

**AN INTERACTIVE APPROACH TO ELICIT AND VERIFY
USER VALUES IN REQUIREMENTS ENGINEERING**

BY

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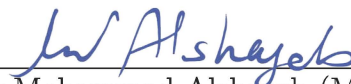
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This thesis, written by **RAWABI MUBARAK ALWADANI** under the direction of his thesis adviser and approved by his thesis committee, has been presented to and accepted by the Dean of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN COMPUTER SCIENCE**.

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I dedicate this thesis to my parents, my husband, and my little princess, Rafeef. I wouldn't make it without you being by my side. To my beloved four brothers and the purest love, my grandmother. To my grandfather, who is no longer here, no words can describe how I wish you were here to see me growing, succeeding, and shining. You will forever live in my heart.

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"Embrace the rhythm of the season," the title of the chapter for my masters journey. This chapter of my life was unique. Most of my life's changes, significant improvements, and maturation happened in it. And most of beautiful things happened in it. It was undoubtedly a challenging but unforgettable

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TABLE OF CONTENTS

ACKNOWLEDGMENTS	v
LIST OF TABLES	xi
LIST OF FIGURES	xii
ABSTRACT (ENGLISH)	xv
ABSTRACT (ARABIC)	xvii
CHAPTER 1 INTRODUCTION	1
1.1 Background	4
1.1.1 Human values definition and characteristics	4
1.1.2 Values definition in requirements engineering	5
1.2 Motives	7
1.3 Problem Statement	8
1.4 Thesis Objectives & Questions	9
1.5 Thesis Contributions	10
1.6 Methodology	10
1.7 Thesis Organization	12
CHAPTER 2 LITERATURE REVIEW	14
2.1 Introduction	14
2.1.1 Value Elicitation Techniques	14
2.2 Values Elicitation Analysis	17

2.2.1	Interactive elicitation technique	21
2.3	Gap Analysis	22

CHAPTER 3 VALUES ELICITATION AND VERIFICATION

	APPROACH	27
3.1	Introduction	27
3.2	Human Values Definition	27
3.3	The Proposed Interactive Approach	31
3.3.1	Pre-steps	32
3.3.2	Phase 1: Values Elicitation and Verification	33
3.3.3	Phase2 : Mapping Value to Requirements	35
3.4	Illustrative Example	36
3.5	Chapter Summary	47

CHAPTER 4 IMPLEMENTATION AND EVALUATION OF THE

	PROPOSED APPROACH	49
4.1	Approach Implementation	49
4.1.1	Overview of the Tool Design	50
4.1.2	Values Elicitation and Verification Phase	51
4.1.3	Requirements Identifications	54
4.2	Technical Implementation Overview	55
4.2.1	Handling Values Analysis	55
4.2.2	Tool Workflow	57
4.2.3	Interpretation of Results:	58
4.2.4	Additional Practitioner Tools:	59
4.2.5	Addressing Gaps and Challenges:	59
4.3	Validation of Value Probing Questions	59
4.3.1	Protocol	60
4.3.2	Participants	61
4.3.3	Data analysis	62
4.3.4	Results	63

4.3.5	Conclusion	69
4.4	Pilot study	70
4.5	Proposed Approach Evaluation	72
4.5.1	Participant	73
4.5.2	Procedures	74
4.5.3	Results	75
4.6	Applicability to Generalization	84
4.7	User Experience Evaluation	87
4.7.1	ValueBot User Experience	87
4.8	Chapter Summary	89
CHAPTER 5 DISCUSSION AND CONCLUSION		95
5.1	Discussion	95
5.2	Threats to Validity	98
5.2.1	Construct Validity:	99
5.2.2	Internal Validity:	100
5.2.3	External Validity:	101
5.2.4	Conclusion Validity:	101
5.3	Limitation	102
5.4	Research Questions Answers	103
5.5	Thesis Contributions:	107
5.6	Future Work	108
5.7	Conclusion	110
APPENDIX A SUPPLEMENTARY MATERIAL		112
A.1	Appendix: Interview Design to Understand Most Important Values of End-Users in the Health-Care Domain	112
A.2	Values Definition Attributes Identified from Existing RE Literature	113
A.3	Implementation Code Repository	113
A.4	Tool Testing Attachment Detailed Analysis of Tool Capability . .	113
A.5	Evaluation Design Materials	113

A.5.1	Feature chosen for evaluation	113
A.5.2	Experiment Running	113
A.6	Implementation Evaluation Result	114
REFERENCES		115
VITAE		124

LIST OF TABLES

Table 2.1	Other values emerged in the literature	24
Table 2.2	Value priorities vary across different app domains	25
Table 2.3	Human values elicitation approaches characteristic	26
Table 3.1	Values elicitation and verification approach	29
Table 3.2	Key findings and implications for designed approach	48
Table 4.1	Values categorizes of health care end-users Note:: * indicates this feature was not used by participants. The number beside the value indicates the number of values mentioned by different participants. . .	64
Table 4.2	Participants human values reporting in the health care app domain	68
Table 4.3	Pilot study elicitation results	71
Table 4.4	Values categorizes of health care end-users	76
Table 4.5	Values categorizes of health care end-users	78
Table 4.9	The complete view of LinkedIn App results	86
Table 4.6	User responses and labels for values not identified by the valueBot	91
Table 4.7	Value categories importance	92
Table 4.8	Values violation reporting across different features	93
Table 5.1	Sehhaty values comparison with elicited values across healthcare and well-being Apps	107

LIST OF FIGURES

Figure 1.1	Thesis methodology	11
Figure 3.1	The proposed interactive approach	30
Figure 3.2	Feature presentation	36
Figure 3.3	Step 1: liking identification	37
Figure 3.4	Step 1.1: key aspect identification	38
Figure 3.5	Values identification probing	39
Figure 3.6	Values verification phase	40
Figure 3.7	Values verification phase	41
Figure 3.8	Value-based requirement verification	42
Figure 3.9	Another aspect reporting process	43
Figure 3.10	Values identification	44
Figure 3.11	User selected not in the list	45
Figure 3.12	Ending conversation with the user	46
Figure 4.1	Perception reveals values violation	72
Figure 4.2	Participants key aspect descriptions	72
Figure 4.3	Number of elicited values based on different user probing questions for both educated and non-educated groups.	79
Figure 4.4	Proportion of elicited values across different probing questions for the educated group.	79
Figure 4.5	Proportion of elicited values across different probing questions for the non-educated group.	80
Figure 4.6	Values elicited distribution among app features	81

Figure 4.7	Reported value violations across application features	82
Figure 4.8	User stories generated by elicitationHub tool	83
Figure 4.9	The distribution of value categories identified by ValueBot	85
Figure 4.10	Evaluation result for the UEQ questionnaire	87
Figure 4.11	Analyst	89
Figure 4.12	Summary of values and importance per feature	90
Figure 5.1	Values elicitation from goal models [1]	105
Figure 5.2	Values categories distribution in the elderly assistance project [1]	106
Figure 5.3	Values categories distribution in Sehhaty App elicited using valueBot	106
Figure 5.4	A visualization between the values elicited using valueBot and the values obtained through a thorough analysis of emotional goal models [1]	106

LIST OF ABBREVIATIONS

NLU Natural Language Understanding

PVQ Portrait Value Questionnaire

RE Requirements Engineering

THESIS ABSTRACT

NAME:

TITLE OF STUDY:

MAJOR FIELD: DATE OF DEGREE:

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Nowadays, with the unlimited variety of software applications that serve the same purpose, it has become essential to go beyond and incorporate users emotions and values. In fact, human values play a crucial role in crafting user experiences, shaping their emotions, perceptions, and behaviors. Neglecting user values while designing applications may lead to an unacceptable application and dissatisfied users. This is a challenging issue that becomes more serious when building socio-technical systems, where there is a need to understand not only the technical but also the social requirements of users. This thesis proposes an interactive approach to elicit and verify values during the requirements engineering phase. This approach has two main phases, the values elicitation and values verification phase, and mapping Value to Requirements phase. This approach has been evaluated by designing a conversational agent named valueBot. Additionally, a tool named

elicitationHub was designed to integrate the *valueBot* and offer insights for analyzing results. The effectiveness and users experiences (UX) of the *valueBot* were assessed. An experiment between educated and non-educated end-user groups on human values was conducted. The results showed that *ValueBot* was more effective with the educated group in terms of the number of values identified. The (UX) evaluation indicates that the *valueBot* offers an interactive and enjoyable experience. Additionally, the UX results demonstrated that the *elicitationHub* will support the practitioners to incorporate values. Hence, the approach is effective in helping requirements practitioners to elicit and verify values. If a violation occurs, the approach provides a solution.

ملخص الرسالة

الاسم: عنوان الدراسة:

التخصص: تاريخ الدرجة العلمية:

في الوقت الحاضر، ومع التنوع غير المحدود لتطبيقات البرامج التي تخدم نفس الغرض، أصبح من الضروري تجاوز مشاعر وقيم المستخدمين ودمجها. في الواقع، تلعب القيم الإنسانية دورًا حاسمًا في صياغة تجارب المستخدم وتشكيل مشاعره وإدراكه وسلوكه. قد يؤدي إهمال قيم المستخدم أثناء تصميم التطبيقات إلى تطبيق غير مقبول ومستخدمين غير راضين. هذه قضية صعبة تصبح أكثر خطورة عند بناء أنظمة اجتماعية تقنية، حيث توجد حاجة لفهم ليس فقط المتطلبات التقنية ولكن أيضًا المتطلبات الاجتماعية للمستخدمين. تقترح هذه الأطروحة نهجًا تفاعليًا لاستنباط القيم والتحقق منها أثناء مرحلة هندسة المتطلبات. يحتوي هذا النهج على مرحلتين رئيسيتين، مرحلة استنباط القيم والتحقق من القيم، ومرحلة ربط القيمة بالمتطلبات. تم تقييم هذا النهج من خلال تصميم وكيل محاكاة يسمى valueBot. بالإضافة إلى ذلك، تم تصميم أداة تسمى elicitationHub لدمج valueBot وتقديم رؤى لتحليل النتائج. تم تقييم فعالية وتجارب المستخدمين (UX) لـ valueBot. تم إجراء تجربة بين مجموعات المستخدمين النهائيين المتعلمين وغير المتعلمين حول القيم الإنسانية. أظهرت النتائج أن ValueBot كان أكثر فعالية مع المجموعة المتعلمة من حيث عدد القيم التي تم تحديدها. يشير تقييم (UX) إلى أن valueBot يقدم تجربة تفاعلية وممتعة. بالإضافة إلى ذلك، أظهرت نتائج UX أن elicitationHub سيدعم الممارسين لدمج القيم. وبالتالي، فإن النهج فعال في مساعدة ممارسي المتطلبات على استنباط القيم والتحقق منها. في حالة حدوث انتهاك، يوفر النهج حلاً.

CHAPTER 1

INTRODUCTION

Software applications have become an integral part of human life. People interact with those applications daily to get access to essential services in many domains, such as healthcare, banking, and transportation. The failure or success of those applications depends on the extent to which user requirements, needs, and values are well addressed and incorporated into software design [2], [3].

Requirements engineering (RE) regroups mature practices for the elicitation, modeling, analysis, specification, validation, and management of requirements [4]. These RE practices are proven to be effective in estimating the satisfaction of users and stakeholders with potential design alternatives, which leads to an evidence-based and rational decision-making process. However, most RE practices focus on functional and non-functional requirements, such as security, performance, reliability, etc., with less consideration for human factors, such as values and emotions [5].

In software engineering, human values are defined as a set of life goals of civilized societies (e.g., accessibility, privacy, security, and social justice) or personal de-

sires of users (e.g., happiness, achievement, social recognition) that are reflected in or through software applications [6].

Although current software engineering approaches do not have clear methods to incorporate human values in system development [7]. There are some works that attempted to investigate the readiness and potential of software processes to incorporate human values [8] [9], and the potential for using combination and/or adaptation of existing techniques and software development methods in incorporating human values [6]. Researchers have made a significant effort in incorporating values by introducing approaches [5], [10], [11], [1], [12], [13], [14], [11], and techniques [15], [16], [17] for considering human values in requirements engineering. However, in practice, human values are not explicitly addressed in software engineering [18]. This is due to the challenges associated with incorporating or addressing human values in software design, such as the lack of guidelines and techniques, the difficulty of converting abstract concepts into actionable software tasks, the lack of quantitative metrics to measure values embedded in software applications, and the absence of approaches to trace the incorporation of values from the elicitation phase to the delivery of software products [5], [6], [19]. Additionally, dealing with values a matter of experience [18]. This is primarily due to the subjective nature of values, which hinders their ability to understand human values. In fact, RE-related activities is heavily reliant on the people involved in those activities, and their characteristics considerably affect that success [20].

Therefore, this thesis introduces an interactive approach for values elicitation and verification, developed based on a deep analysis of existing literature. The pro-

posed approach enhances the elicitation process by enabling analysts to elicit and understand values through active engagement with end-users. By implementing a conversational agent, adopted on a chatbot, referred to as valueBot to facilitates the elicitation and verification.

The approach to implementation was evaluated to assess its effectiveness in selecting human values. I also experimented with two groups, one with pre-education about human values and the other without education to investigate if pre-knowledge would impact the ValueBot performance. In fact, there were differences in the number of values the bot could identify. Educated groups were able to articulate their values using the same language the bot was designed with, which helped the bot to recognize their values. And another finding was that most of the identified values for the non-educated group were resulting from liking reasoning about the values. In fact, values education might enhance users ability to think beyond the app and try to resonate the app to their needs and motives. This was actually noticed by a participant who highlighted that the bot supported her to understand her values.

A detailed analysis of the elicited values was conducted alongside an evaluation of the user experience for both end-users and requirements engineering practitioners. The results were encouraging, demonstrating the effectiveness of the values elicitation approach and the conversational agent in delivering a positive user experience. Additionally, the study identified several limitations and opportunities for improvement, paving the way for future enhancements.

1.1 Background

This section provides an overview of the concept of human values in both social science and requirements engineering.

1.1.1 Human values definition and characteristics

Human values, such as privacy or hedonism, are ‘what people consider important in life and the guiding principles [21] that serve as the criteria that people use “to select and justify actions and evaluate people (including the self) and events” [22]. Rokeach [23] conceptualized values as abstract fundamental coordinators of behavior. Later, Schwartz [22] built upon Rokeach’s work and defines values as desirable, trans-situational goals that serve as guiding principles in people’s lives [22]. He introduced the theory of basic human values, which identified ten motivationally distinct categories of values.

Schwartz and Bilsky [22] emphasized that the primary content of a value is the type of goal or motivational concerns that they express. For example, the desired goal for self-independence is to have independent thought and action—choosing, creating, and exploring—whereas the values of stimulation are excitement, novelty, and challenge in life.

In fact, people’s understanding and instantiation of values can vary across individuals and contexts [24], [25]. In the social sciences, this is called value instantiation, which means a “mental representation of concrete examples that promote or threaten a value” [26]. The reason behind this is that values are subjective and

abstract concepts, which means they cannot be easily understood outside of their social and cultural context [27]. For instance, the value of equality may be interpreted differently in different societies. Some societies might consider equality as treating all children equally; others consider the issue of paying women and men the same salary, and others think about abolishing racism [28].

They further identified five key features of values: they are linked to affect (emotions); they transcend specific situations; they guide selection and evaluation of behavior; they are ordered by relative importance; and the relevant importance of multiple values guides people's actions [29]. This means the relative importance of each value may differ for each person [23].

According to author [30], high-priority values are chronic goals that influence individuals' behavior and decision-making processes. This implies that these values serve as guiding principles, shaping perceptions of situations and directing attention to relevant aspects based on their importance.

Understanding human values has a significant place in understanding and predicting the motivational bases of attitudes and behavior [31], [17]. That is, values influence how we feel towards specific objects or people, which in turn influences our actions [32].

1.1.2 Values definition in requirements engineering

In software engineering, human values are defined as a set of life goals of civilized societies (e.g., accessibility, privacy, security, and social justice) or the personal desires of users (e.g., happiness, achievement, and social recognition) that are re-

flected in or through software applications, representing the crucial characteristics of software that users deem important [6], [13].

Incorporating human values into software is not necessarily new. For a small subset of human values, such as privacy and security, we do find guidelines and tools used by the software industry. However, a large number of human values, such as pleasure, equality, sense of belonging, and self-recognition, are not addressed or understood by practitioners or the Software Engineering (SE) body of knowledge [10], [33].

In requirements engineering (RE), values capture the "why" behind requirements and thus provide one way of augmenting traditional requirements with rationale as to how the requirements relate to broader human values [8]. Understanding values helps requirements engineers interpret the concerns held by individuals and predict their actions and responses [18]. In fact, a threat or support to a value could respectively upset or excite users [16], [34].

In RE literature, there has been no attempt to provide a definition for values in the RE context. Based on the analysis of the literature covering values elicitation, it has been observed that Schwartz's basic human values framework [30] has been used for understanding and categorizing the elicited values. Authors in [16], [17], [35], [10], [8], [1], [33], [36], [5], [37], [38] use the theory of basic human values, while the refined theory of basic value was used in [13] [14].

Some studies were open to analyzing emerging new values [37], [38], [13]. Recent studies [12], [17] have not utilized a value classification framework as a list for elicitation. They highlighted a critical challenge faced in expressing values correctly

[12] [17].

1.2 Motives

Human values are at the core of crafting user experiences and play a crucial role in shaping users emotions, perceptions, and behaviors. For instance, Snapchat app has been successful in stimulating users, offering pleasurable experiences, catering to various values, fostering a sense of belonging, pleasure, and power, and promoting their freedom.

Neglecting user values while designing applications may lead to an unacceptable application and dissatisfied users [9], [39], [40]. An example, when Facebook modified WhatsApp's terms and conditions, compelling users to either provide Facebook with their personal data, such as phone number and behavior, or risk losing their WhatsApp account [5]. Violating trust and freedom led millions of WhatsApp users to migrate to alternative messaging apps, such as Telegram and Signal [5]. Even though it was successful because it was able to demonstrate the most important values users seek. In fact, values are often taken for granted, but when violating an important value, we will dissatisfy the users. Even as humans, we do have values, but sometimes we are unaware of them until a situation touches them, either satisfies or promotes them, or even hurts them. Depending on the importance of these values, the reflection will vary.

Identifying users' values and aligning applications with them remains a challenging

task. Due to the subjective nature of value and the need for end-user engagement. Traditional approaches, like interviews, may be effective in eliciting values, but they remain impractical due to their reliance on the analyst’s personality, motive, and knowledge, as well as the challenges associated with their design. Furthermore, they pose a challenge to user privacy. In contrast, when users actively engage in dynamic, interactive scenarios, ensuring their privacy and immersing them, they are more likely to effectively report and even identify their values. This presents the need for an interactive, user-friendly for eliciting and verifying values.

The driving force behind this thesis is to develop a solution that will effectively guide the requirements practitioner in eliciting user values, understanding the values, verifying these values, and ensuring they are not violated. If a violation occurs, it provides the analyst with solutions for satisfying the values.

1.3 Problem Statement

Examining the existing approaches and techniques for human values elicitation reveals main gaps that remain unaddressed: a lack of systematic methods and tools supporting the elicitation and verification activities, ignorance of the application’s context, a lack of end-user engagement in values elicitation sessions, and a lack of a values verification mechanism. These gaps create challenges that analysts encounter when eliciting human values from the end user. Practitioners also encounter difficulties understanding the values [18], [33]. Additionally, end

users themselves encounter challenges during value elicitation sessions, including privacy. Therefore, this thesis presents an empirically built approach to fulfill practitioners needs in eliciting and verifying values. The first one is the need for an effective approach that elicits human values. The second one is the need for a practical implementation that supports the analyst to understand users' values and what they mean in the given context.

