacit requirements, and these benchmarks can be directly traceable by referring to the stakeholder for validation and verification. From there on, a requirements elicitation repository can be built and updated in an iterative manner during the interviewing process, until the process achieves its intended goals and per the stakeholder's satisfaction.

The metric is utilized after the interviewing process is complete to the satisfaction of the stakeholder. The metric's idea is to comparatively relate and map tacit knowledge

probing questions to requirements they helped elicit. The metric would operate by considering the totality of the requirements elicited from the initial tacit knowledge probing question repository, built and updated across the lifetime of the interview iterations, and evaluate the yields in terms of accuracy, relevancy, and completeness. The metric and repositories are conceptual only and are therefore abstract from specific implementation details.

Based on accommodating a people-first approach, the framework strives to achieve some of the following objectives: foster a more personable and favorable relationship; build mutual trust and cooperation; reach a common vision; and further the requirements positively. By introducing the framework to the stakeholder and explaining to them the framework's vision—one that is holistically and wholeheartedly invested in an approach that has prioritized and accommodated them as individuals, with the purpose of learning about their unique tacit knowledge to craft the best possible requirements and build systems for them, so as to address their real, specific needs and earn their satisfaction—we may achieve more successful elicitation outcomes.

Mitigating Factors

The mitigating factors component of the framework is dedicated to the study and analysis of the interview scene, as well as the identification of the key players and the dynamic of knowledge flow among them.

The Stakeholder-Profile's vision and analysis of the interview scene is supported by the following theories and models:

The Nonaka/Takeuchi or SECI knowledge management model, as featured in Mohamed (2010, para.5)

Clark's Theory of Common Ground, as featured in Sutcliffe and Sawyer (2013, pp. 93-94)

The interview scene consists of two people, according to Ferrari et al. (2016, p.2), namely a stakeholder and a requirements analyst, as they are exchanging their knowledge via oral communication. Based on an active scrutiny of the interview scene, three key factors are identified as the mitigating factors impacting the successful flow and harvesting of tacit knowledge in a requirements elicitation interview. The trifecta consists of people, communication, and knowledge.

People

First and foremost in the trifecta is people. When we are building systems, products, projects, and services, we are doing so to observe and address people and society's needs. We must then place people at the heart and center of our development and elicitation agenda versus any other element. We must adopt an approach that is holistically accommodating to the totality of people's personal situations, including their different abilities, socio-cultural and economic specificities, and emotional and physical states of being. Sutcliffe and Sawyer (2013, p.100) urge that "the common ground quest is to be more sensitive to the stakeholder's setting, feelings, norms and culture." Additionally, Saiedian and Dale (1999, p.419) confirm that "the success of our products and systems are largely determined by our attention to the human dimensions of the requirements process."

To accurately understand and gather people's needs, we must invest in a dedicated approach centered on getting to know them so that we can access their relevant tacit knowledge, and in turn utilize this knowledge to adequately address and satisfy their needs. Therefore, we must know our audience.

The role of people in the context of requirements elicitation, regardless of the elicitation method used, cannot be overemphasized, as it is people, as individuals, and their tacit knowledge, that the literature deems key to successful requirements elicitation and software development endeavors at large. This thesis considers people and their tacit knowledge as the sole, prime concept around which the framework is holistically built.

People are unique, dynamic, and complex beings. People's uniqueness, complexities, knowledge, and idiosyncrasies are securely tucked and packaged within their very beings; they naturally carry it everywhere they go. This personal makeup is encountered in every interaction people have, and requirements elicitation interviews are certainly no different. Quite the contrary; in an elicitation interview setting, the personal element is even more pronounced. It is front and center, unavoidably present, and must be appreciated, understood, and well accommodated to establish a fruitful setting and a successful elicitation outcome. Such an outcome means attaining the already elusive and challenging, yet key and relevant, tacit knowledge. A key challenge in accommodating some of the personal elements arising from the complexities of our human nature is compounded by the fact that we ourselves are human beings, so we are biased in our stature by our visionary perspectives, socialization, cultural and belief systems and

specificities, economic situations, and all other unique factors that make us who we uniquely are in life.

Leffingwell and Widrig (2010, p.101) reflect this notion and contend that the science of “Sociology teaches us that it is *extremely difficult* to truly understand others because each of us is biased by our own conceptual filter, one that results from our environment and cumulative experiences.”

People’s tacit knowledge is the cumulative set of their experiential, procedural, and special niche, a know-how competitive edge that lands them special affordances in life. This tacit knowledge is an inseparable, inherent part of themselves and their awareness, so, together with the explicit knowledge, it forms an integral part of their cumulative knowledge and who they are as people.

This thesis presented selected views on tacit knowledge thus far. We will now contribute a unique illustration to depict tacit knowledge as a subset of a person’s cumulative knowledge in body and mind. This vision is rooted in the observation that our bodies have tacit knowledge, an inner know-how. For example, the beating of the heart, the blinking of the eye, and the aversion to danger via fight-or-flight mechanism all illustrate an inner know-how in the body—an analogous form of biological tacit knowledge. Similarly, we accumulate knowledge in our minds through various avenues of learning, exposure, experiences, and education. We also do not share everything we know; a part of what we know remains covertly hidden, safely tucked within our minds, such as skillsets. Famously, Polanyi (1967) said that “we know more than we can tell” (as cited in Hildreth & Kimble, 2002, para.15). This is independent of what is projected

explicitly outwards, in body and mind. This comparison serves to illustrate that tacit knowledge is a subset of our knowledge, in metaphorical body and mind.

This is in the sense that it represents the knowledge a person has, which is deeply within their awareness and mind, as driving and encompassing their intellectuality. People's tacit knowledge is analogous to uniquely wrapped treasure troves; no two are exactly alike. As such, it is critical to recognize that knowledge exists in people, not in non-living empty-skeleton entities, organizations, shells, or systems. Hildreth and Kimble (2002, abstract) support this assertion and state that a "method is needed which recognizes that knowledge resides in people; not in machines or documents." In this sense, the impediments encountered in the successful harvesting of people's tacit knowledge are largely due to the complexities exhibited in their human nature. Saiedian and Dale (1999, para.1) affirm that knowing your audience is key to successfully addressing their needs. They highlight that "designing from a deep knowledge of the customer...[is] central to any requirements definition process."