1.4 Thesis Objectives & Questions

This study has two main objectives. The **first objective** propose a user-interactive approach that elicits and verifies the user values. The **second objective** evaluate the effectiveness and usefulness of the proposed approach in practice. This assesses how the proposed approach triggers users to prompt them to speak about values and then evaluates the implementation of the approach on a tool support. Hence, to achieve the above-mentioned objectives, this study aims to answer the following main research question: **RQ1: To what extent having a user interactive approach does support the elicitation and verification of user requirements that reflect human values?**

RQ2: To what extent the proposed approach is effective and useful in eliciting and integrating human values into user requirements in practice?

1.5 Thesis Contributions

This thesis has three contributions:

- Interactive approach to elicit and verify user values. This is the major contribution of this thesis.
- Empirical evaluation of the proposed approach.
- Implementation of the approach to elicit and verify user values. This is a tool designed to have a conversational agent, implemented on a chatbot (valueBot).

1.6 Methodology

This thesis has been conducted following six main phases, as shown in Figure 1.

Phase 1: Conducting a Literature Review: to investigate previous work in human values elicitation, specifically focusing on how the literature defines human values, what approaches or techniques have been proposed, and the limitations to identify potential gaps to fill. In addition, the challenges in applying these approaches to industries have been discovered in the literature analysis.

Phase 2: Defining human values in the requirements engineering: After reviewing the literature and analyzing how existing literature attempt to define human values. To identify values attribute and understand values implications, mainly in requirements engineering. In fact, this phase has paved the way for the next phase, which is designing the values elicitation approach, which directly

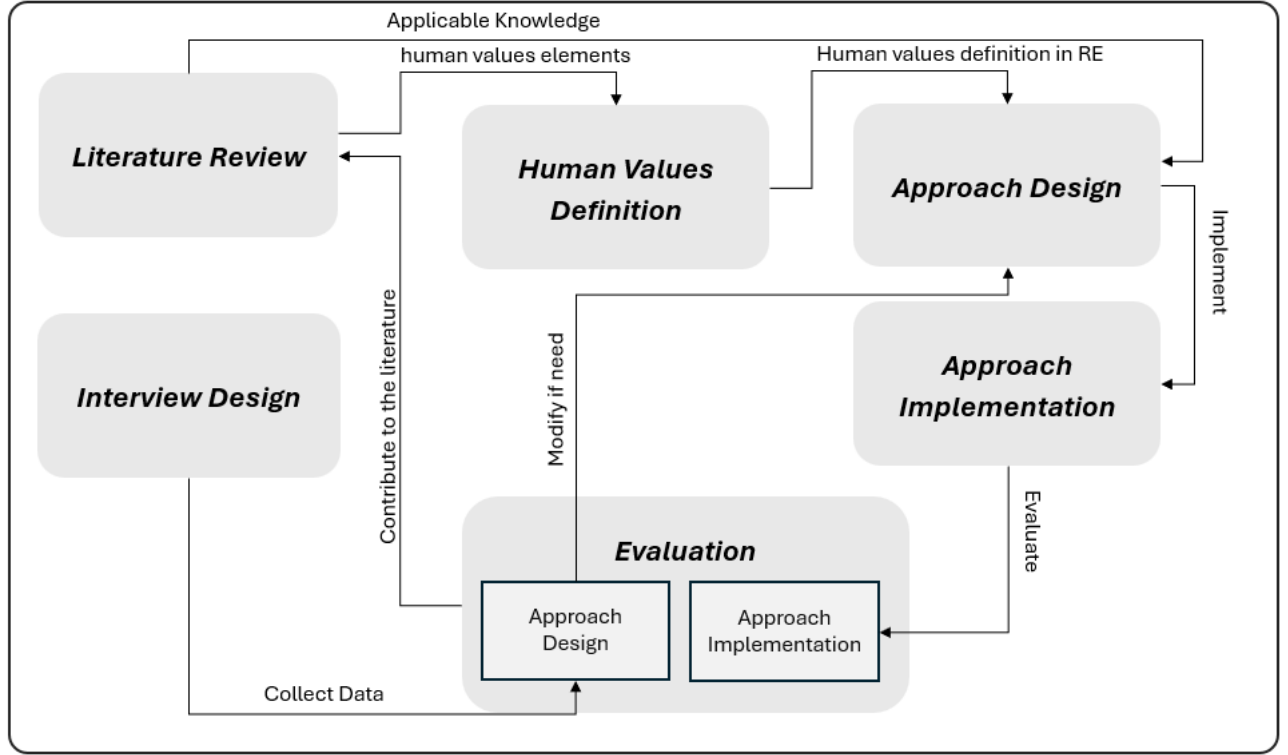


Figure 1.1: Thesis methodology

relies on end-user engagement in the elicitation process.

Phase 3: Designing the values elicitation and verification approach: In this phase, the approach to eliciting and verifying human values has been designed. In fact, the approach has been derived from the values definition, considering the main attributes of the value specified in the previous step. Also, it was designed based on the gaps/findings in literature. This study proposes an interactive approach that consists of tow main phases: elicitation and verification of human values, and mapping values to software features.

Phase 4: The approach implementation: the approach is implemented in an interactive conversational agent, tool support, for the goal of making the approach more practical for practitioners implementation, tackling a set of challenges fac-

ing both end-users, such as privacy concerns, and analysts, such as difficulty to understand values.

Phase5: Approach Evaluation The approach was evaluated from three angles: the first one is validation of the value probing questions that are proposed to elicit human values. The validation was done through conducting interviews with end-users. Then, the approach implantation was evaluated from two perspectives. The first perspective assesses the tool’s effectiveness in eliciting values by prompting end-users to speak about these values correctly, while the second focused on the usability of the tool. In the first section, we analyzed the results of the values elicitation process. Investigate whether the valueBot was able to identify the values of the users, non-educated and educated users about human values. The second step involves evaluating the user’s experience, with the aim of providing an approach that can be effectively implemented in practice. Both valueBot users, the expected end users of an app, and analyst perceptions towards the tool, in terms of how it will support the elicitation process.

1.7 Thesis Organization

The organization of the remaining content is as follows:

Chapter 2: presents a literature review analysis of the elicitation approaches for human values, including their limitations and their domains of application. Also, the main findings and conclusions are identified in this chapter. We also present the recommendations for designing an effective elicitation approach.

Chapter 3: introduces the proposed values definition and the designed approach. Additionally, a primary evaluation of values probing questions designed to trigger values description was discussed as well. At the end, we briefly discuss an illustrative example of the approach.

Chapter 4: presents the evaluation of the approach. This includes presenting the implementation of the approach on an interactive tool, as well as performing the actual application of the approach to elicit end-user values in the healthcare domain. Additionally, tool assessment in terms of effectiveness and user experience. **Chapter 5:** discusses the interesting insights that have been observed. The chapter identifies the limitations of the approach and discusses potential threats to the validity of this thesis, along with strategies to mitigate these threats. It provides answers to the research questions posed in Chapter 1, wraps up the thesis, and explores potential future endeavors concerning the elicitation of human values.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Examining the literature, we discovered that it has covered different domains, including (health care [15], health care and well-being (Healthcare [15], healthcare and well-being (elderly assistant) [1], well-being homeless assistant [5], voice recognition/assistant AI app [38], messaging app [13], futuristic product [37], agriculture [36], [17], [35]) to elicit values either using proactive approaches or reactive approaches. This chapter begins with a brief overview of the literature on values elicitation in requirements engineering, followed by findings, conclusions, and a gap analysis.

2.1.1 Value Elicitation Techniques

Shwartz [41] proposed a Portrait Values Questionnaire (PVQ), which consists of portraits that describe characteristics that reflect the importance of specific human values. It has been used in software engineering to elicit the values of an

end user, as shown in [36], [15]. Authors [36] argue that PVQ is easy to understand as it is less abstract, more concrete, more context-bound, and more suitable for less-educated people, whereas the authors in [15] conclude that when eliciting human values in specific domain contexts, there is a need to develop customized values instruments.

In a semi-structured interview, Winter et al. [14] adopted the PVQ and proposed a value measurement tool (Values Q-Sort) to elicit software engineer values by sorting a series of statements onto a grid according to their level of agreement with each statement. The approach comprises statements that adhere to the ACM Code of Ethics and are dual-coded according to the 19 Schwartz value types. In a semi-structured interview, participants are asked to sort a series of statements onto a grid according to their level of agreement with each statement, which then helps practitioners extract prototypes and capture qualitative data about participants' interpretations of statements.

In [35], Shams et al. used the Schwartz theory of the basic values model and manually analyze user reviews of Bangladeshi agriculture apps to explore the desired, present, and ignored/violated values of the users. Authors [13] carried out a case study to discover human values in issues collected from three different Android apps and provided contextualized software engineering descriptions for each value theme. Later, Shams et al. [38] have tailored an approach for identifying human values from a specific type of AI system. The authors analyzed Alexa users' reviews (AI systems) to identify relevant human values and assess the extent to which these values are addressed or ignored in the app. Obie et al. [16] employed

natural language processing techniques to analyze app reviews to detect perceived end-user human values violations. Although, now published content and empirical evaluation.

In 2021, Shams et al. [17] conducted a mixed-methods empirical study consisting of interviews with app practitioners and focus groups with Bangladeshi female farmers end users to explore expected values to be reflected in agriculture apps.

Perera et al. [10] demonstrated that using personas is effective in identifying stakeholder values. The study's interesting finding is that as they brainstorm with more detailed development levels, the number of values identified for all stakeholders increases. The study used goal modeling and feature modeling to consider human values in software engineering. The study is preliminary and should be evaluated in industrial settings, as suggested in the result, especially in the context where there is no end-user engagement in the value elicitation activity.

The usefulness of co-design activities in revealing perceptions and experiences was shown [5], [11]. The effectiveness of scenarios was shown by the generation of the value-laden software feature in a scenario-based thinking approach [5]. The study discovered that the scenario clearly outlined the objective, context of use, and key requirements, and all participants demonstrated the ability to identify values that aligned with the scenario.

Recent research has made notable advancements in eliciting human values. Iqbal et al. [1] were able to elicit human value according to the theory of human values by Schwartz from the motivational goal models. The authors concluded that emotional goals included in motivational goal models can be mapped to human

values, considering the context provided by the roles and functional goals. According to the study, familiarization with and knowledge of the Schwartz theory of human values are needed to perform this kind of mapping. The study [37] explored the use of ChatGPT for generating value user stories that describe candidate human values by prompting a series of questions. The study showed that the generated stories provide inspiration for stakeholder discussions as creativity triggers that help stakeholders specify human values for a product. Furthermore, authors [12] adapted the ACT (Acceptance and Commitment Therapy) Matrix as a method for eliciting human values-driven user requirements. Although a set of limitations was identified and practitioners highlighted, there are several areas for improvement.

2.2 Values Elicitation Analysis

The analyses of the identified values lead us to seven main findings.

Different proactive and reactive techniques were used

Moving forward with the elicitation techniques, we found that both reactive and proactive approaches were undertaken. In reactive approaches, the authors tend to analyze app reviews [38] [16] [35], issue discussion [13], and motivational goal models [1] to identify users values. The proactive approach involved conducting interviews with focused groups session [17], questionnaire [36] [15], scenario-based survey [34], brainstorming [10], Envisioning Cards [11] and q-sort [14]. Addition-

ally, the authors used ACT, a psychological tool [12], and chatGPT [37] to identify user values.

Table 2.3 presents a comparison between different elicitation instruments.

Human values are not easily interpreted in RE

In [33], authors interviewed software practitioners, and they found some values, such as independence, achievement, and capability, are not well understood by practitioners, while security and privacy are well understood. Authors [13] provided a categorization for values based on the elicited values, highlighting the potential for accessibility and usability to be more readily understood compared to universalism and benevolence in the RE domain.

Additionally, we performed analysis on the value elicited and found some studies identified values as emerging or other values when they used a value framework. This can be referenced to analyst understanding, as the authors[42] emphasize the difficulty software engineers face in articulating human values using language that is not as precise or articulate as the technical jargon they routinely employ. Additionally, the mapping to a value framework, for example, the Schwartz basic theory of values, requires extensive efforts. Authors [1] applied mock sessions with five analysts to bring everyone to the same level of interpretation and understanding of human values, and later, they discussed the results with the social scientist who is an expert in the Schwartz theory.

The reason behind that is the subjectivity and nature of values and the charac-

teristic of values as tacit knowledge can't be understood outside their context [7]. Below is the set of emerged values presented in the table.

In summary, while the Schwartz model of values proves to be suitable for understanding and categorizing the elicited values, its direct application by using, for example, PVQ in requirements engineering may not always be appropriate or practical. These findings align with the understanding that contextual definitions are essential for the applicability and comprehensibility of the Schwartz framework. Researchers advocate leveraging the Schwartz taxonomy to create value portraits that encapsulate the contextual meanings of values in RE [8].

Users' engagement in articulating values is crucial

Engaging users during elicitation sessions enhances their ability to articulate their values more effectively. For example, an analysis the values identified from app reviews in the agriculture apps [35], represent high-priority values, comparing to the values identified for the same domain and context using techniques such as focused group sessions and interviews, generate more values [17].

Furthermore, upon examining the analyzed violated apps as discussed in [16], it becomes evident that users possess the capability to articulate their motivational goals within the context of a particular application. Users declared it's challenging to know their values before using the app [17]. This claim supports the observation, emphasizing the importance of immersive experiences in comprehensively understanding user values.

Value priorities vary across different app domains

Values priorities differ according to the context, and the coverage of values in a given software has to be a contextual decision, where addressing more values does not necessarily mean better software [15]. As an illustration, the value of sense of belonging is predominantly within instant messaging applications, while stimulation or achievement is perceived as significant in gaming or educational applications [13]. Curiosity values are important in the context of AI assistants, as evidenced by user reviews such as, "I've asked difficult things, but every time she's fantastic at answering," and "I feel like my Alexa can't find most of my questions when I ask about something" [38].

Values are attributed to the functional goals and roles

Another observation that was also mentioned by authors [1] roles and functional goals also impact the presence of human values, which provide the context for emotional goals. Different values are identified for the same project, which can likely be attributed to different functional goals, roles, and emotional goals. For example, the human values identified for the roles of older adults and informal caregivers vary because they need to feel informed about different things [1].

Human values differ from the non-functional requirements

Human values play a significant role in shaping both functional and non-functional requirements (NFRs) in software development [18]. While some authors argue that human values and NFRs share similarities in addressing user and contributor con-

cerns [33], others highlight the distinct nature of human values, which encompass broader aspects beyond technical functionalities [8].

Recommendations for designing effective value elicitation techniques

The analysis of values elicitation approach derived as to set of recommendation when eliciting values, these recommendations are presented below:

- Develop a sense of empathy with users by adding new features to extract/elicit values [6], [17].
- Applying human-centered approaches to elicit values such as observations, asking non-scientific questions, employing a bottom-up approach, employing the design thinking method, and using A/B testing [6], [17].
- Taking feedback in person regularly [6], [17], [9].
- Do not require special expertise or skills beyond those that could be expected from a requirement analyst [18].
- Build on and/or integrate with existing, established methods and techniques [18].
- To be open-ended and context-sensitive [18].

2.2.1 Interactive elicitation technique

An exploration of recent interactive elicitation techniques in requirements engineering demonstrates the use of conversation agents in the elicitation process.

A recent 2023 thesis leveraged a chatbot prototype to generate UML diagrams [43]. Authors [44] introduced ReqBot, a chatbot elicitation assistant that prompts users to answer a set of questions, which then generate a requirement in the user story format. Authors [45] developed an Android chatbot application to support the requirements elicitation activity. The authors use the Nazief & Adriani stemming algorithm (commonly used for Indonesian) to pre-process user queries and artificial markup language (AIML) as the knowledge base to process the bot's responses.

IN 2019, authors [46] developed an AI conversational agent (CA) that mimics a human interview capability. It enables end users to articulate needs and requirements on the basis of the laddering method. They argue chatbots serve as a promising form of CAs for approaching a large number of users. Instant availability and platform independence enable barrier-free interaction with the system. [46].

Although it's known that eliciting and documenting chatbot requirements is challenging [47].

2.3 Gap Analysis

The current literature, as depicted in Table 2.3 highlights various human values elicitation approaches to overcome the challenges imposed by ignoring values during software development. Yet, these approaches were limited to value elicitation, and none attempted to consider verification with end users. Yet, none of

the studies attempt to provide a dedicated definition representing human values and their characteristics in requirements engineering. Most of them attempt to provide a reactive approach that doesn't engage the end user in the process, or they provide approaches that require extensive knowledge of values, which can be misinterpreted. This lack of tool support becomes a challenge that is declared by practitioners, which prevents them from incorporating the values [19].

As a result, this research aims to propose a comprehensive human values elicitation and verification approach that addresses the gaps identified in Table 2.3, including engaging end-users, incorporating formal methods and tool support, considering the application context, and mapping values to requirements while ensuring robust verification processes.

Value	[13]	[38]	[37]	[17]	Mapping
Trust	✓	✓			Authors [13] explained trust means, how application convinces users that it is harmless. they mapped it to conformity as it has similar objective of avoiding harm to others.
Accuracy		✓		✓	
Learning		✓	✓	✓	
Response Time		✓			
Usability	✓	✓			Study [5]: benevolence-helpful value, and to self-direction-curious depends on the context. Study [13]: benevolence-helpful.
Accessibility	✓	✓			Study [5]: benevolence-helpful, universalism-equality, self-direction-independent, Study [13]: universalism-equality and benevolence-helpful based on the themes they developed
Reliability	✓	✓			Study [13] we couldn't find any Schwartz values that suitable for reliable
Correctness	✓				Study [13] we couldn't find any Schwartz values that suitable for reliable
Compatibility	✓				Study [13] could be mapped it to power- resources.
Efficiency	✓				Study [13] could be mapped it to power- resources.
Energy preservation	✓				Study [13] could be mapped it to power- resources.
Longevity	✓				Study [13] mapped it security - personal security.
User-friendless		✓		✓	
Tidiness		✓		✓	
Simplicity		✓		✓	
Protectiveness				✓	
Entertainment				✓	
Safety				✓	
Diversity & inclusion				✓	
Access control				✓	
Consistency				✓	
Response time				✓	
Learning		✓	✓	✓	

Table 2.1: Other values emerged in the literature

Different app domains based on literature analysis of values elicitation			
Well-being(elderly as- sistant) [1]	voice tion/assistant AI [38]	Well- being(homeless) [5]	Messaging apps [13]
Security(Healthy, Sense of belonging)	access control	Benevolence	Security (sense of be- longing)
Self- direction(Independence, Self-respect, freedom, Choosing own goals)	Response-time	Self-direction	Self-direction(freedom, independence, Privacy)
Benevolence(true- friendship)	Enjoying life	Security	usability and efficiency.
Stimulation(Excitement in Life)			

Table 2.2: Value priorities vary across different app domains

Reference	Approach	Instrument	Mapping to re-quire-ments	Verification	Tool	End-user engage-ment	Values frame-work	Empirical Evalu-ation
Iqbal et al. [1]	reactive	goal models	✓	✗	✗	✗	✓	✓
McIntosh et al. [12]	reactive	ACT Matrix	✗	✗	✓	✓	✗	✓
Marczak-Czajka & Cleland-Huang [37]	-	chatGPT & focus group session	✗	✗	✗	✓	✓	✗
Shams et al. [38]	reactive	app reviews	✗	✗	✗	✗	✓	✓
Nurwid-yantoro et al. [13]	reactive	(issue tracker in GitHub) issue dis-cussions analysis	✗	✗	✗	✗	✓	✓
Obie et al. [16]	reactive	App reviews	✗	✗	✗	✗	✓	✓
Shams et al. [17]	proactive	Interviews and focus groups	✗	✗	✗	✓	✗	✓
Shams et al. [35]	reactive	App reviews	✗	✗	✗	✗	✓	✓
Perera et al. [5]	proactive	Scenario based sur-vey	✓	✗	✗	✗	✓	✓
Shams et al. [36], Obie et al. [15]	proactive	Questionnaire	✗	✗	✗	✓	✓	✓
Perera et al. [10]	proactive	Extended goal and feature modeling	✓	✗	✗	✗	✓	✗
Winter et al. [14]	proactive	Card sorting & semi-structured interview	✗	✗	✓	✗	✓	✗

Table 2.3: Human values elicitation approaches characteristic

CHAPTER 3

VALUES ELICITATION AND VERIFICATION APPROACH

3.1 Introduction

This section introduces the proposed values elicitation approach, grounded in a values definition developed from human values literature. The definition was validated through an interview study using tailored probing questions, as detailed in the Definition Validation section. Building on these findings, an approach was designed and is illustrated with an example in the following sections.

3.2 Human Values Definition

The analysis of values literature leads us to identify two main attributes for the value, which are motive [22] and importance [22]. Value items can be viewed as one's motivational goals [48]. and what differentiates one value from another is the

motive. Where in requirement engineering, values were considered the end-state users expected to be in the app, such as politeness or mode of conduct developed/improved in themselves after using the app [38]. Importance [22] extends to which a given value is desired by the user. In the requirements engineering, it has been evaluated by the frequency of mentioning certain values by the user [38], [16], [1].

To elicit a value, we need to consider both the context and the motive. The motive has been categorized in the Schwartz framework of basic human values [30]. While the context, it has been attributed by the functional goal and the role performing the goal [1]. In fact, the priority of values varies depending on the domain of the app [49]. This has been seen in the comparison provided in the literature review section 2.2. The satisfaction of values could be seen in users perceptions towards the application [13], [38], [35], [18], [16]. More specifically, the satisfaction of values has an implication on users liking towards the app.

A threat or support to a value could respectively upset or excite users [16], [34].

This thesis defines human values within the context of requirements engineering as *what is important for the user to perceive or the state of mode to be in when using the app or after using the app, which has an implication on user liking towards the app feature.*

Phase	Step	Input	Procedure	Output
Values Elicitation and Verification	Liking identification	Feature	Evaluate users liking of the feature.	Feature labeled with liking
	Values Probing Questions	Labeled feature with liking	Probing users with the values questions. Based on the provided values definition.	Feature labeled values
	Values Mapping Questions	User responses to probing questions	Mapping descriptions to values	Feature labeled values
	Values verification with end-user	Identified value	- User confirms matching. - If the value item was part of a value category, the user selects which statement best describes the user.	Feature tagged with verified values
Mapping Value to Requirements	Requirements identification	values and perception, key feature aspect	User will be instructed to describe their requirements and solutions that enhance their liking and generate positive attitudes toward the feature.	Value based requirement
	Values Requirement Verification	Requirement, reason, and verified values	The elicited requirements will be verified by the user and the mapped to values.	Automatically generated User stories

Table 3.1: Values elicitation and verification approach

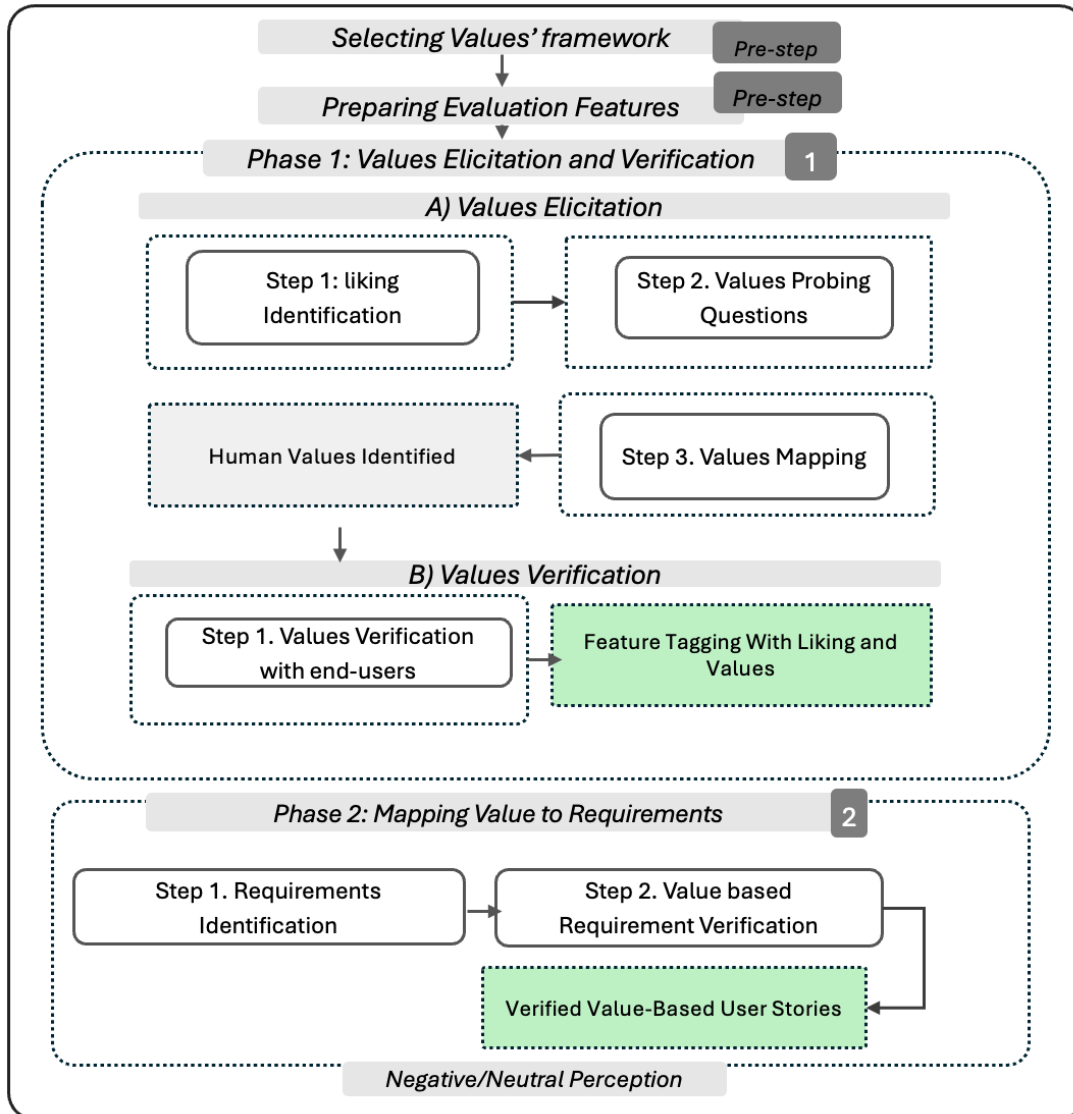


Figure 3.1: The proposed interactive approach

3.3 The Proposed Interactive Approach

This thesis designed an interactive approach to elicit and verify human values through interacting with users. In addition, it maps the elicited values to requirements/features resulting in a meaningful user story. The proposed approach consists of two main phases: values elicitation and verification, and mapping value to requirements. In the first phase, the user will be exposed to multiple features and through probing questions, user values will be elicited and verified. Then, in the second phase, the elected and verified values will be mapped to its corresponding solutions, requirements/features, proposed by the user to increase satisfaction. After the verification of elicited solution(s) with user, the approach converts the proposed solution and elicited values into a meaningful user story. To run the approach appropriately, the requirements engineer shall select the human values framework on which they will base the finding, and prepare the software features to be presented to the user as presented in Figure 3.1.

This approach could be used in the early stages of eliciting requirements, where system design features or similar existing systems exists. In addition, it could be used in user acceptance testing or in improving a software product after it has been released.

We expect that different levels of detail will lead to eliciting more accurate values as shown in the results of the study [10].

The rationale behind exploring value before tending to identify requirements is that users are encouraged to think more creatively and generate a broader range

of requirements that align with their needs [5]. This supports designing features that are meaningful, user-centered, and purpose-driven but also establishes a clear rationale for why each requirement or feature is necessary. Conversely, when users begin with requirements, they tend to propose functionalities that feel familiar rather than those that would enhance their experience. The following is a detailed explanation of each step of the proposed interactive approach.

This approach has been designed and inspired by findings of existing RE literature as presented in Table 3.2.

3.3.1 Pre-steps

Two key preparatory steps are essential to ensure smooth adaptation and effectiveness of the approach. these are:

1. Preparing features to be evaluated: Ensure that the features intended for evaluation are finalized and ready for review and introduce the features to users.
2. Select a human values framework for categorization and mapping: Ensure selecting an accurate and valid values framework to be used in the evaluation. In this thesis, Schwartz framework for human values was adopted [30]. The refined theory a new version of the framework was used [50].

3.3.2 Phase 1: Values Elicitation and Verification

A) Value elicitation

This phase aims to identify users' values by prompting them to describe their values by triggering them with the key aspects of the feature, reasoning about their liking, and then mapping the values description to a well-known human values framework. A bottom-up approach to elicit human values was adopted previously and proved to be significant [5], [35], [17]. This phase consists of three steps that are identification of what users like/dislike, eliciting values through probing questions, and mapping elicited values to the values identified in Schwartz's human values framework.

Liking Identification Step: This step evaluates users' liking towards the existing app features. This is because values satisfaction or violation has an impact on users' liking towards the feature [13], [35], [16]. Additionally, high-priority value satisfaction can be seen in users' attitudes [32] when making decisions choosing options, and the like/dislike attitude towards the options is based on values among other factors [50].

At the end of this step, features will be tagged with users' liking.

Values Probing Questions: following the liking findings, the probing questions are designed to trigger users to describe their human values, which in this context refer to values that the end users expect to develop/improve in themselves after using the app and values the end users expect the app to promote.

The questions start with identifying the key aspect of the feature that shaped the user's perception, followed by a reasoning process to understand the user's values. If values are not clear, the second probing questions will prompt them to explain what important for users when using the feature, mainly for the aspect selected. This process is iterative.

Values Mapping: In this step, users' value descriptions are mapped to a structured human values framework. The Schwartz refined theory of human values framework [50] was adopted in the study for both values categorization and verification. The purpose of the mapping is to align these values with predefined categories and to ensure consistency while providing a systematic basis for validating the insights and informing further analysis or design decisions. In some cases, user value descriptions are not mapped to a value category, and users will be required to label the values.

The outcome of this phase is a feature labeled with liking and values elicited. In the following phase, these values will be verified with the end user.

B) Values Verification

This phase is designed to ensure the validity and correctness of the mapped values within the selected human value framework. Users first will see the values identified and will be asked to confirm these are their values. Then, to ensure the correct mapping of the values, I used Schwartz portrait values questionnaire (PVQ)[50] that serves as the values measurement survey where each value has a

descriptive statement, capturing its core meaning. Users are presented with these statements and asked to evaluate their alignment with the statement. The output of this step is a feature tagged with verified values.

3.3.3 Phase2 : Mapping Value to Requirements

This phase is designed to elicit solutions, user requirements, when the perception of a feature is negative or neutral. Based on the literature, it is assumed that a negative liking indicates a violation of values and an indication of unmet user requirements [16]. Strong and negative perception is prioritized over negative or neutral perception. For the neutral perception, this thesis assumed that an existing value was not satisfied and that considering given user values would enhance their liking, while positive liking is an indication of value satisfaction [16]. Based on the liking, users will be instructed to describe their requirements and solutions that enhance their liking and generate positive attitudes toward the feature. Then, the elicited requirements will be verified by the user and the mapped to values. The outcome of this step is automatically generated User stories that captures the proposed new requirements and values. It has been chosen to align with the recommendations from the literature [11]. Users' answers to the prompts in the previous phase are presented in the user story in the following format: As a [role], I want... [requirement] so that [motive description] supports values: [the verified values]. Implementing these requirements is expected to enhance the end user's perception of the app's features, leading to a more positive user experience.

3.4 Illustrative Example

This section is intended to illustrate how the proposed approach engages end users in identifying important human values and value-based requirements. A conversational agent, named "ValueBot," a chatbot, was designed to implement this approach, which will illustrate the process. The illustration will be conducted on the Share Medical File feature in the Sehhaty app. This feature allows the end user to share the medical file using Bluetooth or scanning the QR code. See figure 3.2.

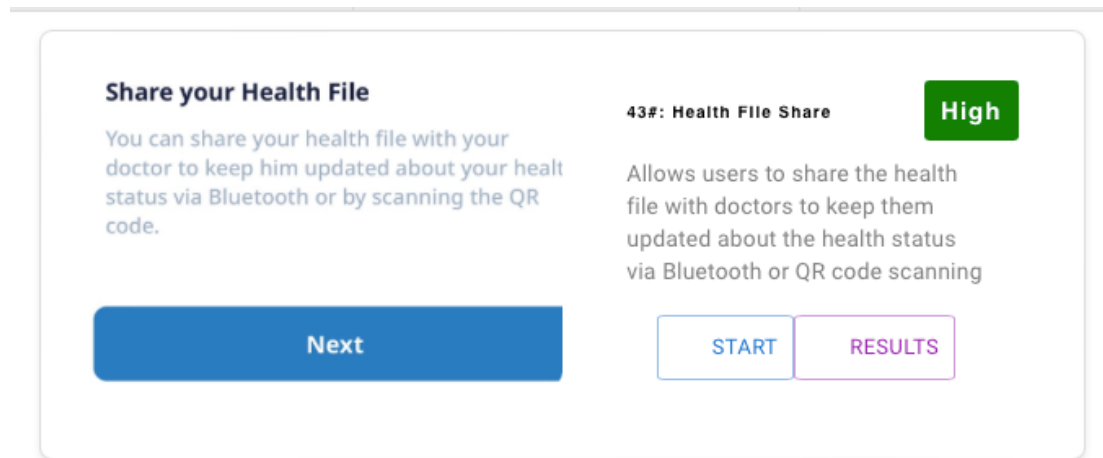


Figure 3.2: Feature presentation

Initially, ValueBot asks users whether they liked the feature or not liked the feature.

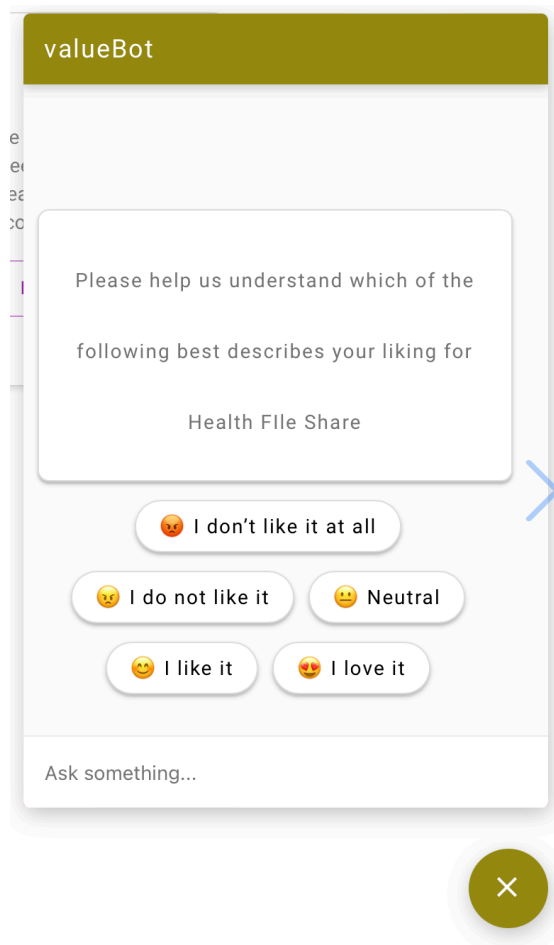
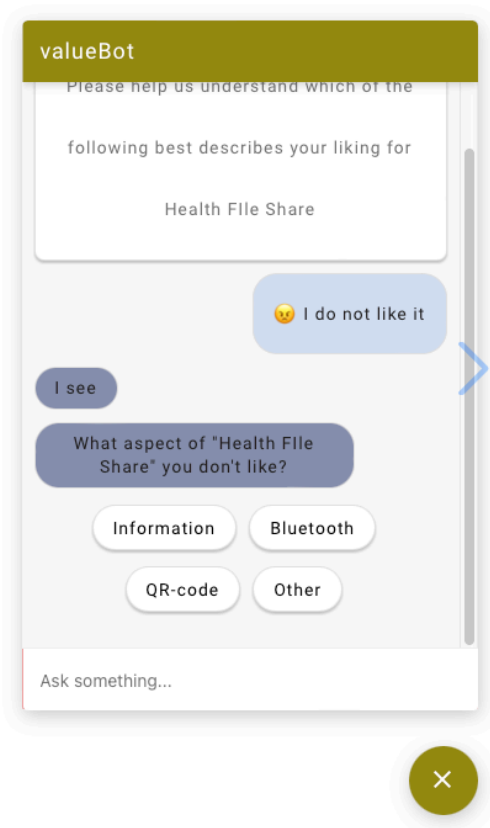
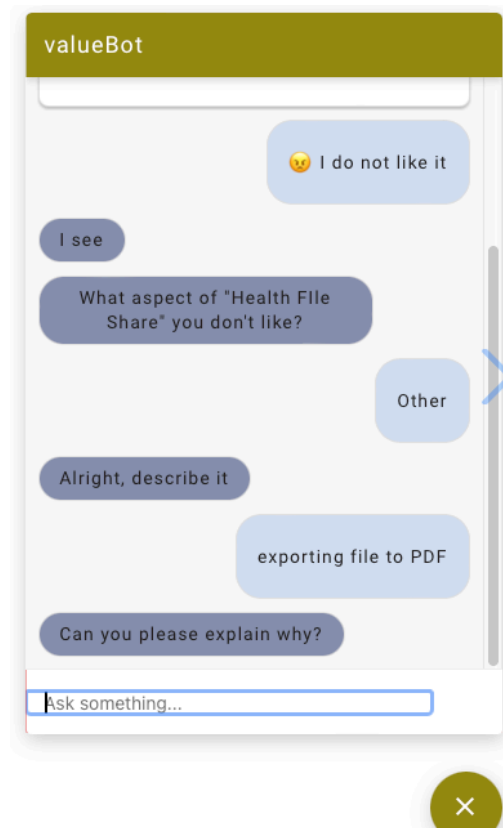


Figure 3.3: Step 1: liking identification

Based on user input, the bot tailors its responses. In this example, the user response was that he did not like the feature. The bot classified this as a negative perception and prompted the user to identify specific aspects they don't like, presenting a list of options. When the user chose "Others," the bot asked them to describe the disliked aspect in detail, as seen below 3.12(a). The user responded with, "Exporting file to PDF." To understand the reason for the negative perception, the bot asked the user to explain his concerns. Aiming at identifying the driving value for the user. However, when the bot could not



(a) Aspect probing identification



(b) user selection

Figure 3.4: Step 1.1: key aspect identification

determine the specific value based on its current design, it further probed by asking, "What is important to you when using the Share Medical File feature?". User responses, in this case, the bot was able to identify the category for value and categorized the user's motive under the "Security" value category, even though it could not initially identify an exact value. It then presented a list of related values for user selection. See figure 3.5. The user chose "Healthy," which the bot