Communication

Second in the trifecta is communication, a complex element in its own right and whose complexities are further compounded in dialogue settings, such as requirements elicitation interviews. These complexities are injected by the human factor and displayed by the people taking part in the communication. Communication is a two-way street through which knowledge is relayed and the contextual, intended meanings behind the dialogue are expressed, all within the specific context and setting of a requirements elicitation interview. The aim is to facilitate the achievement of elicitation goals and

objectives. Communication is a function of knowledge. As such, communication is the key vehicle of knowledge transfer in requirements elicitation settings. In the precise requirements elicitation via interviews setting, the specific mechanism for knowledge transfer is oral communication. Effective communication, therefore, is an element critical to the collaborative progress of a setting, and it is as much an art as it is a science, with a multitude of layers, complexities, and goals all its own. And as such, the prime, critical value and importance of effective communication, particularly in high stakes settings like requirements elicitation, can neither be understated nor overlooked. Inefficient communication can be very costly and easily sabotage the elicitation effort. Saiedian and Dale (1999, para 1) assert this central role that communication plays in elicitation settings, arguing that although “we often focus on actions to take interviews, questionnaires, and observation...the success of all these activities ultimately depends on how well people communicate and work together.”

Tacit knowledge impediments encountered at the oral communication level include ambiguities, linguistic and cultural barriers, religious and belief system barriers, inconsistencies, redundancies, complexities, and abstractions. This articulation is reflected in Leffingwell and Widrig (2011, p. 92), who explain that “users and developers are typically from different worlds ... and have different backgrounds, motivations, and objectives.”

Noteworthy to highlight in support of the critical, primary role communication plays in requirements elicitation settings, and elicitation interviews no less, is Clark’s Theory of

Common Ground (CG), which illustrates many of the underlying contexts featured in Sutcliffe and Sawyer (2013, pp. 93-94).

A requirements elicitation interview can be viewed as a specific instance of a contextual communications event, with its own set of particularities: a setting, a communications space, and participants, namely a stakeholder and a requirements analyst.

The setting, space, and participants should work harmoniously and effectively towards achieving a unified, shared vision and common goals, which they reach through the vehicle of oral communication, as carried in conversations and dialogue.

Communication is also not uniform but is rather a complex element with layers of deeper meanings. These referenced meanings arise from social, cultural norms and interactions, as well as languages.

All these elements are illustrated and reflected in Clark's theory of Common Ground (CG). According to Sutcliffe and Sawyer (2013, pp. 93-94), CG theory illustrates conversations in the context of their setting, referring to a specific time and location, together with the respective knowledge that each of the participants possesses. Furthermore, according to CG theory, conversations carry an explicit and a tacit layer, where the tacit layer is attached to the deeper meanings and linguistic interpretations, metaphors, "puns, irony, jokes, and fiction" (Sutcliffe & Sawyer, 2013, p. 94). Finally, CG theory references the notion of the shared communications space as the "arena of shared knowledge about the culture, norms, history and assumptions, which allow dialogue between people to be interpreted in their context" (Sutcliffe & Sawyer, 2013, p.

94). Ideally, arriving at a unified vision in working towards harmonized, common goals, and illuminating the shared communications space in an elicitation interview becomes a key goal, thereby facilitating successful elicitation outcomes.

Knowledge

The third factor in the trifecta is knowledge. One of the main takeaways in the discussions established in chapter one is that the successful harvesting of the stakeholder's tacit knowledge is key to successful requirements elicitation and software development efforts at large. Tacit knowledge is a key crown jewel that is coveted in requirements elicitation, irrespective of the elicitation method used. Its importance can be qualitatively critical in situations where the explicit knowledge is not sufficient to either fully capture the requirements or bring about the necessary quality and fulfill the stakeholder's satisfaction.

The impediments that exist at this level—with respect to the successful harvesting of tacit knowledge—include failure to tap into the stakeholder's tacit knowledge domain. This could either be on the part of the requirements analyst failing to ask the correct, relevant, and complete set of questions that would elicit the corresponding set of correct, relevant, and complete knowledge, or on the part of the stakeholder in terms of tapping into and relaying such knowledge. Perhaps the stakeholder did not assess correctly that certain knowledge was necessary, so the knowledge remained unprobed and tacit. Additionally, and most notoriously, there is the problem of the unknowns, where there is not even the basic awareness at the elicitation time that certain knowledge exists, much

less that it would be necessary. For example, other domains might be needed to complete the requirements that neither party is aware of at the time.

The framework's derived analysis of the mitigating factors considers that in order to successfully harvest tacit knowledge for elicitation purposes, we must be able to identify and access, in the necessary range, the accurate and relevant type of the stakeholder's tacit knowledge. Furthermore, we must be able to successfully mitigate mishaps and impediments encountered at the oral communication level, such as ambiguities, complexities, inconsistencies, and abstractions, among other speech related infractions. Finally, we must accommodate and appreciate the totality of what comes with our humanity as people. This means embracing the personal element of the human factor and being able to successfully mitigate a wide range of biases, flaws, and complexities induced by the human factor and brought onto the interview scene inevitably by people. All of these highlighted issues depict highly complex elements, to which there are no easy fixes, and are intertwined across several disciplines.

The interview scene also exhibits knowledge exchange scenarios, with some degrees of overlap, to the four knowledge conversion scenarios depicted by the Nonaka or SECI model, and therefore a refresher of the model is provided below.

Mohamed (2010) elucidates this knowledge conversion process by Nonaka as follows:

Nonaka defined four modes of knowledge conversion, firstly, in the *socialisation* mode (tacit to tacit), knowledge workers acquire new knowledge directly from each other. Secondly, the *externalization* mode represents the articulation of tacit knowledge into tangible form. Thirdly, in the *combination* mode, different forms

of explicit knowledge are combined to generate new factual knowledge. Finally, the *internalization* mode (Explicit to Tacit) comes as a result of the three previous modes. (para.5)

Next, we introduce three diagrams to illustrate the content discussed so far.