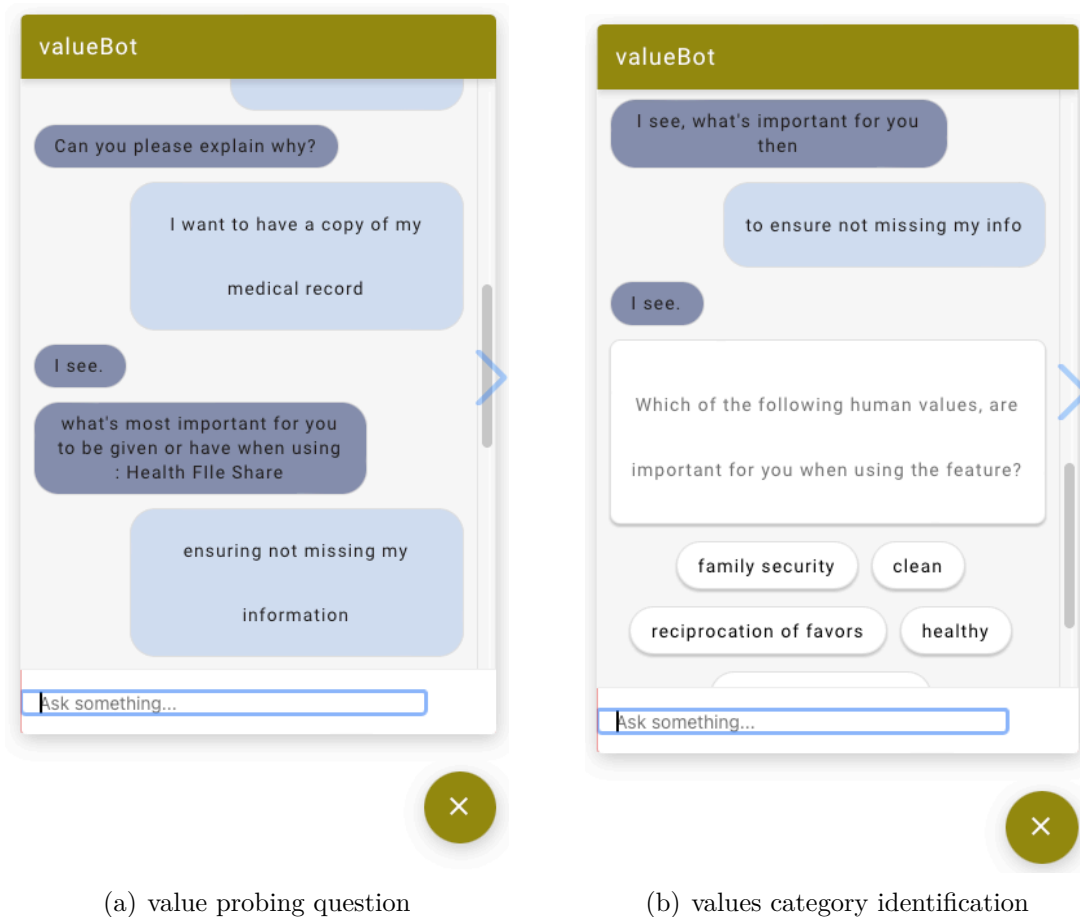
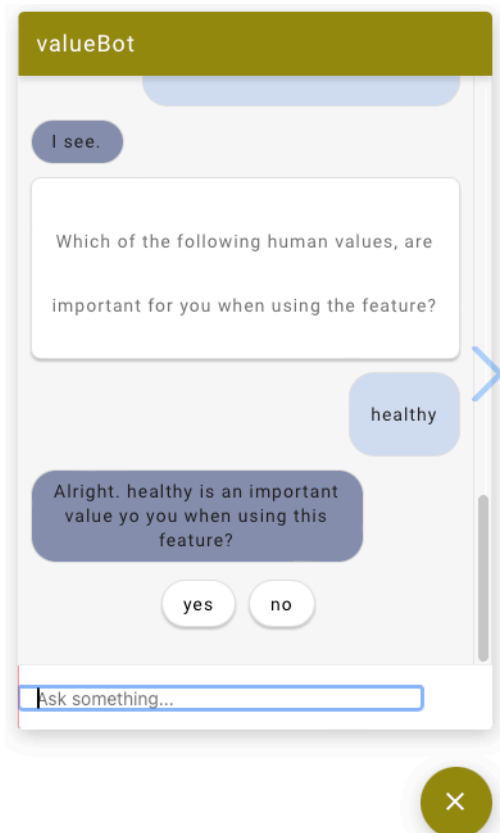
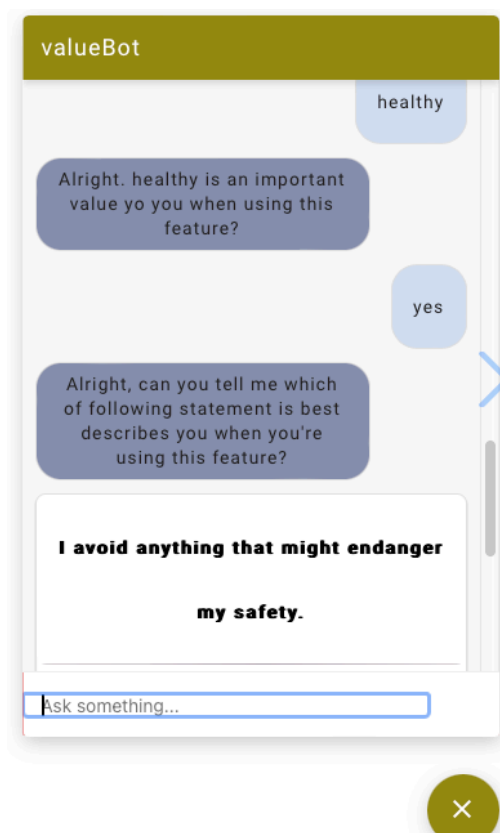


Figure 3.5: Values identification probing

confirmed. To ensure alignment, ValueBot asked the user to select a value portrait statement that best described their interpretation of "Healthy." The user selected a statement and submitted their response, as shown below 3.9. After verifying



(a) bot confirm the value



(b) bot verify the values

Figure 3.6: Values verification phase

the value, the bot asked if the user wanted to report another one, presented below. fig 3.7. When the user declined, the bot moved on to the next step: asking how the feature could better support the identified value. For example, the bot prompted, "What changes would make you like the feature?". This step is ignored if users liked the feature, as we assume no modification is needed. The user described

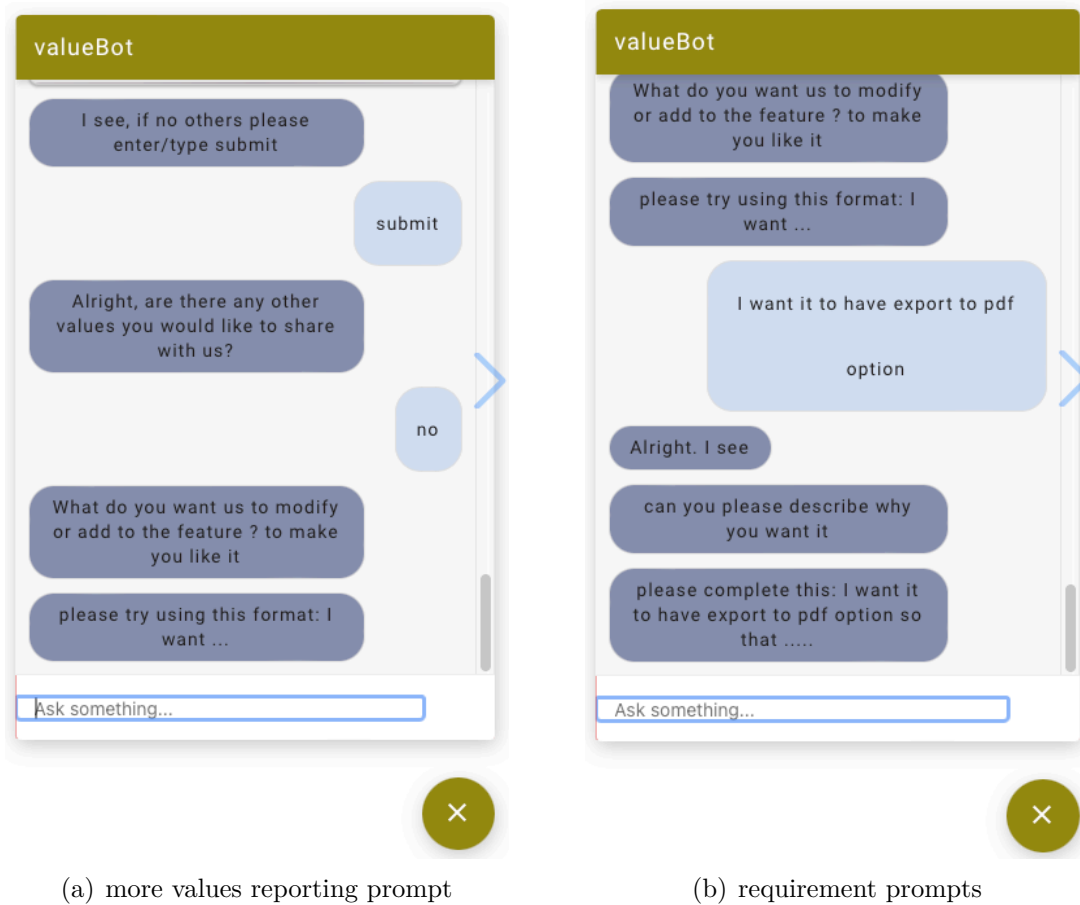


Figure 3.7: Values verification phase

their requirements, and the bot followed up with a question about the benefits they expected from the change. Based on this input, ValueBot generated a user story, structured as follows: "As a user, I want [requirement] so that [benefits]." In addition to the values that were elicited. The user will verify the story, which the

bot then saved. User can report changes, by selecting the part they would like to change. In this example, the user selected to submit the user story.

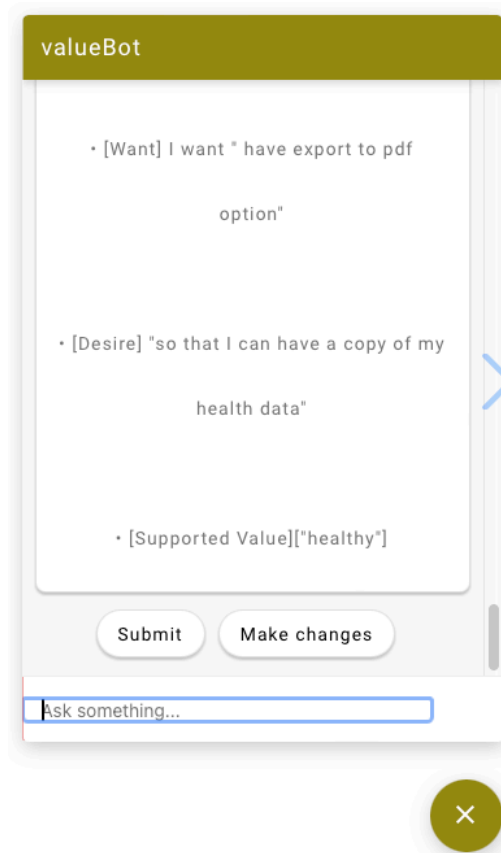
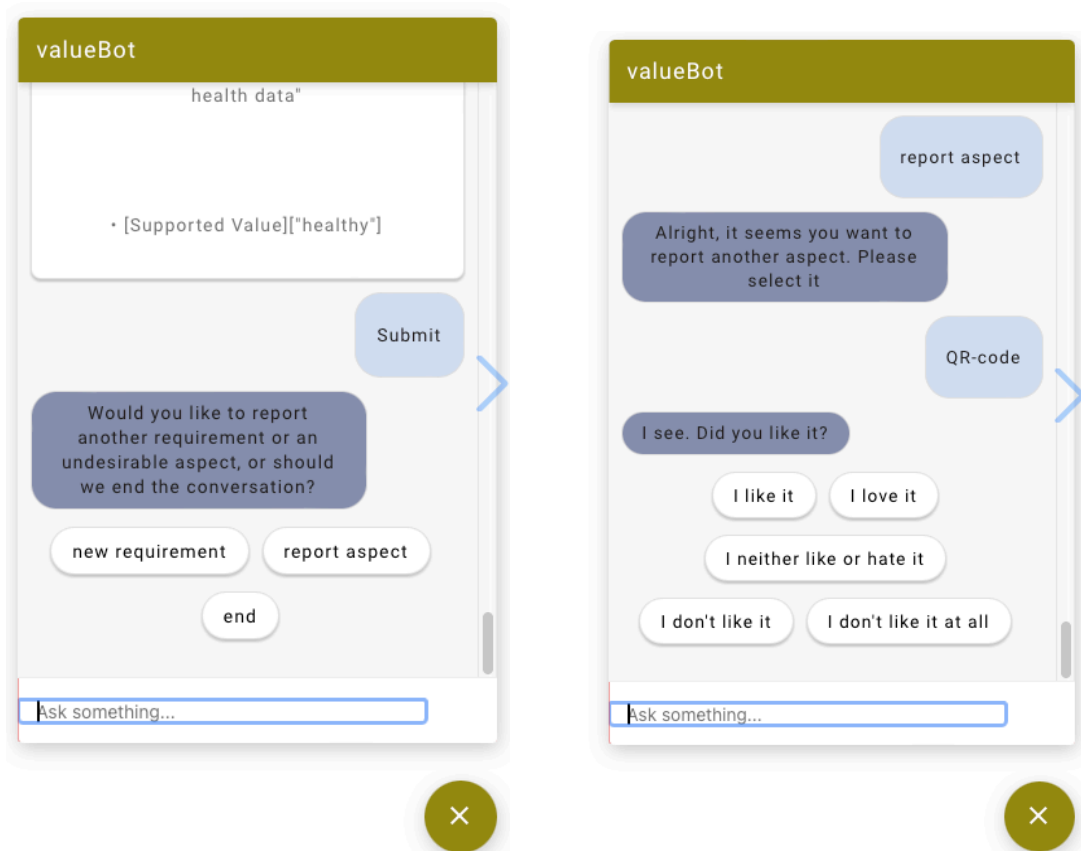


Figure 3.8: Value-based requirement verification

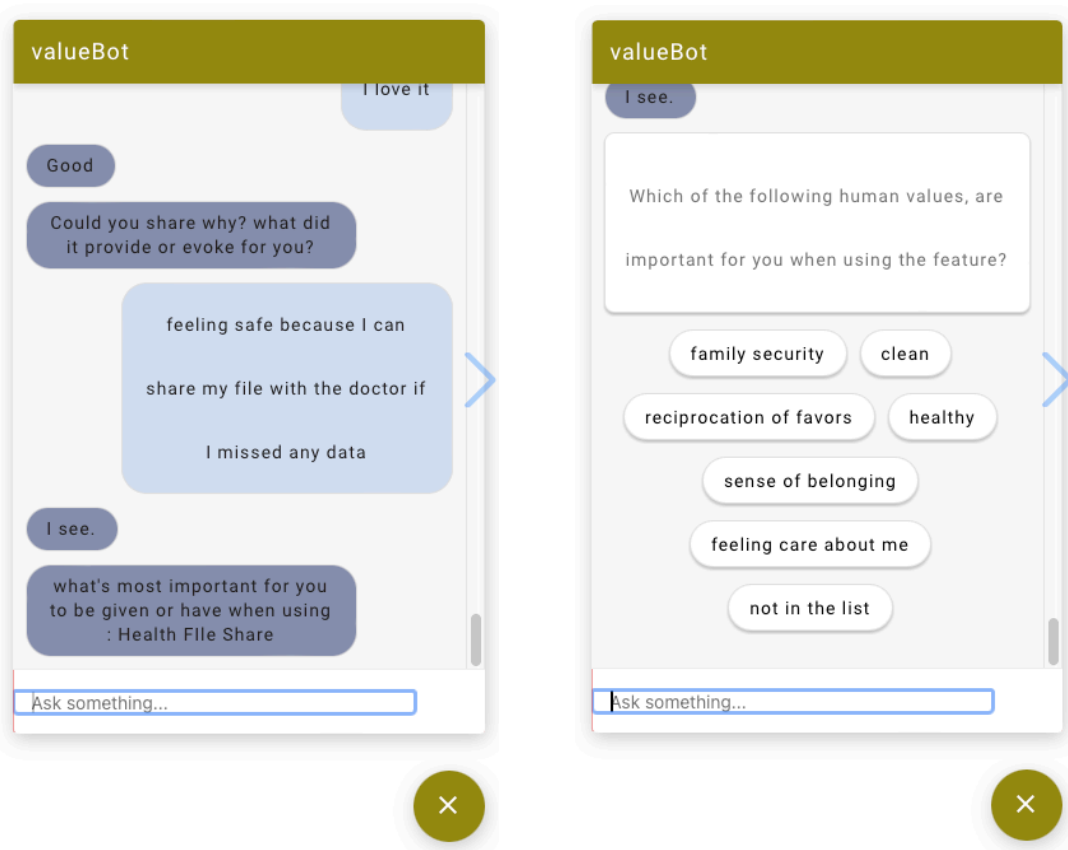
The bot then asked if the user wanted to report another aspect. This time, the user selected to report another aspect and chose "QR code" as the aspect. When asked for their perception, the user expressed liking the feature. The bot then asked what the feature provided or evoked, to which the user responded, "Feeling safe because I can share my file with the doctor if I missed any data." See below figure, 3.10. The bot was able to recognize the value category and presented list of values. The user selected not in the list. The bot prompted the user to



(a) ValueBot asks the user if he want to report another

(b) User selected reporting aspect

Figure 3.9: Another aspect reporting process



(a) values prompt reporting

(b) values identification

Figure 3.10: Values identification

describe it, refer to 3.11. The user stated, "Stay safe," which the bot mapped to the "Healthy" value category. ValueBot then repeated the process of value confirmation, statement selection. In this case, the user was reporting positive perception towards QR-code aspect, where then we don't need to go further for requirement elicitation and verification phase. The interaction ended with the bot saving the identified values, thanking the user, and concluding the session. See figure, 3.12.

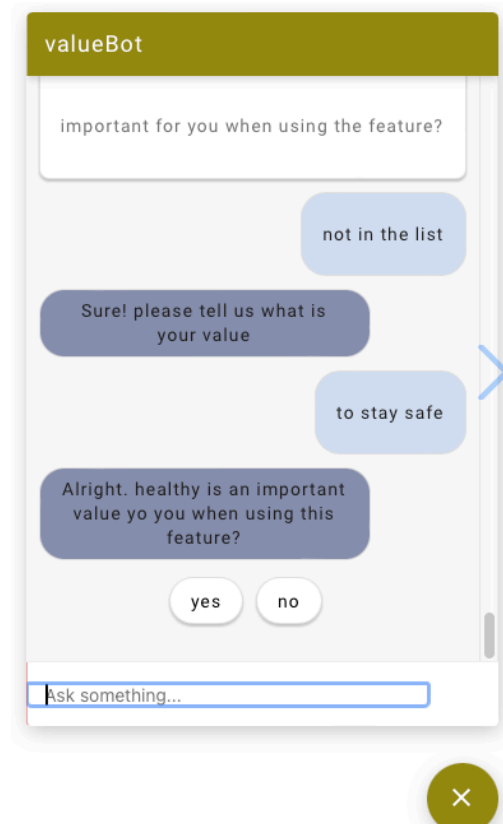
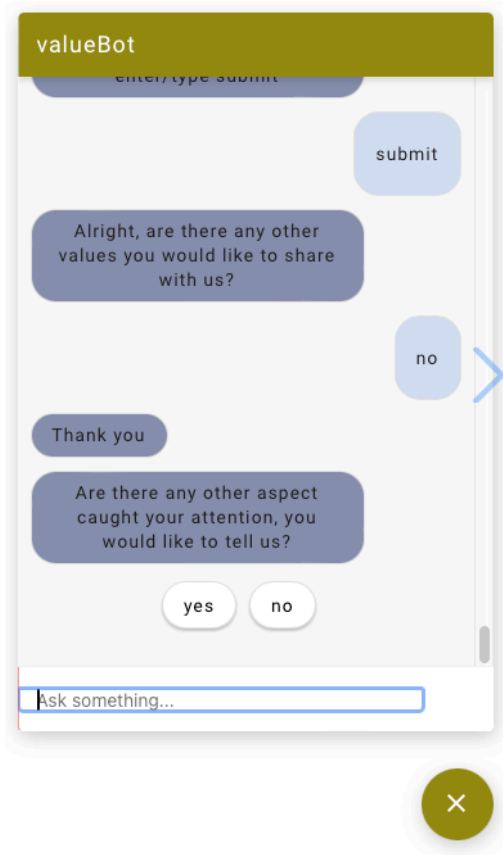
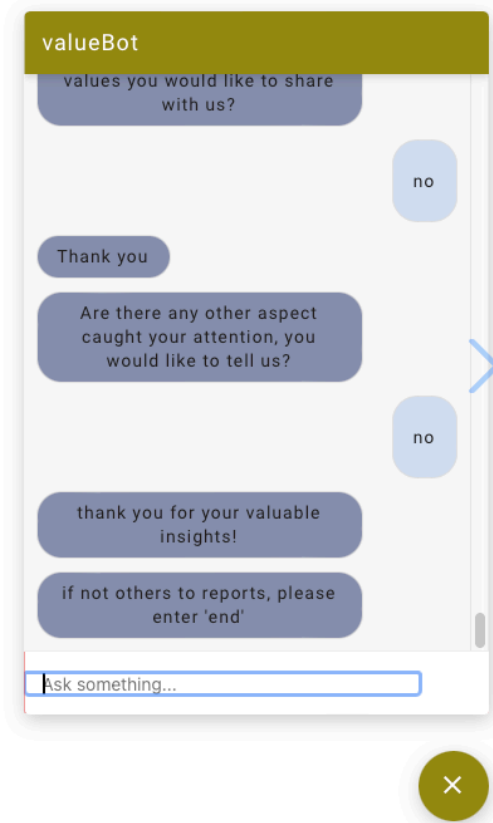


Figure 3.11: User selected not in the list



(a) reporting another aspect



(b) Ending the conversation

Figure 3.12: Ending conversation with the user

3.5 Chapter Summary

This chapter presents a proposed approach that aims to support the requirements engineer in eliciting values and verifying those values with end users. This approach has four phases: two main phases: elicitation and verification of human values, and mapping values to features. Each phase has been discussed in detail. The chapter also provides an illustrative example that demonstrates the idea of interacting with the valuBot, an implementation of the proposed approach, to elicit end-user values and verify these values.

Author(s)	Key Findings	Inspired Factors of the Approach Design
• [6] • [17]	• Develop a sense of empathy with users by adding new features to extract/elicit values.	• Inspired the adoption of interactive techniques to elicit human values. • Emphasized the importance of engaging end-users in the design process.
• [18] • [38]	• Values appear to be tacit knowledge: we recognize them when we encounter them, but trying to articulate them before hand is difficult. • End-users are more likely to provide negative reviews that indicate ignored values rather than addressed values	• Led to design an approach to elicit the values when app design is exists.
• [13] • [16] • [35]	• Values incorporation has an implication on users' liking towards certain app features	• Inspired the design of the first step, focusing on understanding users' liking towards app features.
• [1] • [17]	• Values are attributed to the functional goals and roles. • Interviewed end-user to elicit values by asking which aspects/features of the existing mobile apps are (more) important? Why?).	• Focused on triggering users' with feature aspects to understand their values.
• [38] • [5]	• " We limit the elicitation of values which the end-users expect from the app, such as politeness and the values which the end-users expect to develop/improve in themselves after using the app, such as wisdom "	• Contributed to values definition
• [16]	• "Values violations reflected in the user reviews, can be seen as values requirements"	• Implication on eliciting user requirements, when users have negative perception towards feature.

Table 3.2: Key findings and implications for designed approach

CHAPTER 4

IMPLEMENTATION AND EVALUATION OF THE PROPOSED APPROACH

4.1 Approach Implementation

The proposed approach was implemented on an AI conversational agent to leverage its natural language understanding (NLU) capability for identifying users' values and understanding their meaning within the app context. This chatbot is expected to communicate with an end user evaluating app features to elicit the values. This thesis designed a tool, elcitationHub, to integrate the valueBot. This is to facilitate the elicitation process and to provide insights on the obtained results. This support addresses the challenges of identifying human values, which are often ambiguous, implicit, and context-dependent [27], [7], while ensuring the

preservation of user privacy.

4.1.1 Overview of the Tool Design

Dialogflow was used to design (ValueBot) agent. Dialog Flow is a Google-backed platform for building conversational agents, empowering a natural language understanding (NLU) [51]. It leverages intents, entities, and training phrases to interpret user inputs, extract relevant parameters, and generate meaningful responses. Key components of the implementation:

- **Intents:** Represent user intentions which is trained to recognize user intent from their input. These intents define the actions the bot should take. ValueBot designed to identifying values and helping the bot drive the conversation.
 - ValueBot designed to have intents represents each specific value categories (e.g., stimulation, security). Each values categories intents was trained using statements from the Portrait Value Questionnaire (PVQ). A measurement questionnaire for the value framework adapted in the study.
 - ValueBot designed to have conversational intents for user probing. These intents are triggered by specific events designed from the back-end.
- **Entities:** extract parameters from user inputs. ValueBot designed to have set of entities to extract values from user responses.

- ValueBot designed to have entities representing each value for each values category. These values entities were created using values and synonyms derived from the Schwartz Value Survey (SVS). The second measurement questionnaire for the adapted values framework.
- **Fallback Mechanisms:** Handle situations where the bot cannot identify a value directly, prompting the user for clarification or suggestions.

Please refer to the appendix for the valueBot’s capabilities, and visit GitHub for the implementations of these intents. For further information, please refer to the GitHub repository A.3.

4.1.2 Values Elicitation and Verification Phase

Our elicitation approach is feature-focused, ensuring that the values elicited are directly align with the user’s values and are context-specific. It employs values-probing questions and key feature aspects to identify users’ values. Refer to section 4.3. These probing questions enable the bot to prompt end users to describe their values, which further be used by the bot as input, attempting to match them with existing value categories. For example, in an in-person appointment healthcare application, users may evaluate aspects such as appointment booking, doctor information, or cancellation to indirectly focus on their values that are either satisfied or not satisfied by the given aspect. Refer to section 4.3.

The design of the questions was driven by value definitions and characteristics identified from literature in both social science and requirements engineering. For

example, values are the driving motives that have been classified by different frameworks and have implications for users, where satisfaction of these values is reflected in users' perceptions and liking. These questions were initially developed based on this understanding and later validated through interview sessions with six participants to elicit their values within a healthcare context. Additionally, we focused on key aspects of application features that could trigger users to reflect on their underlying motives, whether those motives were fulfilled or unmet. The effectiveness of the probing questions was also evaluated during these sessions.

Liking Identification Step

Liking Identification Step: This process starts when the bot initiates the conversation asking users to describe their liking for the feature. Likert scale was used to identify users' liking. A five point scale was chosen to identify users' liking, starting from strongly positive to neutral and negative. These scales are: I love it, I like it, Neutral, I don't like it, I don't like it at all.

In this step, users will be required to review the features and provide answers to the following question for each feature:

- How do you describe your liking for (this feature)? using a scale varying from 1 strongly dislike, 2 dislike, 3 neutral, 4 liked it, to 5 love it.

Values Probing Questions

Then, the bot then prompts users to specify the feature aspect they like or not liked. It presents a list of main feature aspects that were previously defined in

addition to others. This to support linking the aspect with the values either satisfied or ignored. And, triggering users to describe their driving motive for their liking or not liking. In case neutral liking, this step is ignored. Next, the bot asks about the reason behind the liking which will be used by the bot to identify the value.

The bot takes users responses to liking reason, and tries to match it with existing defined value categories intent. If the bot successfully identifies the value it proceeds to the verification phase. If the bot fails to identify the value, it will ask for clarification to gather more information.

If the bot could not identify the value from the previous question, it proceeds with a second probing question: **What's important for you when using the feature?.**

If the bot still cannot identify the value, it asks the user to label their values. This allows the analysis to ensure if the labeled value, a new value not part of any category, or a value the bot fails to identify as it was not trained enough.

Values Mapping

- **Values category matched, but values item was not:** during attempt 1 or attempt 2, if the bot identifies a value category but was unable to determine the specific value, it will present a list of values that are linked to that category for user selection. Users can choose an values or select "Not in the List" if none apply. In case the user selected not in the list, users will be prompt to label the value. Values labeling is described above.

Values verification with end-users

: If the value have been identified during the elicitation phase, the bot will verify it with the user by asking: **When using the feature, this values is important for you?**. Additionally, the bot will present relevant values statements from the PVQ (Portrait Values Questionnaire) and ask the user to rate how well these statement describes them when using the feature.

4.1.3 Requirements Identifications

For negative or neutral (not like it or neutral) liking, the bot will proceed to gather users requirements in the following step.

Requirements Identification Step

The valueBot asks users about their requirements, as follows: What could make this feature better or more appealing to you?, The reason behind the proposed requirement?

The bot takes users responses, as requirements which then will be verified in the requirement verification phase. This step comes after the bot verifies the values with the end-user.

Value based requirements Verification

After requirements elicitation, the bot generates a user story (based on the requirements) aligned with the verified values and asks the user to verify it: **Would**

you like to submit it or make changes?.

Users can modify the story or requirements if they feel they are inaccurate. If the user proceed with making changes request, the bot will ask follow-up questions to choose any part of the user story to change. The values, the requirements, the reason. Based on user selection, the bot will ask users for the new changes, and the user story is again then verified by the user.

4.2 Technical Implementation Overview

The implementation of the **valueBot** is integrated into **ElicitationHub tool**. This tool was developed to supports end-users in evaluating application features. Please visit the GitHub. It facilitates seamless interaction between users and the bot, providing a structured workflow for value and requirement elicitation and verification.

4.2.1 Handling Values Analysis

Classification

When the valueBot recognizes a value category, such as "security" or "self-direction," , it prompts the user to explore the specific values by asking them to select the one they are interested in and then allows them to select more. For example, under the "self-direction" category, users might value both "freedom" and "independence" in different contexts of a feature. For a feature like reminders, users may associate "freedom" with the ability to customize reminder times, while "independence"

could relate to creating medication reminders autonomously. By identifying and presenting these values individually, the bot enables the user to indicate the relevance and importance of each value for the specific feature. This allows for a more accurate understanding of user values and associates them with feature aspects.

Misclassification of a value

In the case of misclassification, the bot relies on user feedback to correct its response. For instance, when the bot assigns a user response to a value, it asks the users to confirm the value he means. Once the user confirms the value, the bot will guide them to select the PVQ statement on their behalf. In case the user doesn't confirm the values, or what they intend to, the bot asks for a clarifying description of the value and then tries to map it to refine its understanding.

Failure to verify a value

Once the bot is unable to confidently identify which value category a user query belongs to (e.g., due to low similarity scores or ambiguous input, or even new emerging values), a fallback intent is triggered. This fallback guides the bot to ask the user for additional information, depending on the three expected scenarios.

Based on the user's clarification, the bot reattempts classification, either identifying the correct values or suggesting the most relevant categories for the user to choose from. In situations where ambiguity persists, the bot will ask the user to answer the second value-prop question to refine the classification. After three trials, the bot will directly ask the user to assign a value to his answer, which

the analyst will then investigate. The bot will follow the three probing questions described in section three.

4.2.2 Tool Workflow

1. Feature Presentation:

- Upon entering **ElicitationHub tool**, users are presented with a list of app features, including their descriptions and names.
- User can initiate the bot conversation by selecting “Start.”

2. **Bot Interaction:** The bot guides the users through evaluating the feature by capturing and verifying their values, and requirements. as described above. Once the elicitation process is complete, the bot asks users to confirm the captured information, report any other information, or end the session.

3. **Results Presentation:** After completing the conversation, users can view features evaluation details, including:

- Feature names
- Liking or disliking of the feature.
- Identified values, along with the descriptions leading to their identification.
- Verified requirements linked to the user’s values responses.
- Additionally, users can provide comments or feedback directly on the results page.

4. **Practitioner Access and Insights:** Practitioners have access to a results page where evaluation outcomes are organized into:

- **Perceptions:** Highlighting positive, neutral, or negative liking.
- **Elicited values:** Including the frequency of values in a given feature.
- **User Stories:** Derived from elicited requirements linked to users' values.
- **Description Details:** Showing the iterative steps leading to values identification.

4.2.3 Interpretation of Results:

- Negative Perception: assume a potential issues exist requiring investigation and modification.
- Neutral Perception: assume that implementing elicited requirements could improve user perception.
- Positive Perception: Indicates satisfaction, with no modifications needed. The elicited values are satisfied and deem important for the user.
- Number of mentioning the value, provides indication for their importance, guiding prioritization for feature design. In case negative perception, the priority to consider and modify a features is given for negative perceptions.

4.2.4 Additional Practitioner Tools:

- Review Option: Practitioners can add comments, such as “Needs investigation” or “Key insights.”
- Delete Option: Enables practitioners to remove outdated or irrelevant evaluations.

4.2.5 Addressing Gaps and Challenges:

This implementation addresses several gaps and challenges in the literature, including:

- challenge with lack of tools supporting values elicitation
- the gap of absence of effective verification mechanisms for user inputs.
- end-user challenge with privacy concerns.
- practitioners challenge to understand the value in the given context.

4.3 Validation of Value Probing Questions

After designing the probing questions and before evaluating the proposed work with actual participants, it is important to validate the the sequence and content of the questions are valid and leads to the desired results. Hence, I conducted an interview to illustrate the healthcare domain and identify the key human values

that end-users perceive in healthcare apps. The interview aims to answer the following two questions:

- Q1. What are the most important values for the end-users in the healthcare app?
- Q2. How effectively do the proposed values probing questions encourage users to describe their values?
- Q3. How do end-users understand human values?

The result of the first question will be used later in the overall evaluation of the proposed approach.

4.3.1 Protocol

The first step in conducting the interview was to recruit participants. The interview was designed to target active app users in the healthcare domain. “Sehhaty app” was chosen after analyzing its features. The primary reason for selecting this app was our expectation that it may embody a unique set of human values. The participants were recruited by searching for users of the app under study and inviting them to fill out a registration form. The form was designed to first confirm the participants are of the targeted group, ”end users of Sehhaty app,” gather preliminary demographic data, and verify their availability. The study aimed to carry out individual interviews with every participant. Then, each selected participant received a consent form, requesting their signature after they had read it. The consent form was used to explain to the participants the purpose of the

interview and the intended use of the data. Participants signed the consent form before having the interview.

The interviews consisted of three parts. In the first part, 2-5 minutes were allocated for icebreaking. In this part, the researcher engaged in an informal conversation, introducing herself, outlining the research objectives, and explaining the interview process. Then, the second part was designed for reflecting values in healthcare apps and investigating the clarity and effectiveness of the designed values prompting questions in identifying human values. The prompts are clearly designed to prompt users to describe their values. The participants spent 10–15 minutes answering various questions about the app’s primary features. The third part of the interview focused on how users understood human values. The researcher (interviewer) introduced the definition of human values with an example in application context in the entertainment domain and asked the participant directly to describe the values important for end users in the healthcare domain, mainly when using the “Sehhaty app.” The important values when they use the health care app. This part took only 2 to 5 minutes.

The researcher conducted all six interviews. Each interview session was conducted individually, remotely through Zoom, and recorded it. The interview was conducted in an informal manner, without adhering to any specific structure.

4.3.2 Participants

The characteristics of all six recruited participants align with the target user group, which consists of active users of the Sehhaty App, chosen by convenience

and availability. All the participants were female, holding bachelor degree with the exception of one who held a high school diploma. The participants ranged in age from 18 to 40 years. All participants are active users of the app. One of them reported she had almost 50 appointments booked through Sehhaty.

4.3.3 Data analysis

The first session was conducted as a pilot study to ensure the subsequent sessions would proceed smoothly. No concerns were raised by the participant. Each session lasted approximately 10–20 minutes, except for one session, which extended to 40 minutes.

Following the interviews, the data were transcribed by the researcher and subsequently translated into English. An inductive approach was employed to develop the coding scheme, with codes distilled directly from the transcripts. These codes were then mapped to a value categorization framework based on the theory of basic human values [30]. This framework was selected due to its validation and frequent application in values elicitation within requirements engineering, particularly in the healthcare and wellbeing domains. To compare value categorizations, similar domains were expected to exhibit overlapping values. Any codes that could not be mapped to a value item within the framework were categorized as non-Schwartz values, as previously adopted in similar elicitation studies [1], [5]. This categorization accounted for values requiring additional interpretation or those that could not be mapped. Given the subjective nature of values, the knowledge and experience of the analyst may influence the mapping process.

To address certain limitations, the decision was made to map codes to value categories rather than specific values. This approach aimed to provide broader interpretations and enhance the robustness of the mapping process.

The mapping process was conducted in two phases. In the first analysis, the researcher mapped the participants' transcripts to various value categories, comparing the values' definitions with the initial mappings. During this process, instances that lacked clarity or required further interpretation were identified. In the second phase, all transcripts were re-mapped, and the initial mappings were double-checked to ensure consistency. While the initial intention was to map codes to a single value, the final decision was to align codes with categories that encapsulate and describe end-users' motives. A specific category, denoted by a star (*), emerged from the second mapping, reflecting this refined categorization approach.

4.3.4 Results

All participants reported using the app for in-person and virtual appointment booking, but none used other features such as the family care team, daily activity tracking, Asefny, or medical file sharing. Despite this, participants were able to articulate their values through the probing questions, even for features they did not actively use. **Answering Q1: What are the most important values for end-users of "Sehhaty" app?** The interview results identified Security, Benevolence, Self-Direction, and Conformity as the most significant value categories for "Sehhaty" app end-users. These values were consistently mentioned

Features	participant 1	participant 2	participant 3	participant 4	participant 5	participant 6
In-person ap- pointment	Face, Self- direction	Self- direction	conformity	conformity	Self- direction, Benevo- lence, Tradition	self- direction
Virtual appoint- ment	Benevolence	benevolence,	Conformity, Trust , Benev- olence, Self- direction, Face, Uni- versalism , Tradition	Conformity, self- direction, benevo- lence	Benevolence, security	Benevolence, security, trust
share medical file	security	security	security	security	universalism, benevo- lence, security	security
Daily Activity Tracking	Stimulation	achievement, stimula- tion, self- direction	stimulation	stimulation		
Asefny	benevolence	benevolence, security	security	benevolence	security, benevo- lence	security
My care team	benevolence	benevolence	benevolence	security	self- direction	self- direction

Table 4.1: Values categorizes of health care end-users **Note::** * indicates this feature was not used by participants. The number beside the value indicates the number of values mentioned by different participants.

across participants, underscoring their importance within this domain. Additionally, features related to well-being, such as tracking daily activity, revealed values linked to Stimulation, including encouragement, motivation, and excitement, as well as achievement. Refer to Table 4.1 for the complete list of values identified.

Tradition values in the form of language respect were also presented in appointment booking. This was stated by participants who said, "When asked what was important to her, the participant explained, "Speaking Arabic. He came here, and he must speak in our language and explain things to me in Arabic; other medical symbols he can explain.". While this initially appeared to reflect benevolence, seeking understanding and help, further probing revealed a deeper cultural value tied to tradition.

Answering Q2. How effectively did the probing questions, based on the proposed values definition, encourage users to describe their values? The probing questions effectively encouraged participants to articulate their values, even for features they had not used. For features used by participants, questions about participants' liking and reasoning provided insights into the values associated with those features. For example, participants using the virtual clinic highlighted issues such as disrespect for scheduled appointment times, inadequate communication, and feelings of neglect. These responses reflected values ,benevolence, security, face - respect, and Conformity-following rules. One participant described their experience, stating:"The doctor did not understand me, ignored me, and quickly ended the chat. I felt ignored and he doesn't care for".