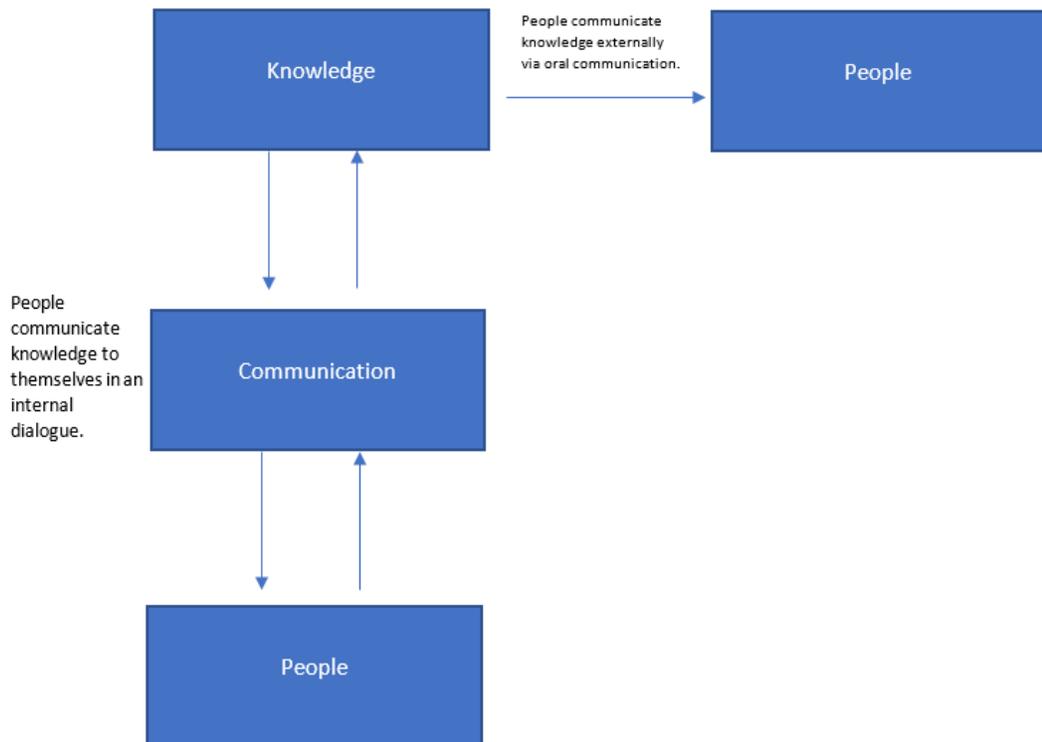


Figure 3. Illustration of the three key mitigating factors and their interactions in an interview scene.

Figure 3 illustrates the three key identified mitigating factors impacting the flow of tacit knowledge in an interview scene. The figure shows that people communicate their knowledge internally—meaning back to themselves as internal dialogue—and externally

to other people, by oral communication for the case of a requirements elicitation interview.

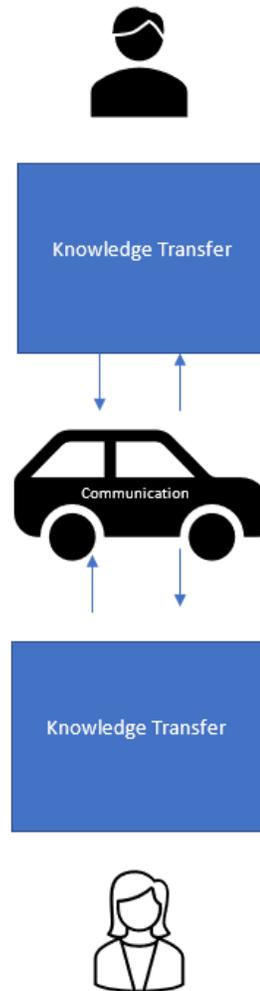


Figure 4. Depiction of communication as a vehicle for facilitating knowledge transfer.

Figure 4 illustrates that communication is a vehicle for knowledge transfer between people. In the case of requirements elicitation interviews, the vehicle of knowledge transfer is oral communication.

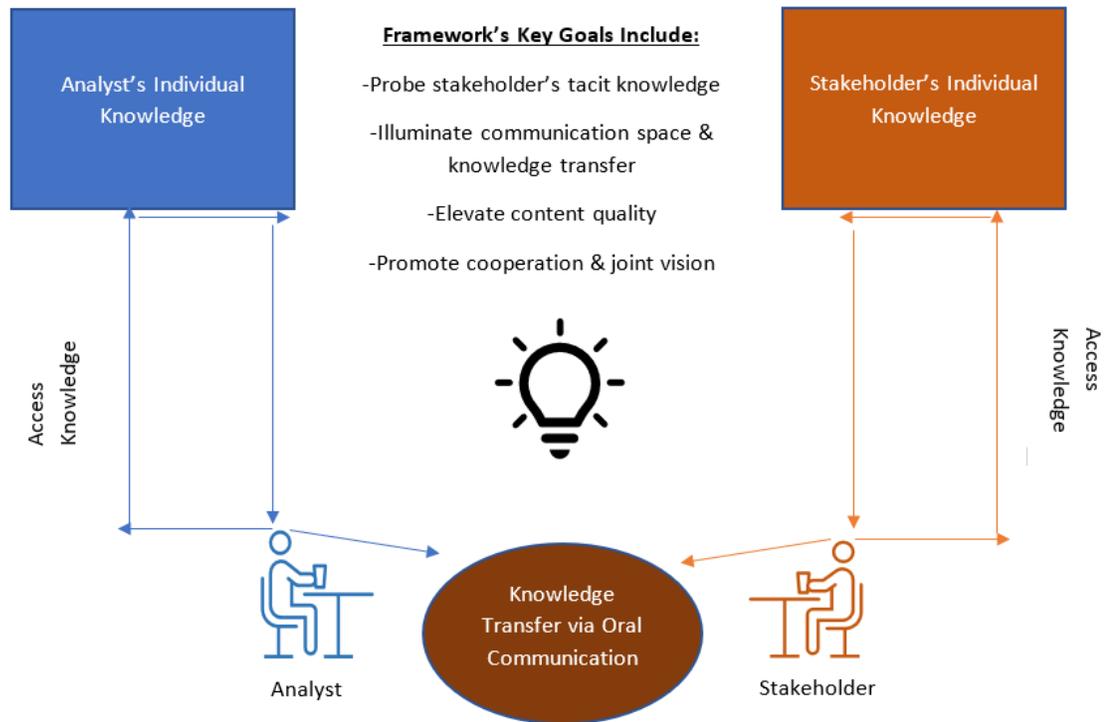


Figure 5. Depiction of knowledge conversion, key factors, and framework's solution vision in an interview scene.

Figure 5 exhibits the four levels of knowledge conversion depicted in the Nonaka/SECI model. In the scene, the interview is underway with the analyst and the stakeholder present. As the two interview parties encounter one another, they engage with each other on some personal level of socialization as people, therefore depicting the SECI's socialization phase. As the interview progresses, the analyst and the stakeholder are also engaged in several knowledge conversion scenarios. They are exchanging their knowledge externally, levelling up their shared knowledge, learning from one another combinedly updating their knowledge as they do so, and internalizing what they have come to learn as they go. In doing so, they are exhibiting the rest of the phases of the SECI model of externalization, combination, and internalization.

Tacit Knowledge Acquisition Theory

Overview

The theoretical domain component of the framework provides the rationale adopted for the synthesis of our view of a stakeholder's tacit knowledge. The domain element presents the conceptual approach adopted to dissect a stakeholder's individualized tacit knowledge, and to understand its makeup, synthesis, and cumulative accrual.

Additionally, this section presents illustrative examples of how the knowledge domains may intersect and overlap. These examples show knowledge background scenarios that a stakeholder may have.

Tacit Knowledge Domain Theory

Following our examination of the mitigating factors, we can now turn our attention to the stakeholder and the types of knowledge they may have as an individual person. We intend to theorize on the potential sources and makeup of this knowledge.

In analyzing the ways in which people accrue knowledge and learning, there are several possible sources. People can gain knowledge from learning, and this learning can come from a variety of settings. The genesis of this framework is to scrutinize knowledge sources in a person's life in terms of some categories. We want to answer a key question: how do people gain and acquire knowledge? This framework is interested in a deeper analysis of the composition and distribution of an individual's knowledge, as a greater understanding of the layout of an individual's tacit knowledge could make it easier to elicit necessary knowledge.

We identify three key areas over which a stakeholder may receive and accrue knowledge over the span of their life. These areas are the personal capacity for knowledge acquisition, educational capacity for knowledge acquisition, and professional capacity for knowledge acquisition. In the personal capacity, a person learns from informal school, societal interactions, or the home environment. The socialization mode of the SECI model supports this depiction. This capacity can include social media, friends, colleagues, media, and other informal settings. In the educational capacity, a person learns from formal schooling in its various forms, such as homeschooling, regular schooling, vocational training, military school, and other educational complexes. Finally, in the professional capacity, a person learns from workplace settings, such as jobs, internships, and training programs. For the educational and professional capacities, the externalization and combination modes of the SECI model support such depictions. The internalization mode of the SECI model is depicted in all capacities. We observe these knowledge sources as constituents of a person's cumulative life knowledge capacity. We can represent these knowledge capacities as sets of knowledge from the respective settings, and we argue that each item of a person's knowledge falls into at least one of these domains. The cumulative sum of these domains intends to capture the person's total life knowledge.

Next, this section provides the theories used to support the thesis' tacit knowledge domain theory.

Theoretical Considerations

1. Set theory, from Enderton (1977, pp. 1-3)

2. According to Michael Polanyi (1967), people “know more than we can tell” (as cited in Kimble & Hildreth, 2002, para.15). Therefore, there exists some tacit knowledge that is uncommunicated, which is the focus of the framework.
3. According to Michael Polanyi and Nonaka, knowledge is either explicit or tacit (Jiang-ping et al., 2009; Kimble & Hildreth, 2002; Basir & Salam, 2015).
4. The four modes of the SECI model—socialization, externalization, combination, and internalization—are depicted in the illustrated domains. Socialization lends depiction to the personal domain, while the externalization and combination modes lend depiction to sharing knowledge externally in different contexts. Internalization supports the presence of a tacit characteristic of knowledge.
5. Knowledge accrues cumulatively and in a continuum over the span of a person’s life, via several distinct domains. Leonard and Sensiper (1998) support the specific aspect of the depiction of knowledge as existing in a continuum (as cited in Kimble & Hildreth, 2002).
6. The different domains of knowledge in a person’s life overlap with varying degrees.
7. The conceptual sliding scale is a predictive analysis tool that operates in tandem with the domain theory.

The conceptual sliding scale mentioned in point 7 will be defined later in the discussion.

Consider a person’s Total Knowledge [TK] to be the sum of their explicit knowledge [E] and their tacit knowledge [T].

Further, let $TK = 1$ to demonstrate the totality of a person’s knowledge. Then,

$$(1) TK = E + T$$

Therefore,

$$(2) TK - E = T$$

The interpretation of this equation is to assert that we isolate and focus only on the tacit aspect of the total knowledge and not the explicit aspect.

Domain Sets

Next, we define the different domains in a person's life through which they accrue knowledge over their lifespan. We present set theory definitions to illustrate the context.

In general, a set can be considered "a collection of things (called its *members* or *elements*)" treated as a single object (Enderton, 1977, p.1). For sets A and B , there are different operations that can relate their elements. For instance, the union of sets A and B is "the set $A \cup B$ of all things that are members of A or B (or both)," while the intersection of sets A and B "is the set $A \cap B$ of all things that are members of both A and B " (Enderton, 1977, p.3). Finally, "a set A is said to be a *subset* of a set B iff all the members of A are also members of B " (Enderton, 1977, p.3).

Define set L to be the universal set of a person's cumulative life tacit knowledge. L is comprised of three subsets: a personal subset P ; an educational subset E ; and a professional subset R . The set P includes tacit knowledge obtained from informal social settings, such as a grandmother teaching her grandchild how to knit. The set E includes tacit knowledge obtained from formal educational settings, such as college, school, and vocational programs. The set R refers to tacit knowledge obtained from workplace

settings, such as jobs, internships, and workshops. Illustratively, the following relations exist:

$$(3) L = P + E + R$$

$$(4) L = P \cup E \cup R$$

Figure 6 displays the life set L as the union of P , E , and R . Within each set, there are some elements of tacit knowledge that are exclusive to that set, and there are some elements of tacit knowledge that are shared with the other sets, per our set definitions.