For unused features, the interviewer introduced the feature and inquired about participants' perceptions towards it, how do they see it and why.

We discovered that participants' liking for the app features mirrored their attitudes towards the applications. And the reasoning about their liking was a source for identifying values and whether they were supported or ignored in the feature. The reasoning behind participants' dislikes or frustrations was often reflected unmet user requirements. A value based requirements. For example, participant frustrations with the virtual clinic. He stated: "Sometimes, if the doctor is not speaking Arabic, he switches to chatting and tries to conclude and end the session." When asked what was important to her, the participant explained: "Speaking Arabic. he came here, and he must speak in our language and explain things to me in Arabic; other medical symbols he can explain."

This was reported by another participant, who suggested that doctors' speaking language be included in their profiles, stating: "Doctors speaking languages should also be included in the profile information, so I can make my selection. This was seen a users requirement to consider their values.

Another effective prompt involved inquiring about the importance of the features for the users. The majority of our values were derived from asking users what is important to them when using a specific feature. For example, when discussing the virtual clinic, participants emphasized: "Understanding, feeling cared for, being listened to, and not being rushed. I want to speak without time limits." Another participant reflected on conformity: "It's important that the doctor respects the scheduled time. Sometimes they don't even join the session, and

the app says it's successfully completed!". These responses are mapped to values like benevolence-help, benevolence-care, and conformity-rules, demonstrating that users actively sought these values while using the app.

Probing users to describe their desirable end state was not clear for all participants. Only one participant understood the prompt and responded, "Taking care of my health and being aware.". We observed that the prompt directly encourages end users to articulate their ultimate goals after using the app only. Ignoring that values are what you want to achieve after using the app is also when using the app.

Answering Q3: How do end-users understand human values? All participants were introduced to a shared definition of values and examples at the beginning of the interviews. At the end-of-interview, participants were asked to describe their values in the given app. The results revealed variations in how participants perceived values:

- one participant viewed values as the ultimate goal of using the app. For instance, one participant noted: "Self-care and health awareness—this app supports people's values of taking care of themselves."
- Others understood values as the end state they sought by or after using the app, such as improved time management: "Respect time, not like in the past we need to go and wait and then we might find appointment and we might not".
- two of the participants demonstrated an understanding of values as what is

important to perceive during app usage and after.

This variation in understanding values highlighted the importance of carefully designing prompts to guide participants in reflecting on their desirable end-states during and after app usage. For a comprehensive overview of identified values and their alignment with app features, refer to the table below.

Participant	Reported values
Participant 1	“Time value, now not like in the past, we need to go and wait; now directly we go on the time we booked, and we can directly see the doctor”
Participant 2	”life”
Participant 3	”Respect my time. Equality, deal with me like the person who came to the clinic, all at the end-patient, consider their health status”
Participant 4	”Health awareness and taking care of myself ”
Participant 5	”cooperative, and they achieve it, privacy, many things, freedom, you can select only the doctors you can’t... and this might be different; sometimes I choose a doctor, but they don’t allow me... This might be the clinic policy, not the app. Helpful: It helps me as a patient or human; it helps me as much as it can; everything is covered, They provide different options for humans.”
Participant 6	”Finding an appointment at the same time I want”

Table 4.2: Participants human values reporting in the health care app domain

Your values? Time, respect time value Respect my time. Health awareness and taking care of myself Cooperative, and it achieves it, privacy, helpful, you

can select, it gives me options I don't know. Finding an appointment at the same time I want

4.3.5 Conclusion

Focusing on features and their aspects prompted users to reflect on their own values, regardless of whether the features were actively used. While asking about the importance of features proved more effective in identifying values, relying solely on this approach may not reveal whether a feature supports or violates those values. Similarly, direct questioning about values is highly dependent on end-users' knowledge and expertise.

To achieve the best insights into values, we recommend focusing and directing users to specific features rather than discussing the app at a broader level. Start by asking users about their liking towards a feature and the reasoning behind their liking. Selecting key aspects. If their reasoning is not clear enough to identify values, probe further by asking users to describe what's important to them, with an emphasis on the feature's specific aspects. If additional clarification is required, consider their responses and prompt them to articulate the value underlying their stated importance.

This structured approach ensures a comprehensive understanding of how features align with or deviate from users' values, facilitating improvements that resonate with end-users' expectations and experiences.

4.4 Pilot study

The first evaluation of the approach and the tool was conducted with two participants. The evaluation was running on the healthcare domain, mainly the "Sehatty" app, the same app used in the interview. Refer to 4.3.

Protocol The evaluation session aimed to assess eight key features of the app. These features include "virtual appointments, in-person appointments, medication reminders, daily activity tracking, lab results, my care team, and Asefny, health file share." The evaluation was conducted in two parts. The first part was to ensure participants familiarity with the features. Each participant was instructed to perform a set of tasks on the app for each feature. After completing the first part, the participants received instructions to proceed to the second part. The second part provided the participants with a link to access the ValueBot tool and instructions on its use. These instructions include login steps and how to start the evaluation. Upon logging in to the tool, the participant will receive an introduction that allows him to consent to the process. Then, each participant was presented with the features, one by one. The participant was instructed to proceed feature by feature and not go to the next until completing the evaluation. For details of the instructions and documents shared with participants, please see the appendix A.5.

The evaluation started when the participants clicked on Start. A chatbot was presented to the participant and asked them about their perception, specifically their liking for the features. The bot then follows different paths depending on

the participant’s response.

Results The first look at the results of the participants showed promising results. The prompting questions were able to guide the users to describe their values in the form of our definition. Based on their descriptions, the bot was able to identify the users’ values. The users verified these values by following the previously described verification process. The majority of the values fell into the categories of self-direction, benevolence, and security; no values related to tradition, hedonism, stimulation, conformity, or universalism were present. The power values were identified in two situations: as social recognition, as a violation in the appointment booking, as users were not able to find any available doctors, and she assumed because she’s not Saudi and her account is dealt with differently, and as resource power when the participants expressed liking for the daily tracking activity features.

Features	Participant 1 -values	Participant 2 - values
Virtual appointment	Self-direction (independent)	Security(Sense of belonging)
In-person appointment	Face (Social-recognition)	Benevolence(responsible)
Medication Reminders	Benevolence(helpful)	Self-direction(independent)
Daily Activity Tracking	Benevolence (helpful)	Power-resources (wealth)
Asefny	Benevolence (helpful)	Benevolence (responsible)
My care team	Security (sense of belonging)	Security (sense of belonging)
Lab results	Self-direction (privacy)	Self-direction(independent)
Health File Share	Benevolence(helpful)	Self-direction(independent)

Table 4.3: Pilot study elicitation results

Note: * indicates labeled values. Labeled values are values were not identified by the bot after two clarification questions, or labeled by the bot and end-user didn’t agree with it. other values are identified by the valueBot.

Participants in some cases referred to technical or design aspects when discussing what they found attractive or undesirable about the features. The results

Undesirable aspect/issues	Desired Requirement	Benefit	Supported values
i dont like of that is did not work for me	work for me	I want it to work for me so that I can book appointments easily	social recognition

Figure 4.1: Perception reveals values violation

Perception flag:Positive Perception Results						
Participant Id	Desired Aspect	Benefit	Supported values	Value Details	Analyst Actions	Reviews
30	The results listed online without the need of going to the hospital	Easiness	Independent	DETAILS	REVIEW DELETE	
32	Easy accessibility	privacy	privacy	DETAILS	REVIEW DELETE	

Figure 4.2: Participants key aspect descriptions

showed no concerns with the approach. Only we planned to remove some features (meditation reminders and lab results, my medical care team) to reduce the evaluation time.

4.5 Proposed Approach Evaluation

The aim of the approach evaluation is to assess its effectiveness in elicitation and verification of human values. In addition, as the previous results in the validation of probing questions and the pilot study seemed promising without pre-education of participants about human values, this evaluation investigates if any difference exists in the identification of human value due to participants pre-education about human values.

The main research question of the experiment is the following: *Is there an impact of end-users' education about human values on eliciting human values using valueBot?* To answer this question, we design an experiment with two groups of participants, an **educated** and a **non-educated** group, on human values. Par-

ticipants were randomly assigned to one of these group, and have been instructed individually to the study.

To answer this question, we designed an experiment with two groups of participants, an **educated** and a **non-educated** group, on human values. Participants were randomly assigned to one of these groups and have been instructed individually on the study. The key independent variable of the experiment is **values education**, which means whether the participants were provided education on human values or not before they started the evaluation. The primary dependent variable is the **number of values** matched to a specific category by the ValueBot agent for each group.

4.5.1 Participant

The experiment recruited two groups: one with no previous education about human values and the second will be provided education on human values before they start the evaluation. The context of the study was selected to be in the healthcare domain using Sehatty application. Participants criteria includes:

English Language Literacy: Participants must demonstrate proficiency in English, as the study materials and instructions will be provided in English. This is essential to ensure that participants can fully understand and accurately respond to prompts related to values identification and feature evaluation. To ensure meeting the criteria, the recruitment questionnaire includes a language proficiency question. **Prior App Features Familiarity:** Participants should be familiar with the app features. To ensure they are familiar with the app's func-

tionalties and can focus on evaluating features and reporting their values more accurately. For this, the study planned to have an initial exercise with participants before conducting the primary study, where participants were instructed to complete certain tasks to ensure their familiarity. The study chose the non-probability sampling technique and mainly the convenience sampling. The study was able to recruit fourteen participants, including the pilot study participants.

4.5.2 Procedures

We conducted a one-to-one session for each participant. Each session lasted approximately one to two and a half hours, depending on the participant. We provided an instruction file that detailed the purpose of the evaluation and the participation process. Please refer to "Experiment Evaluation Design Materials" section in the appendix A.

The participation process consisted of two steps. The first step required participants to familiarize themselves with the application "Sehhaty app" through a set of tasks provided in the instruction file. The tasks include tracking health data, booking virtual and in-person appointments, using Asefny, and sharing medical files. Once the participant completed the first step, they use the shared login credentials to access the tool.

We designed the tool to evaluate five features of the Sehhaty application. These same features were also included in part 1. The tool added these features, provided information about them, and presented the list of features to each participant individually. Upon logging in, the participant will initially need to confirm whether

he has received value education or not. The participant should answer this question before proceeding to the start of evaluating the features.

The facilitator provided additional context for the educated group. The facilitator introduced the values framework, offered examples, and explained its relevance within the application context. Webook, an app for entertainment events and activity bookings, served as the chosen context for illustration. Furthermore, the values framework categorization was shared within the instruction file. This educated group introduction spent around 10 minutes.

4.5.3 Results

The primary objective of this analysis is to investigate whether there is a significant difference in the number of values identified by the ValueBot between the educated and non-educated groups. Fourteen participants were introduced to the study and completed the consent form. Ten of these participants evaluated the tool. Nine completed evaluations for all five app features, while one participant from the educated group evaluated only three features due to technical issues that prevented tool access. This participant assessed health activity tracking, virtual appointment, and Asefny, reporting three values: helpful, benefit, and trust. The valueBot identified helpful, while benefit and trust were labeled by the participant after clarification attempts. For the virtual appointment feature, the bot suggested values, including helpful, but the participant selected benefit, later verified as helpful.

To ensure balanced group comparisons, one participant from the non-educated

group (the only male participant, a validation engineer) was also excluded. This participant was completed evaluation for five features, reporting only two values out of five identified by valueBot. These are daring, a stimulation value for health tracking activity, and freedom, a self-direction value for in-person appointment.

Total Number of Values Identified

After removing the excluded participants, each group consisted of four participants. For the educated group, the ValueBot identified 20 values across the five features, with two labeled values, trust and comfortable. Labeled values are the values that were not identified by the valueBot, and users were directly prompting to labeled the value. For the non-educated group, the ValueBot identified 14 values, while six additional values—easy, quick and easy, support, direct interaction, transparency, and trust—were labeled by participants. Please, refer to table 4.6 for investigating not mapped values.

Experiment group	Total values identified by valueBot	Total values were not identified by valueBot (labeled)	Proportion "Labeled" identified	of not
Educated group	20	2	10.0%	
Non-educated group	14	6	30.0 %	

Table 4.4: Values categorizes of health care end-users

Note: **labeled:** Values labeled by participants, not recognized by valueBot after values probing questions.

Group Comparisons

The analysis revealed differences in the triggers for values between the two groups. This is presented in table 4.5. We identified some values through liking reasoning, as shown in (5), and others through importance probing questions, as shown in (4). The third method involves direct value probing to describe the value, labeled by (3). In the third explanation, when users input statements exceeding three words, the bot prompts them to provide a brief description, and (2) labels their response. In fact, when the user labeled the value, the valueBot checked if he recognized the label or not. If the bot identified the label, then we recognize the value as matched, even after user labeling. If the valueBot was unable to identify the label, we recognize the value as labeled. Below table 4.5 presents the distributions of values identified by valueBot and labeled among each participant. We observed that direct value probing and importance probing questions worked more effectively in prompting users to describe their values in the educated group than in the non-educated group. See figure 4.3. For the educated group, the bot primarily identified values through liking probing question. They were able to articulate values clearly through questions about importance and direct value probing. See Figure 4.4.

For the non-educated group, the values identified by the bot were primarily identified through liking probing question. See Figure 4.5.

There was no difference in term of the values identified. values, which were identified by the bot, primarily fall into four distinct value categories. Benevolence—

Non-educated group values' elicitation results					
Features		ID(30)	ID(32)	ID(35)	ID(37)
In-person	Ap-	Benevolence	Face(social	Benevolence	Support ₂
pointment		(responsible) ₅	recognition) ₅	(helpful) ₃	
Virtual	Appoint-	Security (sense of	Self-direction	Benevolence	The direct in-
ment		belonging) ₄	(independent) ₅	(helpful) ₅	teraction ₂
Share	Medical	Self-direction	Benevolence	Quick	and transparency ₂
File		(independent) ₅	(helpful) ₅	Easy Access ₂	
Health	Activity	Power (wealth) ₅	Benevolence	Trust ₃	Tradition (re-
Tracking			(helpful) ₅		spect tradition) ₅
Asefny		Benevolence	Benevolence	Easy ₂	Universalism-
		(responsible) ₂	(helpful) ₅		concern (world
					at peace) ₅
Educated group values' elicitation results					
Features		ID(39)	ID(41)	ID(42)	ID(48)
In-person	Ap-	Conformity (hon-	Benevolence	Self-direction	Comfortable ₃
pointment		oring parents) ₅	(helpful) ₄ , Benev-	(Freedom) ₄	
			olence (helpful) ₅		
Virtual	Appoint-	Universalism	Security (sense of	Power (social	Self-direction
ment		(world at peace) ₅	belonging) ₅	power) ₃	(freedom) ₄
Share	Medical	Security (family	Benevolence	Benevolence	Security(sense of
File		security) ₅	(helpful) ₃	(responsible) ₅	belonging) ₄
Health	Activity	Self direction	Stimulation	Security(family-	Security
Tracking		(Choosing own	(novelty) ₄	security) ₃	(healthy) ₃
		goal) ₃			
Asefny		Security (family	Security (fam-	Benevolence	Security (family
		security) ₂	ily security) ₃ ,	(helpful) ₅	security) ₅
			Trust ₃		

Table 4.5: Values categorizes of health care end-users

- **Bold:** Values labeled by participants, not recognized by the bot or not in the list.
- ***:** Features excluded after the pilot study.
- **Number:** Count of clarifications until labeling.
- **CAPITALIZED:** Values identified but not matching descriptions.

caring, security—personal, self-direction, benevolence—dependability, and universalism. Other values, such as stimulation, conformity-interpersonal, and power, emerged less frequently; refer to table 4.7. See figure 4.6 for values distribution

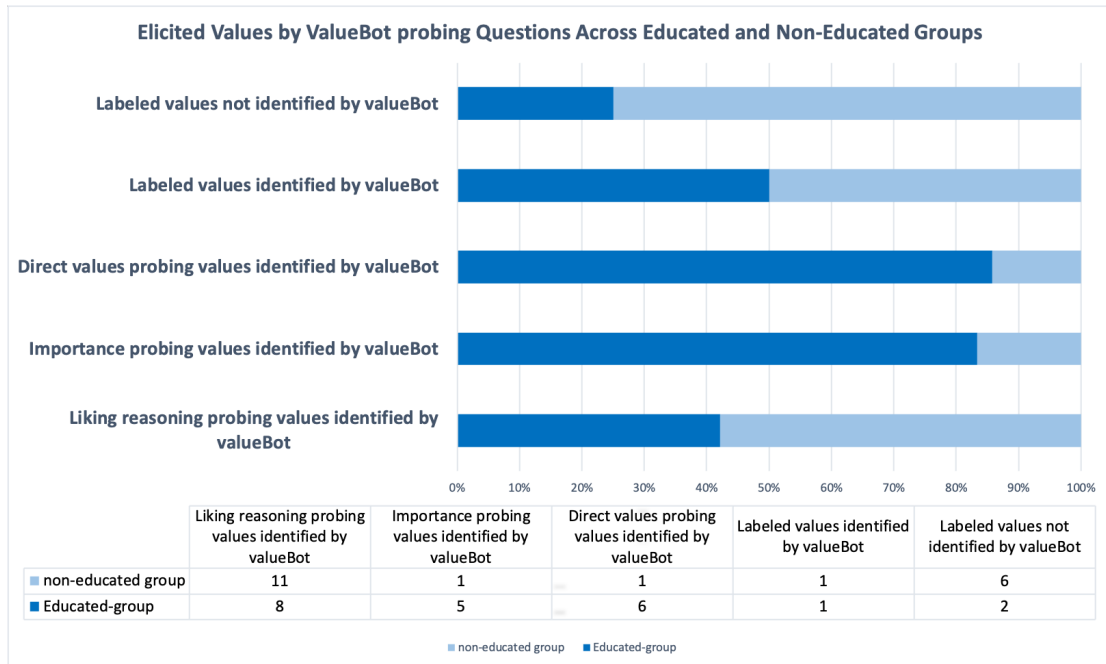


Figure 4.3: Number of elicited values based on different user probing questions for both educated and non-educated groups.

Note: The data includes responses from different probing such as reasoning, importance, direct questioning, labeling, and whether a label was identified by valueBot or not identified.

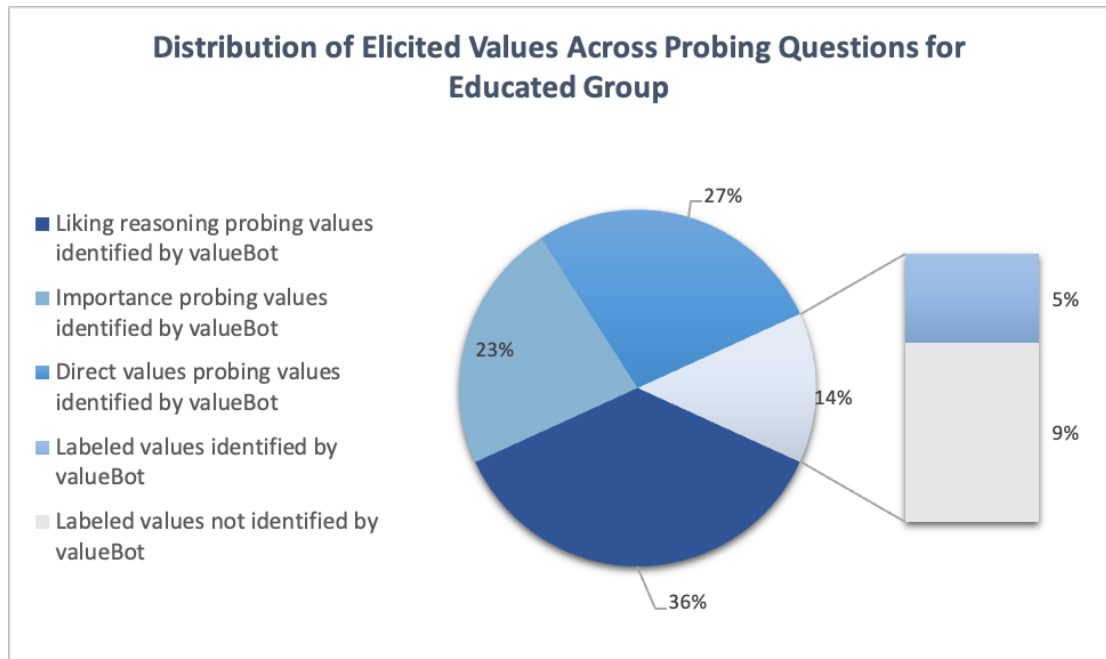


Figure 4.4: Proportion of elicited values across different probing questions for the educated group.