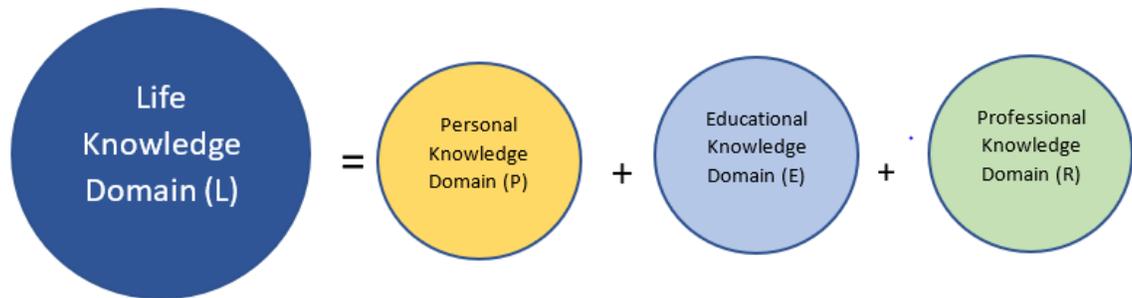


Figure 6. Breakdown of a person's capacities for tacit knowledge acquisition.

This domain theorization serves as a blueprint for the analyst to approach the process of sourcing a stakeholder's tacit knowledge. This domain theory section is a bridge that leads into the interview process model. Under the purview of this framework, central to the success of the elicitation process is the analyst's expertise in thoroughly mapping the stakeholder's tacit knowledge backgrounds onto the domains. Furthermore, the analyst will need to utilize the conceptual sliding scale, in tandem with the established domains, to reflect how the stakeholder's domains may overlap. In these areas of overlap, the analyst should aim to locate potential tacit knowledge concentrations. From here, the

analyst should intend to extrapolate plausible questions for probing relevant areas, per the stakeholder's needs.

There is some overlap in the tacit knowledge areas between the sets depending on the specificity of each person's life. The analyst seeks to elicit the tacit knowledge of the stakeholder, so the analyst needs to consider the different permutations of shared tacit knowledge.

The first case of overlap is between the personal and professional domains, excluding the educational. That is,

$$(5) P \cap R \cap \sim E$$

In this case, a person may have attained the tacit knowledge from a family-owned business and traditions, but not in formal education. One case is a family-owned jewelry store passed down across generations.

The second case of overlap is between the professional and educational domains, excluding the personal. Then,

$$(6) \sim P \cap R \cap E$$

For this case, a person obtained tacit knowledge from work or school, and this tacit knowledge is likely relevant to both domains. Many cases of professional occupancy fulfill this condition, such as medicine and engineering.

The third case of overlap is across the personal and educational domains, excluding the professional. Thus,

$$(7) P \cap \sim R \cap E$$

This case can involve hobbies and projects that motivate further studies. As an example, someone who learns painting at home and attends arts skill to hone their craft learned this tacit knowledge at home and school, but not in a professional setting.

The final case of overlap involves the personal, professional, and educational domains. So,

$$(8) P \cap R \cap E$$

An example for such a case is a chef who learned to cook at home, went to culinary school, and then became an executive chef.

The Conceptual Sliding Scale for Tacit Knowledge Acquisition

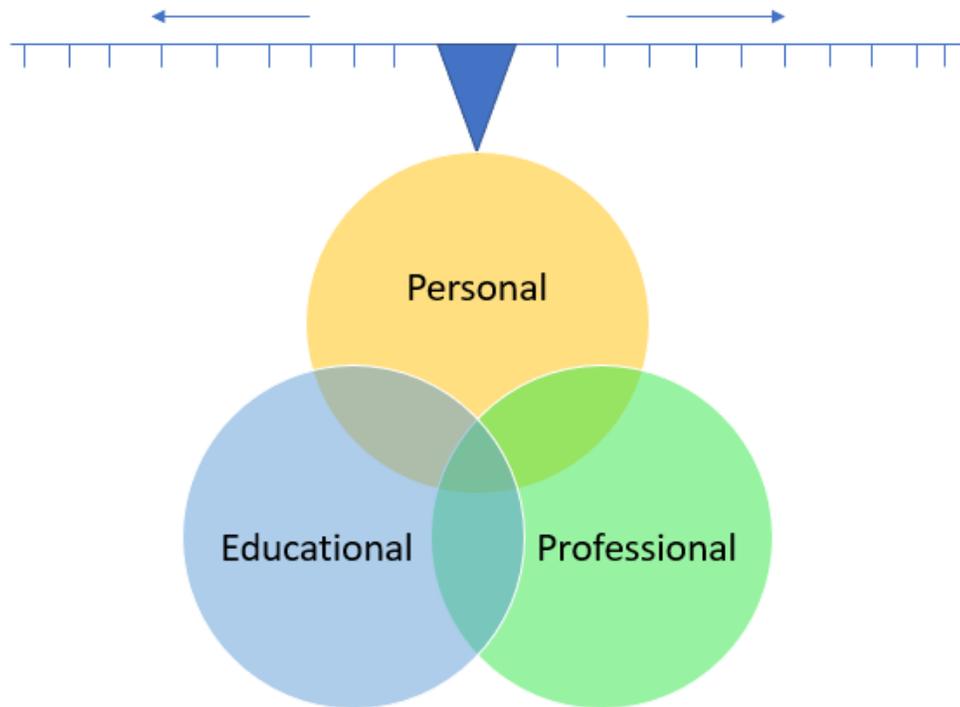


Figure 7. Illustration of the conceptual sliding scale, a predictive analysis gauge for tacit knowledge concentrations, unique per stakeholder.

The conceptual sliding scale is a predictive analysis tool. It features a sliding scale for tacit knowledge acquisition that points to potential areas where tacit knowledge concentrations may reside across several identified, accrued knowledge domains in a person's life.

The sliding scale can be thought of as a conceptual gauge, flexible and sliding like a pendulum across the three identified knowledge domains. Its primary function is to point to areas where concentrations of tacit knowledge may exist or may overlap with varying degrees. The sliding scale for tacit knowledge is unique per project and per stakeholder,

meaning it is applied to probe the tacit knowledge background for the specific stakeholder for their specific project and needs.

Prior to the requirements elicitation interview, before the analyst utilizes the interview process model of the framework (to be outlined next), the analyst should receive preliminary information about the stakeholder and the requirements project—for instance, in terms of a feasibility study of the stakeholder and their project needs. This preliminary information is abstract because it is implementation-specific, so it will not be named. The analyst will utilize the tacit knowledge acquisition theory to map the stakeholder's initial knowledge background into the corresponding key domains. This will require the analyst to carefully examine the stakeholder's background in order to extrapolate the locations of said knowledge. Afterwards, the analyst can leverage the conceptual sliding scale to gauge potential areas and scenarios of tacit knowledge overlap among the domains. This is done so that the analyst will extrapolate questions to populate the initial interview questionnaire. We emphasize that the questionnaire is an abstract entity because the specifics of its data are dependent on practical experimentation, meaning it is implementation specific. Once the analyst has established this criterion, they are ready to initiate the interview.