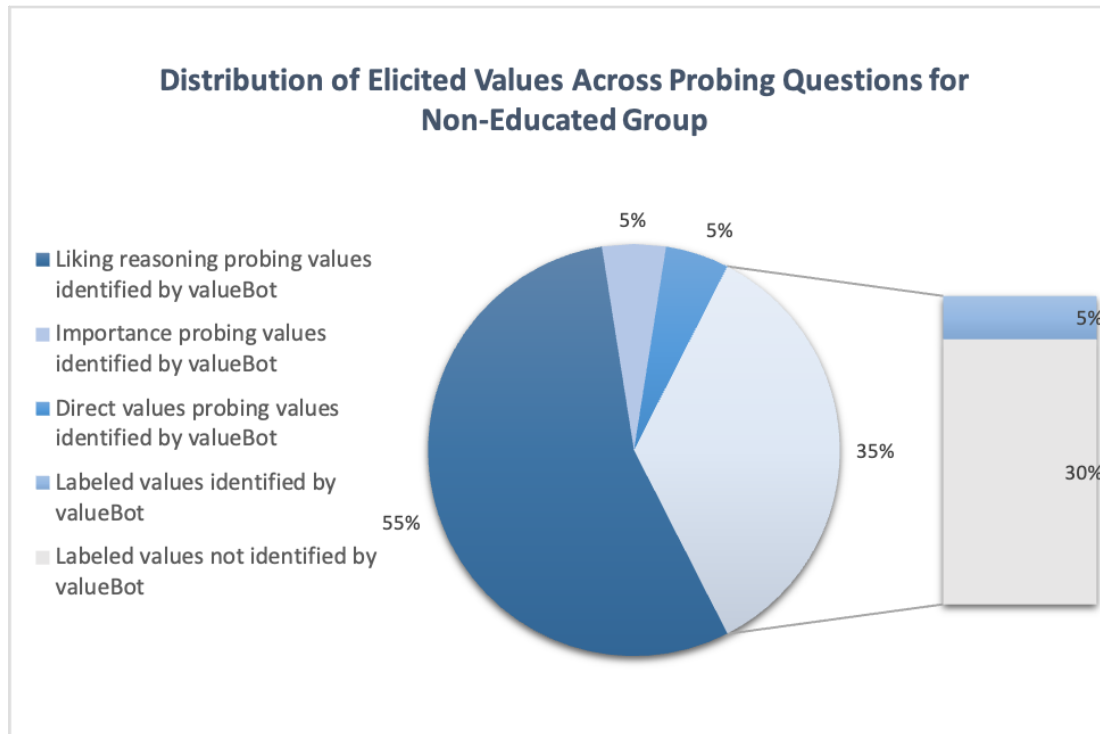


Figure 4.5: Proportion of elicited values across different probing questions for the non-educated group.

among different features.

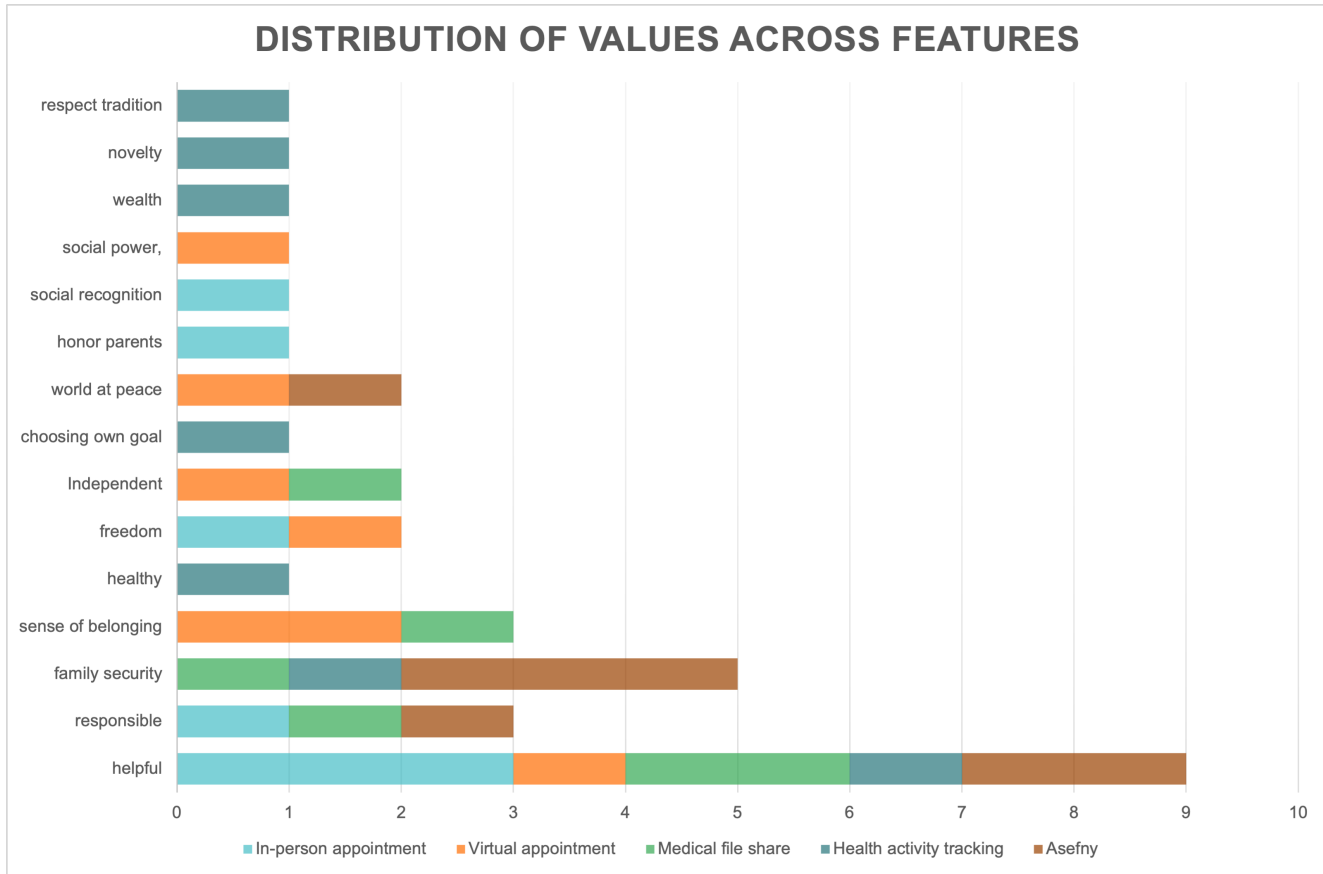


Figure 4.6: Values elicited distribution among app features

3 Values Violation Reporting

Based on the results, values violation is reported when participants are facing a situation that violated the values. It can't be identified prior, and it has no relationship to education. As most of the reported violations in the experiments were reported by non-educated participants, although they faced a situation that violated a value.

The approach of triggering users selecting the aspect they were not satisfied with and reasoning about it was effective in identifying violations of values during the

Evaluation Result for Session NO #5

Negative Perception Results

Feature Id	Feature Name	Perceptions	Total Undesirable Aspect/Issues	Total Desired Requirement	Value Details	User story
13	Virtual Appointment	👎 I do not like it	1	1	FEATURE DETAILS	USER STORY
21	In-person Appointment	👎 I do not like it	1	1	FEATURE DETAILS	USER STORY
12	Health Activity Tracking	👎 I don't like it at all	1	1	FEATURE DETAILS	USER STORY

Figure 4.7: Reported value violations across application features

experiment. These violations occurred in the familiarity step of the evaluation process, where participants encountered issues with specific features.

These violations were identified in four features: in-person appointment, virtual appointment, health activity tracking, and Asefny, with four values being violated: social recognition, independence, trust, and responsibility. Please refer to table 4.5.3 for violated values details.

A violation indicates that a user's requirement was not met. For this, users were asked to report their requirements, and these requirements are linked to the values unsupported. In fact, these user requirements were verified by the bot with the users in the conversation session after the requirements elicitation. You can visualize the resulting user stories below. For details, please refer to table 4.5.3. These two features, virtual appointment and Asefny, were also reported to have unsatisfied values. However, unlike the violations, these unsatisfied values did not constitute violations, as the users' perceptions were neutral—neither liking nor

Value: Independent							EXPLORE
High	Label: of no doctors available	ID:122	Role:patient	Want: book an appointment at different time	Benefit: I want to book an appointments at a different time so that I can choose doctor option	Value: Independent	DETAILS
Value: sense of belonging							EXPLORE
neutral		ID:187	Role:patient	Want: provide me options to select how i want the doctor talk to me	Benefit: i select the preferred way to communicate with him	Value: sense of belonging	DETAILS
Value: benefit							EXPLORE
neutral		ID:206	Role:patient	Want: good communication with doctor to prove me good examination	Benefit: so that he can help me well	Value: benefit	DETAILS

Figure 4.8: User stories generated by elicitationHub tool

disliking the features. In this context, participants described specific requirements that could improve their perceptions of these features. It's important to note that violated values typically have a higher priority than unsatisfied values, as they reflect more significant user concerns. The table below presents the two reported values along with the corresponding user requirements aimed at enhancing their satisfaction.

Conclusion

We conducted an experiment to assess the valueBot's ability to identify user values between the educated and non-educated participant groups.

Six out of 20 values of the non-educated group were labeled by the user and were not identified by the valueBot. Even though the participants have been prompting several times. The bot failed to identify two values within an educated

group. These values are trust and comfort. Trust has been presented in each group. In fact, authors [13] explained trust as a value system theme, which could be defined as how an application convinces users that it is harmless. They mapped it to conformity as it has a similar objective of avoiding harm to others. After removing trust, there will be five labeled values for the non-educated group, which could be mapped to a sense of belonging and helpfulness. The other values, "easy and quick," were not sufficiently clear.

The overall results show that the ValueBot is effective in eliciting human values whether directly in early probing phase or later when users provide their values.

4.6 Applicability to Generalization

To assess the applicability of the tool in a different domain, we selected the LinkedIn application for evaluation. This platform offers a professional environment for networking, job seeking, and career-related connections. Five key features were chosen for assessment: profiles, postings, learning, networking, and jobs.

We invited ten participants to evaluate the platform. These participants had no prior exposure to human values. Among them, four participants completed the evaluation of three features. To mitigate the limited number of participants, we encouraged those who evaluated the first three features to assess two additional features.

The tool successfully identified nineteen user values. These values were con-

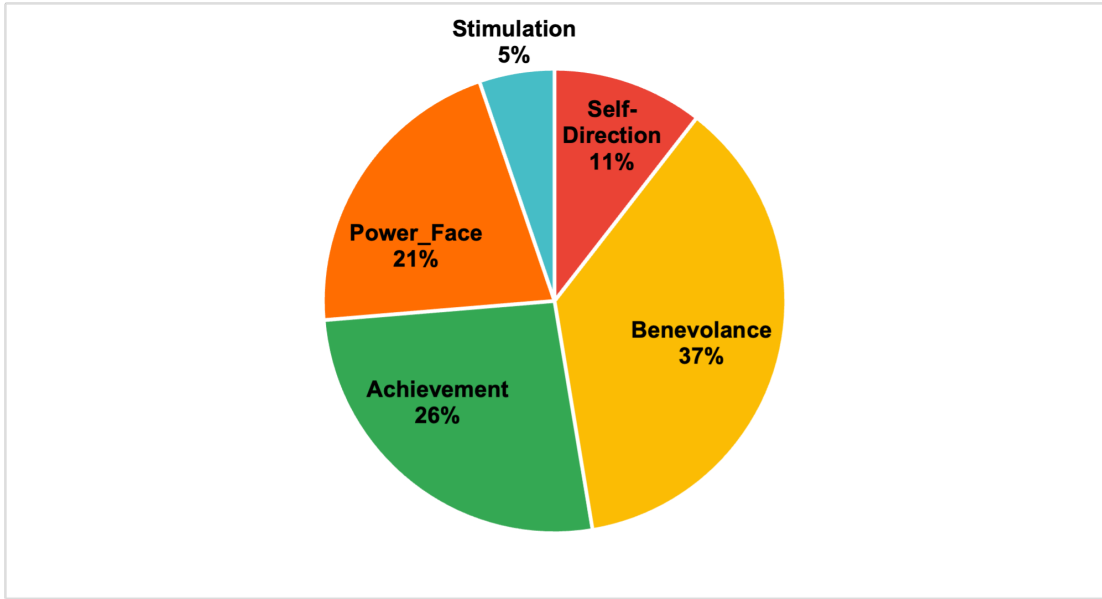


Figure 4.9: The distribution of value categories identified by ValueBot
firmed and verified with the end-user by the bot during the session. Out of the
twenty-seven values, eight were labeled by users, which were not able to be iden-
tified by the bot even after responding to the bot’s probing questions.

The most frequently identified values were (helpful, ambitious, social recogni-
tion, curious, see Figure 4.9. These non recognized values by bot are learning and
growing, trust, awareness, confidence, motivation, attracting people, and clarity.
Please refer to table 4.6 for detailed view of the values elicited among different
features.

Table 4.9: The complete view of LinkedIn App results

ID	Feature	Perception	Aspect	Value Category	Value	Matched/Labeled
60	Profile	I Love It	Analytics	Self-Direction	Curious	Matched
60	Profile	I Love It	Analytics	benevolence-Caring	Honest	Matched
60	Post	I Like It	Post Views Analytics	benevolence	Helpful	Matched
60	Jobs	I Love It	Recommendations	Not Matched	Trust	Labeled
60	Network	I Love It	Suggestions	Not Matched	Confidence	Labeled
60	Learning	I Love It	Learning Experience	benevolence	Responsible	Matched
73	Profile	I Love It	Featured Posts	Achievement	Ambitious	Matched
73	Profile	I Like It	Recommendations	Achievement	Ambitious	Matched
73	Profile	I Like It	Endorsements	Achievement	Show Abilities	Matched
73	Post	I Like It	Edit	Power_Face	Social Recognition	Matched
73	Jobs		Job Recommendations	Not Matched	Learning And Growing	Labeled
73	My Network	I Like It	Suggestions	benevolence	Helpful	Matched
73	My Network	I Do not Like It	Recruiter Interactions	Benevolence	Helpful	Matched
73	Learning	I Love It	Recommendations	Achievement	Successful	Matched
73	Learning	I Love It	Certification Sharing	Achievement	Have People Admire You	Matched
75	Profile	I Like It	Experience	Stimulation	Daring	Matched
76	Profile	I Like It	Analytics	Not Matched	Awareness	Labeled
76	Post	I Like It	Post Views Analytics	Not Matched	Awareness	Labeled
76	Jobs	I Like It	Recommendations	Power_Face	Social Recognition	Matched
76	Network	I Love It	Suggestions	Power_Face	Social Recognition	Matched
76	Learning	I Like It	Learning Experience	Not Matched	Clarity	Labeled
77	Profile	I Love It	Analytics	Self_Direction	Curious	Matched
77	Profile	I Like It	Suggestions	Not Matched	attract people	Labeled
77	Post	I Love It	Post Views Analytics	Not Matched	motivation	Labeled
77	Jobs	I Like It	Recommendations	Benevolence	Helpful	Matched
77	Network	I Like It	Invitations	Benevolence	Helpful	Matched
77	Learning	I Like It	Recommendations	Power_Face	social recognition	Matched

4.7 User Experience Evaluation

4.7.1 ValueBot User Experience

ValueBot received a score of 1.615 for pragmatic qualities, which represent usability-related aspects. This score suggests a positive perception of the bot’s usability, though it does not reach the highest levels of satisfaction.

The hedonic quality represents the emotional appeal and enjoyment derived from using the system, such as stimulation, novelty, and attractiveness. Our tool received a score of 2.259. This means that participants experienced a strong positive emotional response to the tool, finding it engaging and enjoyable to use. This indicates that the valueBot agent was well received in terms of user experience and aesthetic design. It was encouraging that all participants expressed a willingness

Item	Mean	Variance	Std. Dev.	No.	Negative	Positive	Scale	
1	1.7	1.5	1.2	9	obstructive	supportive	Pragmatic Quality	
2	1.6	3.0	1.7	9	complicated	easy	Pragmatic Quality	
3	2.0	1.0	1.0	9	inefficient	efficient	Pragmatic Quality	
4	1.2	2.2	1.5	9	confusing	clear	Pragmatic Quality	
5	2.2	1.7	1.3	9	boring	exciting	Hedonic Quality	
6	2.6	0.3	0.5	9	not interesting	interesting	Hedonic Quality	
7	2.1	0.6	0.8	9	conventional	inventive	Hedonic Quality	
8	2.1	0.9	0.9	9	usual	leading edge	Hedonic Quality	

Figure 4.10: Evaluation result for the UEQ questionnaire

to use the tool again if invited, with the chatbot (4) being the most attractive feature, followed by user stories and the results. One participant explained how the tool supported her understanding of herself.”The tool does an excellent job of helping me explore and identify my core human values. It guides the process in a structured yet personalized manner, allowing for meaningful self-reflection

and clarity.” This was actually reported by another participant, highlighting, ”It helped me in thinking in a different way when chatting with the chatbot.” For more insights, see the table below: 4.7.1.

Participant impression	Favorite part
”Simple and clear.”	”Chatbot”
”I needed help at first but then it was easy to complete the evaluation by my own”	” The results and user stories part”
” very easy and clear for me”	”Chat bots ”
”it helped me in thinking in diffrent way when chatting with the chatbot”	”the chatbot”
”i find it quite efficient and interesting as well”	”that is it so easy not complicated at all”
”Simple and easy. In the beginning I thought I will need support but after first feature it becomes clear and I learned it”	”chatbot”
”I loved how easy it is to use it”	”Easy access and smooth communication ”
”Innovative”	”Explanations ”
”The tool does an excellent job of helping me explore and identify my core human values. It guides the process in a structured yet personalized manner, allowing for meaningful self-reflection and clarity.”	”It was how effectively it helped me explore and identify my human values. ”

We conducted a fifteen-minute session with two senior experienced requirements engineering practitioners individually to evaluate the analyst experience, during which the researcher presented the tool, provided examples, and demonstrated its use. Participants shared their insights and were asking about different aspects, including communication, how they can see the results, if they can modify it or not, and how it could be used.

The results were 2 for the pragmatic, where the hedonism quality reached 2.5.

Short UEQ Scales	
Pragmatic Quality	2.000
Hedonic Quality	2.750
Overall	2.375

Figure 4.11: Analyst

Both described the effectiveness of the bot and demonstrated how it would support requirements engineering. "As a business and systems analyst, I will use it to understand the user, their requirements, and their values," and the other one, "I will use it to help my analysis for the requirements of the owner in the project."