The Stakeholder-Profile Interview Process Model

The interview process model is designed to conceptually put the derived tacit knowledge acquisition into practice within the context of a specific requirements elicitation interview, albeit in theory. The Stakeholder-Profile integrates its solution vision with a distinctly developed interview model, with a specific pre-interview phase.

This phase is dedicated to kick-starting the tacit probing questionnaire and initializing a corresponding elicited requirements repository. This repository is to be updated iteratively, with subsequent feedbacks and interviews as needed, until the elicitation goals are fully met, per the stakeholder's satisfaction. Together with the distinctly developed pre-interview phase, the framework's process model accommodates a semi-structured interview setting, allowing for additional input from the stakeholder in an iterative manner. From here, the analyst can probe for more requirements elicitation and update the initial repository. The framework devised a theoretical quality metric designed to test the efficacy of the framework and does so in terms of three main attributes: accuracy, relevancy, and completeness. It works conceptually by assembling the tacit knowledge probing question repository and the corresponding requirements elicited repository to qualitatively map them directly onto one another, based on the three named attributes. The metric is used as a self-critiquing tool to gauge the framework's usefulness and efficacy.

The interview process model is comprised of three phases, namely a pre-interview phase, an interview phase, and a post interview phase. As this framework proposes, each interview phase consists of a prescribed set of entry and exit criteria, with a set of prescribed tasks and activities designed to lead into, seamlessly flow, and complement the next phase.

We notably highlight and introduce three abstract entities: a questionnaire; a tacit knowledge probing questions repository; and a requirements elicited repository. These three entities are integral to our framework because they are the specific inner

mechanisms that integrate and actualize the tacit knowledge acquisition theory into the interview process model. The analyst must implement and populate these tools as part of the interview preparation and procession. We emphasize that all three entities are implementation-specific, meaning that the data content that populates these entities depends on actual implementation details.

Table 1. Abstract inner mechanisms of the interview process model.

Questionnaire	Tacit Knowledge Probing Questions Repository	Requirements Elicited Repository
Uniquely populated by analyst upon stakeholder and project inception	Uniquely populated by analyst initially (pre-interview) and updated per interviewing	Uniquely populated and updated by analyst per interviewing

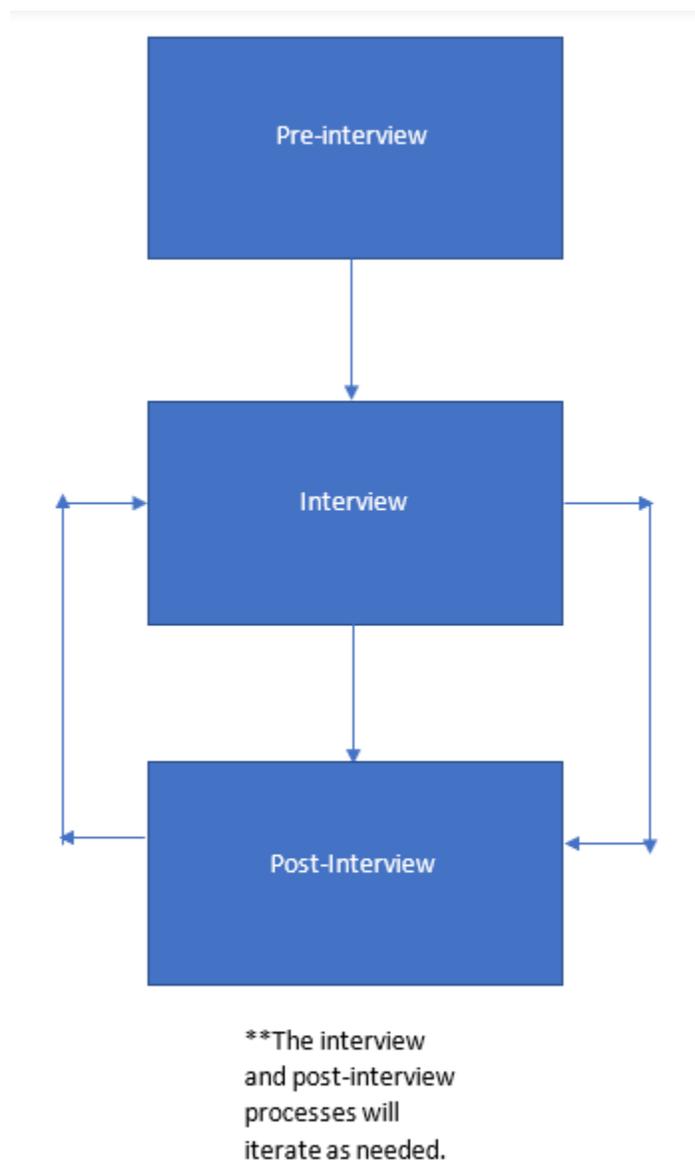


Figure 8. Illustration of the framework's interview process model.

Table 2. Detailed outline of the activities, entry and exit criteria for the interview process model.

Activities	Pre-Interview	Interview	Post-Interview
Entry Criteria	Study and analysis of a feasibility study or some baseline data of the project at hand and its preliminary whereabouts.	Exit criteria of the pre-interview phase.	A fully recorded interview session.
Step One	The tacit knowledge conceptual domain scale is initialized and set. This means the analyst is ready to receive the initial whereabouts of the stakeholder's background, together with their project information. This information is sometimes supplied as a feasibility study or other initial requirements entry criteria. This is an abstract entity. The analyst will then apply the tacit domain analysis and extract initial tacit knowledge probing questions for the interview.	The analyst schedules an interview with the stakeholder, and the interview is underway.	A thorough study and analysis of the recorded interview session is conducted.
Step Two	Preliminary baseline tacit knowledge probing questions are drawn from the identified tacit knowledge probing areas.	The analyst fully records the interview for post interview analysis and feedback.	The tacit knowledge questionnaire repository is updated upon discovery of added content that arose during the interview session on an as needed basis.
Step Three	An abstract tacit knowledge probing questions repository is initialized and set, meaning ready to store initially drawn questions. These questions will be updated as needed as the interview process evolves.	The analyst accommodates input from the stakeholder, in addition to the baseline of tacit questions populated in the questionnaire. In this sense, the interview model acts as a semi-structured model to aid in the facilitation and furtherance of the requirements elicitation process	The elicited requirements repository is updated with the relevant and corresponding content that arose during the interview.
Step Four	The interview questionnaire is introduced at this point. The questionnaire is populated from the initialized tacit knowledge questions baseline repository with preliminary	-	The analyst prepares a summary report with their findings and feedback. The analyst provides a

	probing questions, themes, and categories.		copy to the stakeholder for review and commentary.
Step Five	An abstract repository of requirements elicited is initialized and set. Meaning readied to store requirements elicited from initial tacit knowledge probing questions repository from step 2. The requirements repository will be updated as needed as the interview process evolves.	-	The analyst follows up with the stakeholder to address their feedback, at which point another interview may be scheduled.
Step Six	-	-	The analyst schedules re-interviews as needed based on the stakeholder's feedback and needs. In such scenarios, the interview and post-interview processes may iterate as needed and to the satisfaction of the stakeholder.
Exit Criteria	The completion of these activities marks the exit criteria of the pre-interview phase, and the entry criteria of the interview phase.	A fully recorded interview session. The fully recorded session also marks the entry criteria of the post-interview phase.	Satisfaction of the stakeholder with the elicitation process.

The Theoretical Process Model Metric

The theoretical metric for the interview process model is the component developed to contemplate a means of probing the quality of the framework. This metric would need to assess the framework's efficacy, serving as a self-critiquing entity in this sense. For the metric to achieve its objective, it would observe three key quality attributes as a point of reference: accuracy, relevancy, and completeness. Conceptually speaking, the metric

operates by bringing together the two repositories assembled along the interview's process model phases, namely the tacit knowledge probing questions repository and the requirements elicited repository, and applies a qualitative comparison referencing the three quality attributes.

It is important to highlight that the specifics of what tool or qualitative model the analyst shall use to carry out these measurements is beyond the scope of this thesis, and therefore will not be specified, as this is an abstract entity. The three attributes simply act as quality reference points to provide a benchmark for conceptual assessment. Their key objectives can be articulated as follows:

The ability of the analyst to be able to directly map elicited requirements to a tacit probing question or set of questions asked, that helped directly in its elicitation, points to the relevancy quality attribute.

The ability of the tacit probing questions to elicit the comprehensive and full range of needed requirements, points to the completeness quality attribute.

Finally, the ability of the tacit probing questions to elicit the precise and specific requirements meant and needed by the stakeholder, points to the accuracy quality attribute.

Notably, we would like to highlight that the metric is intended to showcase some initial parameters for assessing the quality of the elicitation outcome of the interview process model. In doing so, it inevitably also assesses the framework on some level, as the working parameters of the interview process model are derived from the domain theorization. However, we would like to emphasize that the evaluation does not solely

depend on these metric parameters. Other key factors may also weigh in. For example, the expertise of the analyst in mapping the stakeholder's background knowledge onto the respective domains can impact the results. Furthermore, the ability of the analyst to utilize the conceptual sliding scale with proficiency and accuracy, in terms of gauging the scenarios of overlap for probing tacit knowledge and extrapolating efficient sets of questions, can also affect the outcome of the elicitation process. Similarly, the readiness of the stakeholder in lending favorable cooperation with transferring knowledge to the analyst can affect the facilitation of the process as well.

There is also the problem of the unknown domains, where neither party may be aware that there is knowledge in a certain domain that may be relevant and necessary to the project. There may also arise issues in oral communication that impede consensus and common ground. This notion is in agreement with the framework's identification of mitigating factors: people, knowledge, and communication. Thus, the issue of tacit knowledge is a highly complex matter, further exacerbated by many or all of these factors and beyond.

The Stakeholder-Profile Framework Critique

The Stakeholder-Profile framework for tacit knowledge acquisition is not meant to perfect the art and science of how to conduct the ultimate requirements elicitation interview. It is rather focused on the narrow and specific element of tacit knowledge as key and critical, with significant qualitative value and leverage in the context of requirements elicitation activities, focused on interviews.

Several principal thoughts influenced the creation of this framework. These are also possible probing areas for future verification. In essence, this framework observes that knowledge is the basis of social progress, and further that knowledge is in people, deeply inherent in their conscious and subconscious awareness. It is people who associate meanings and interpretations to elements in the universe at large, thus creating their own view of the knowledge about them, and later disseminating this knowledge to others in society.

Additionally, requirements stem specifically from people; therefore, for as long as there shall be people, there shall also be requirements. Moreover, people are unique, and no two people are alike. Because requirements stem from people, they act as a people-specific attribute, inheriting their uniqueness aspect from their parent class—people (as in inheritance from object-oriented principles). Therefore, we can also infer that no two requirements elicitation projects are alike. Requirements are not a one size fits all phenomenon.

People and their unique needs must be placed strategically and squarely in the center of core engineering phenomenon, as these activities are principally endeavored for the betterment of people's lives and societies at large. Therefore, this framework adopts the notion of socialization of engineering and placing people first to promote the common good as core engineering design principles.

This thesis observed the totality of the factors discussed thus far. Additionally, upon analysis of the factors impacting the flow of tacit knowledge in the specific elicitation context of interviews, the thesis further observed that there is direct conceptual

connectedness between several elements. These elements are people, communication, knowledge, needs, and requirements. This framework supports the assertion that all elements have explicit and tacit components, and further that people are the central factor tying the rest of the elements together. Thus, this thesis sets out to design a solution model centered around this key premise. People know things. Some of the things people know are their own inner knowledge and awareness about their real needs, and how best these needs can be addressed and satisfied. Ultimately, these notions comprise the real requirements. A key issue surfaces in the absence of people's own abilities to communicate their real needs accurately, relevantly, and fully in the context of requirements. Therefore, investing in methods to help probe that tacit knowledge are all the more useful.

The Stakeholder-Profile is a theoretical framework for tacit knowledge acquisition, centered upon the unique synthesis of a stakeholder's tacit knowledge as an individualized person. The framework contributes to the body of the literature of knowledge by adding new knowledge, which is aimed at addressing a highly complex issue with noted scarcity of established solutions. Tacit knowledge is a key challenge, one which is often encountered in high-stakes elicitation contexts, with highly impactful outcomes. The framework absorbs the totality of the noted key and complex issues and strives to provide value and benefit in several areas.

First, the framework attempts to address the issue of tacit knowledge in the specific setting of requirements elicitation interviews. The framework strives to offer a

theoretically comprehensive and a conceptually fluid perspective of a stakeholder's tacit knowledge through the presentation of its different phases and inner workings.

Second, the stakeholder's tacit knowledge extracted from the domain theorization phase of the framework kickstarts the interview questioning, starting the interview from an enlightened, directly verifiable, and reliable source, the stakeholders themselves. This may have a desired benefit of improving the interview results, as starting from the stakeholders' relevant tacit knowledge background may help to elevate the quality of the exchanged interview content in terms of related themes and topics. Consequentially, this helps give rise to a methodical interview structure.

Third, the pre-interview phase of the process model is fully dedicated to analyzing and harvesting the stakeholder's tacit knowledge in the sense of "getting-to-know-you," as studying the stakeholder's knowledge to better understand their requirements and needs intends to serve several benefits. This approach strives to show the stakeholder that they are prioritized, as an entire model is built around them and their needs. This perspective strives to promote trust between the stakeholder and the analyst, to bolster cooperation, and to foster a positive working environment to propel successful requirements elicitation process and outcomes. This approach also hopes to accommodate the human factor that usually accompanies requirements elicitation interviews, such as nerves, apprehension, and anxieties by creating an air of familiarity between the analyst and the stakeholder, through the framework's "getting-to-know-you approach." The human element, unfortunately, is often overlooked, so the framework hopes to put it back in focus and appreciate its key role. Based on observation of human nature, people generally like to be

accommodated and prioritized on an individual basis. In light of this observation, the framework's vision appreciates the opportunity this people-based ethos confers, especially in high tension settings, such as requirements elicitation. Approaching people based on a process centered on studying their background, in order to cater to their specific needs, breeds familiarity. This can help in mitigating the above stated issues often encountered in such settings. It also hopes to relieve the immense pressure that a stakeholder might have from the belief that the burden falls squarely on them to come up with all the necessary information, in its full spectrum and quality, to drive successful elicitation. The framework's approach attempts to diffuse this pressure by emphasizing the critical role that the analyst must play on their end. This is in terms of conducting the deep analysis, study, and mapping of the stakeholder's tacit domain background into the tacit knowledge domain theory, deriving the questioning, and updating knowledge and requirements repositories, as well as sourcing the interview iterative feedback, to the satisfaction of the stakeholder. This approach strives to provide the stakeholder with, at least, the semblance that they are getting more value for their business. This is a significant point to consider in that regard, in terms of the stakeholders seeing, and hopefully appreciating, how the analyst is significantly contributing and going the extra mile to specifically cater to them and their specific needs throughout the process.

Finally, the approach strives to lend efficiency and a prescriptive, traceable method, clearly outlined to structure and conduct an elicitation interview, and centered on a key, critical concept that holds significant leverage: the tacit knowledge of the stakeholders themselves. The approach may also be adaptable because it is people-based and may therefore be adapted to work in other people-based elicitation settings.

The limitations of the framework are that it is an introductory-level framework and is strictly theoretical. The framework has not been evaluated or tested by practical experimentation, as this is beyond the scope of this project. The framework may be experimented with using case studies.

Recommendations for Future Works

Sutcliffe and Sawyer (2013) cite the emergence of people-based trends as influencers of requirements elicitation. Some examples include collaborative social efforts and social media trends. These trends are in line with the notion of the socialization of engineering that this thesis adopted in developing the Stakeholder-Profile framework.

A future-appropriate quest arises from observing people, communities, and populations with socio-cultural, economic, religious and belief system specificities, and begs the question of how to best engineer requirements for them. Could this quest inspire a stand-alone and emerging field? What would it entail? Such contexts may be immense treasure troves of tacit knowledge, within which it stands to hold even greater leverage.

With respect to the approach of harvesting tacit knowledge via addressing the mishaps of oral communication, it seems that the ailment is the cure itself. Meaning and akin to the ambiguity framework of Ferrari et al. (2016), an approach perhaps worth investing in would be to cast a wider net to categorize oral communication attributes and designate them as precursors to unlocking tacit knowledge. These might include, for example, complexities, redundancies, abstractions, incompleteness, and linguistic specificities.

Complexities, for example, can be categorized via a rigor-based metric system in terms of qualitative values, meaning semantic assignments, and quantitative values, meaning the cardinality of a spoken statement and the number of ways it can be parsed.

Conclusion

In conclusion, this thesis has attempted to address the highly complex issue of a stakeholder's tacit knowledge acquisition in the context of requirements elicitation interviews. The topic itself is multiplexed by many different factors. Many are rooted in its very own complex nature of being highly elusive, innately covert, and difficult to articulate, relay, and elicit. Other factors arise from the contextual and spatial position the topic has, being at the heart and center of highly complicated activities and phases exhibited in software development and requirements elicitation.

The thesis has presented two main chapters to address the issue of tacit knowledge. Chapter one presented a comprehensive theoretical background to provide context and illuminate the presentation of the topic and the literature. Chapter two presented an original contribution for the purpose of furthering the body of knowledge: the Stakeholder-Profile theoretical framework for tacit knowledge acquisition in requirements elicitation interviews. The framework attempted to provide a holistic solution vision, including an in-depth analysis of key outstanding issues, in addition to a novel tacit knowledge acquisition theory, and a prospective, uniquely designed model capturing its conceptual implementation. Furthermore, the framework provided a theoretical metric to help assess the efficacy of the outcome of the elicitation, based on

the domain theory and the interview process. We provided a critique to spark future experimentation and identified several areas for future works.

Most notably, the quest of developing creative and authentic tacit knowledge approaches from a KM perspective ought to be a highly desirable goal in its own right. If the powerful leverage tacit knowledge has can be fully and successfully accessed and operationalized, the benefits can be limitless, particularly in the context of requirements elicitation.

People's tacit knowledge is a treasure trove that safely nests their unique talents, skillsets, and needs. Probing these treasure troves inevitably births new and evolving arrays and spectrums of limitless knowledge for the benefit and betterment of mankind.

After all, people hold the key to their own unique knowledge, as it is deeply inherent to their conscious and subconscious beings. And so, deliberately investing in approaches to probe people's tacit knowledge, perhaps, holds a great many keys to radically transformative levels.

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