4.8 Chapter Summary

This chapter described the implementation approach and demonstrated its practical application. An evaluation of the approach was conducted. Initially, a pilot

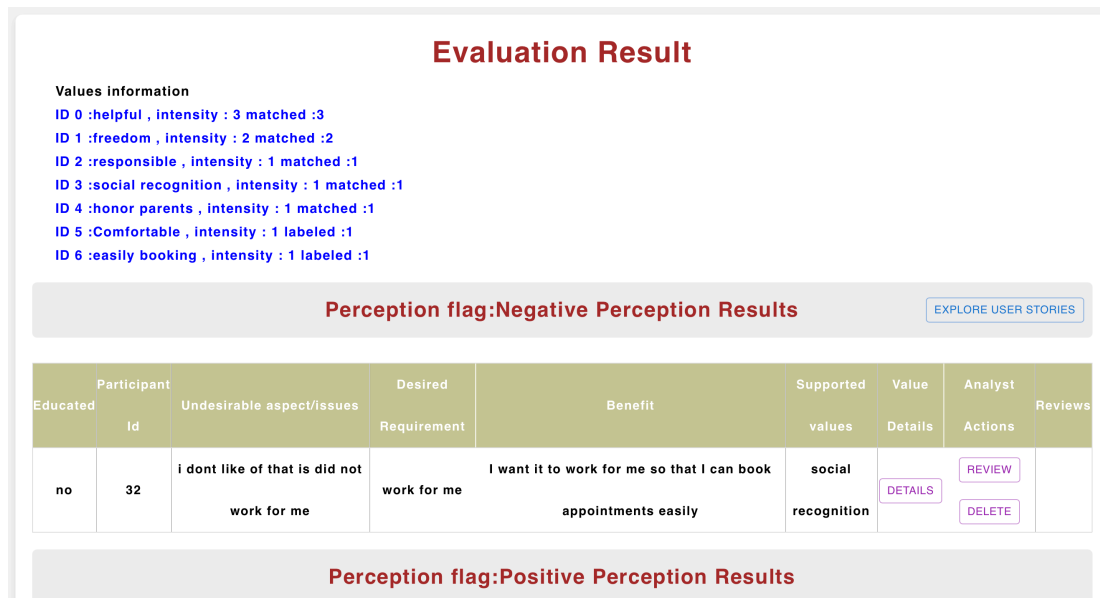


Figure 4.12: Summary of values and importance per feature

study was conducted to investigate the applicability of the current approach implementation. Later, the results of the experiment and its design were presented. Followed by the conclusion and the user's experience evaluation for both requirements engineering practitioners and app users.

Value Label	Value Descriptions	Liking	Aspect	Participant Group
ID.1 In person appointment				
Comfortable	"Its super easy and straightforward" "ease of use " " Comfortable "	I like it	Booking for my family member	Educated
Support	"The transparency of the information for the doctor" "The transparency and how I easily i can book the appointment" " It was simple booking the appointment the in person appointment and i can see the doctor information that was very helpful" "Support"	I like it	Doctor Info	Non-educated
ID.2 Virtual Appointment				
The direct interaction	"The doctor was there to hear and interact with me" "It provides immediate assistance" "Being in a communication in the doctor either using call or chat" "The direct interaction"	I like it	Session	Non-educated
ID.3 Share Medical File				
Quick and Easy Access	"This is easier to convey my health profile and history to the doctor" "save my time" "Quick and Easy Access"	I like it	QR-code	Non-educated
Transparency	" The easy sharing between the doctor and the patient" "The transparency of sharing my information with my doctor and he be able to track my progress" "To make my information visible to the doctor" "transparency"	I love it	QR-code	Non-educated
ID.4 Health Activity Tracking				
Trust	" the data is not accurate" "It's important for me to give me accurate data" "to give accurate data so i can trust it" "Trust"	I don't like it at all	Tracking Data	Non-educated
ID.5 Asefny				
Easy	" Direct access and informative form we need to fill" "easy to fill" "easy"	I like it	Information	Non-educated
Trust	" trust they will take action" "trust they will come" "trust"	neutral	no call	Educated

Table 4.6: User responses and labels for values not identified by the valueBot

Value Category	Value Item	Total
Benevolence-caring	helpful	9
Benevolence-dependability	responsible *	3
Security-personal	family security	5
	sense of belonging	3
	health	1
Self-direction-action	freedom	2
	independent*	2
	choosing own goal	
Universalism- concerns	world at peace	2
Stimulation	novelty	1
Tradition	respect tradition	1
Face	social recognition *	1
Power-resourced	wealth	1
Power-dominance	social power	1

Table 4.7: Value categories importance

Note: **Bold:** Bold and star values have been reported as violated. Social recognition violation occurred in in-person appointments, independent with virtual appointments, while the responsible party reported not satisfied but was not violated in the Asefny feature. Please refer to the table for details 4.5.3 and table 4.5.3

In-Person Appointment: I do not like it	
Aspect	Booking
Values probing responses	"I want it to work for me so that I can book appointments easily." "Respect"
Values identified	Face-(Social recognition)
Verification statement	"I want people always to treat me with respect and dignity" participant response: "very much like me"
User requirement	"I want it to work for me so that I can book appointments easily."
Virtual Appointment: I do not like it	
Aspect	No doctor available
Values probing responses	"of no doctors available" " I can choose doctor option"
Values identified:	Self-direction (Independent)
Verification statement	"Doing everything independently is important to me" participant response: "very much like me"
User requirement	"I want to book an appointments at a different time so that I can choose doctor option."
Health Activity Tracking: I do not like it very much	
Aspect	Tracking Data
Values probing response	"the data is not accurate" " It's important for me to give me accurate data" " to give accurate data so i can trust it"
Values Identified	User label: Trust
Verification statement	Alright. Trust is an important value yo you when using this feature? participant response: "Yes"
User requirement	"I want to give accurate data so that I trust it."
Asefny: I do not like it	
Aspect	lagging
Values probing response	"be more reliable, it kept existing me out of the app" "so that be reliable" "The whole idea is amazing, but it kept lagging" "it is reliable"
Values Identified	Benevolence (Responsible)
Verification statement	"I go out of my way to be a dependable and trustworthy friend." "I want those I spend time with to be able to rely on me completely."
User requirement	"I want it to be more reliable, it kept existing me out of the app so that it is reliable "

Table 4.8: Values violation reporting across different features

Note: Verification statements are adapted from the PVQ measurement questionnaire. In case a value did not belong to any value category, we confirmed it with users as seen in the tracking data.

Virtual Appointment: Neutral	
Values probing response	" I select the preferred way to communicate with him" "he listen to me clearly and show caring"
Values Identified	Security-(Sense of belonging)
Verification statement	"feeling care about me." Participant response: "very much like me"
User requirement	"I want provide me options to select how i want the doctor talk to me so the i select the prefered way to communicate with him"
Asefny: Neutral - participant-41	
Values probing response	First value: Family security" " ensure they respond and receive" "it's important for me to feel they will receive it and will respond"
	"family security"
	Second value: Trust "trust they will take action" "trust they will come"
	"trust"
	:Security (family security), User Label: Trust
Values Identified	"It is important to me to live in secure surroundings."
Verification statement	User selected statement Alright. Trust is an important value yo you when using this feature? Participant response: "Yes"
User requirement	"i want to call not send it as request so that i ensure they respond and receive "

Note: For neutral perceptions, users are encouraged to describe how the feature could be ideal for them, followed by value-prompting questions to enhance their perceptions.

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter discusses insights and findings about the approach and its implementation, the valueBot. Also, it presents the threats that might affect the validity of the user study, states the limitations of the approach, answers the research questions, concludes the research, and provides future directions that are related to value elicitation and verification.

5.1 Discussion

The most remarkable contribution of our proposed approach is its ability to help analysts elicit and understand the values of end-users within application contexts. Practitioners often face challenges in eliciting values due to their subjective and implicit nature, which makes them difficult to understand outside of their context. To address this, we designed the approach to provide contextual meaning

for values. By linking them to roles and functional goals to enhance their understanding. Our approach is designed around engaging end-users in the elicitation through triggering them with values-prompting questions to describe their important values. Then to verify these values with them. Thus, we centered it around the users, the main source of values.

Another contribution is identifying the values violation in existing app features, understanding if a violation of values exists, and then it provides a mechanism to identify unmet user requirements. By interacting with the end-users.

This supports analysts in designing innovative app features that satisfy user values, ensuring no violations exist while identifying the values of utmost importance and any necessary modifications to features based on value violations. And, mostly, verified values, which none of the literature has provided a mechanism for verification. Which mostly relied on the analysis of app reviews. Although these were done manually by a researcher, only one provided an automated way, although no empirical evaluation was done.

Another important aspect of this thesis is the implementation of the approach, valueBot, which solves the challenges facing the end-user. Such as identifying their values before using an application and concerns about privacy. By linking value elicitation to app features, aspects can trigger users to speak and focus on their values. Most importantly, its dynamic and interactive nature allows users to report values at any time and verify them. This interactive approach was inspiring and provided promising reflection. Based on the results of the valueBot evaluations in terms of the values elicited and user experience evaluation.

Almost all participants were impressed by the interactive way and simplicity, with many reporting that the process helped them learn more about their own values. The most important aspect was the chatbot. This was actually important, especially in the design for an approach to elicit the human aspect, as we want to ensure their engagement and motive during the process. Yes, this was totally satisfied by the value bot, based on participants reporting.

For the effectiveness of the valueBot, we designed an experiment to elicit values in a healthcare and well-being domain, which is Sehhaty app. We then compared the elicited values with the values elicited from the literatures, See table 5.1 We noticed that in two from literature, and our interview study, and the experiment results, security is becoming more important than self-direction. In fact, it was surprising that all the group shared the same values. While in our two studies, benevolence comes before security; this is because of the nature of app features, which significantly affect the values, as it forms the context.

From the analyst's perspective, we implemented a tool to integrate the valueBot. This tool, the elicitationHub, supports the analyst by providing them insights into the importance of values (based on their frequency), their contextual meanings, and their relation to specific app features. Analysts can easily identify which features violate user values and which have unmet values. Not only the features but also the aspect of the feature that either has a violation or is supportive of the values. Additionally, supporting the analyst to present the users requirements and the supported values in a user story, showing priority based on perception and grouping by the values. Also, it provides them with a mechanism to review

each result.

This tool was implemented to fill the gap of lacking a tool supporting the elicitation. And, most importantly, this was evaluated empirically. The analyst provided their feedback. Analysts found it interactive and simple, which would support them in requirements elicitation, not only with values elicitation. They can tailor it to support the product owner.

This approach is useful in both emerging and established domains. In domains with established user experience guidance, such as gamification, the tool can support a more profound understanding of users' values and assess whether the app is meeting them or not. This includes understanding how users expect the feature to be. In domains where there is limited information about users, the tool can play a foundational role in establishing the groundwork for developing UX guidelines. This is because the approach is built around understanding users' values by considering the context, which is defined by the functional goal and the role performing the goal based on values elicitation in the requirements literature. For example, different values are expected for different roles performing the same function, as described in the answer to research question 1.

5.2 Threats to Validity

This section investigates the four types of validity threats that are involved in the study, which are construct, internal, external, and conclusion validity. Also, the mitigation of each threat has been discussed.

5.2.1 Construct Validity:

In this thesis, the definition of human values is considered a threat to construct. This because values have been vague and declared to be challenging and implicit. I mitigated this threat by conducting a thorough analysis of how literature defines values when they were eliciting values in addition to social definitions, and then we came up with our definition, based on identifying main attributes and implications of values. Then, we conducted an interview study prior to designing the approach, ensuring that our definition and probing questions were effective in identifying users' values. Also, during the evaluation, we introduced our definition of values to all participants, providing examples before conducting the experiment to establish a common understanding.

Another possible threat to construct validity arises from the decision to use the Schwartz theory of human values [30]. There are also other theories of human values that could be used in place of the Schwartz theory. However, none of these theories has been applied in software engineering, while the Schwartz theory has already been widely used in requirements engineering for values elicitation[16], [17], [35], [10], [8], [1], [33], [36], [5], [37], [38]. The refined theory of basic value was used in [13] [14].

Additionally, our implementation of the approach (valueBot) was designed to be open, capturing unmatched values and addressing those not fully articulated, as seen with trust values. To account for other potential emergent values, participants were given the opportunity to label these values themselves.

Lastly, the process of identifying violations was based entirely on negative liking. To ensure that this dislike was indeed caused by value violations, participants were asked to select the aspect of the feature they did not like, followed by a targeted question probing the specific values associated with their dissatisfaction.

5.2.2 Internal Validity:

An anticipated risk for the study was that all participants were potential users of the app and are not active users, as we expect active users are expected to report more values violation. To address this, we introduced a preliminary step before the expert evaluation to ensure that participants were familiar with the app under evaluation. We asked them to perform specific tasks related to the features under evaluation to ensure their familiarity with the app. Although some participants became active users, they encountered value violations during this step and subsequently reported the issues they encountered.

Potential selection bias posed a threat to this study, as all participants were female. After removing one participant, a male, to ensure a balanced comparison between the groups in the experiment evaluation, four of them have technical backgrounds, and four have none. To mitigate this, we intentionally included two non-technical participants in each evaluation group. This helped minimize the risk of the evaluation focusing more on technical aspects and usability rather than on the intended values perspective.

5.2.3 External Validity:

A threat to external validity is the generalizability of our results, mainly the values elicited, evaluation was focused on the domains of healthcare and well-being and is limited by the size of participants who participated in the study. We mitigated this threat by comparing the results obtained using the approach design phase, the interview, the approach implementation results obtained through ValuBot, and the results obtained from two studies conducted in the same domain [1], [5] to a similar domain. Furthermore, we conducted another session on the Professional Networking domain using the LinkedIn app, and the results were promising. Please refer to section 4.6

5.2.4 Conclusion Validity:

The small sample size could lead to low statistical power, which might impact the validity of the conclusions drawn from evaluating the impact of the human values education on valueBot ability to recognize users values. To mitigate the impact of this small sample size, each participant was asked to evaluate five features of the app. This approach ensured that each participant contributed valuable data for multiple aspects of the study, thereby maximizing the information obtained from the available participants.

5.3 Limitation

The value-based approach implementation revealed several limitations. First, the approach relied on a conversational agent (ValueBot) with Natural Language Understanding (NLU) capabilities to identify values. The training phrases for the agent were based solely on the portrait value questionnaire to ensure validity. However, this limited the bot's ability to recognize user values effectively from descriptions. We developed a values synonym dictionary to address this issue, we were not able to validate it so we didn't use it in the study. Another limitation involved the verification process, which used the Portrait value Questionnaire (PVQ). Although widely used in requirement engineering, the PVQ is context-free, which might be confusing for the end user to reflect the value on the application context. We tried mitigating this by referring to the app when questioning the user.

Third limitation for the valueBot design was lacking natural, human-like interaction capabilities of more sophisticated systems and appeared rule-based in its responses. Fourth, our valueBot did not verify the correctness of requirements or detect ambiguities, it was focusing on syntax and format, ensuring the context is active. We mean by the context, is the the bot is asking about the requirements phase. This limitation was intentional, and was not considered to solve, as the bot was designed to demonstrate the approach's applicability to value elicitation rather than provide a comprehensive requirements engineering solution.

Finally, limitation with the value probing questions, some users focused on fea-

ture design rather than reflecting on their intrinsic values, even when explicitly asked to consider the application context. These limitations underscore areas for improvement in future iterations of the approach, particularly in enhancing the conversational agent’s capabilities, refining the verification process, and addressing user engagement challenges.

5.4 Research Questions Answers

This section presents all the answers to the research questions were introduced in Chapter 1.

- RQ1: To what extent having a user interactive approach does support the elicitation and verification of user requirements that reflect human values?.

Answer: Our results show that interactive approaches, whether through traditional methods such as interviews or advanced techniques like the interactive agent’s valueBot, hold significant promise in uncovering both important values and potential violations within application features. Although interviews are extensive and subjective as they rely on the analyst’s knowledge and understanding of values. This makes it vulnerable to values verification, which requires their understanding in order to verify it with the user directly. In addition, personal skills to conduct the interviews.

Not only the interviews, authors [1] highlighted that the mapping of motivational goal model was success, although familiarization with and knowledge of the Schwartz theory of human values are needed to perform this kind of map-

ping. The comparison of our findings from both interviews and the ValueBot—a conversational agent with this study, as it targeted the same domain—revealed encouraging and consistent outcomes.

Authors [1] manually analyze motivational goal models to identify human values for health care and well-being projects. They tried mapping emotional goals, functional goals, and roles to human values manually. The results showed. Security, self-direction, and benevolence rank as the top value categories overall. refer to table 5.1. Keeping in mind the context, which is the role, and the functional goal attributes to the values. In our app, benevolence, in terms of helpful and responsible values, becomes more important for users than a sense of belonging. Both in-person and virtual appointments primarily highlighted these values. In fact, in virtual appointments, security was demonstrating above others, where users report it's important for the healthcare provider to show caring and understanding. This value sense of belonging was not presented in the booking in-person appointment. In the in-person appointment, one participant of the valueBot report the honor parenting as an important value, and they associated this value with booking for the family aspect. This value was also reported by professional crafters for managing health goals. Please refer to figure 5.1 to investigate the mapping of functional goals to the values considered in the role.

The figure 5.4 shows the verified value categories from ValueBot compared to those obtained through manual analysis, aligned with Schwartz's value theory as seen in previous studies.

Functional goal	Role	Emotional Goals	Human Values
Manage health	OA	Informed	Self-direction : Independence, Self-respect Security : Healthy, Sense of belonging
Manage health	ICG	Informed	Power : Social power Benevolence : Helpful, Responsible
Manage health	OA	Empowered	Self-direction : Freedom, Choosing own goals Achievement: Capable
Manage health	OA	In touch	Security : Sense of belonging Benevolence : True friendship
Manage health	OA	Involved	Self-direction : Choosing own goals, Independence
Manage health	PCG	Aware	Achievement : Influential, Capable Conformity : Honoring parents and Elders Power : Authority
Manage health	OA	Stress free	Hedonism : Pleasure, Enjoying life Self-direction : Independence, Privacy
Contact relatives, Make behavior suggestions	ICG	Reassured	Benevolence : Responsible, Helpful Power : Recognition, Authority
Make behavior suggestions	OA	Safe	Security : Healthy
Stimulation	OA	Active	Stimulation : Varied life, Excitement in Life
Provide feedback on the exercise suggestion (physical)	OA	Motivated	Stimulation : Excitement in Life Achievement : Ambitious
Provide feedback on the exercise suggestion (cognitive)	OA	Motivated	Stimulation : Excitement in Life Hedonism : Pleasure, Enjoying life
Socialize	OA	Empowered	Self-direction : Freedom, Choosing own goals Power : Recognition, Preserving my own image
Maintain relationships	OA	Involved	Benevolence : True friendship Stimulation : Excitement in life Security : Sense of belonging
Maintain relationships	OA	In touch	Benevolence : True friendship Stimulation : Excitement in life Security : Sense of belonging

OA= Older Adult, ICG= Informal Caregiver, PCG= Professional Caregiver
TABLE II

Figure 5.1: Values elicitation from goal models [1]

- RQ2: To what extent the proposed approach is effective and useful in eliciting and integrating human values into user requirements in practice?

Answer: The main challenges preventing values elicitation in practice were the lack of tools supporting the analysis and the lack of tools for analyzing values [19], [5]. And the challenge to understand values [18], [33]. Our interactive approach succeeds by actively involving end users and supporting analysts during the elicitation process. This helps to identify values, link them to specific features, and verify them effectively. When violations are found, we work with users to find solutions that address their concerns.

The user experience evaluation showed end users were motivated to use the tool and enjoyed the evaluation, which is most importantly to engage them in the evaluation process. The tool received a score of 2, indicating that the users are

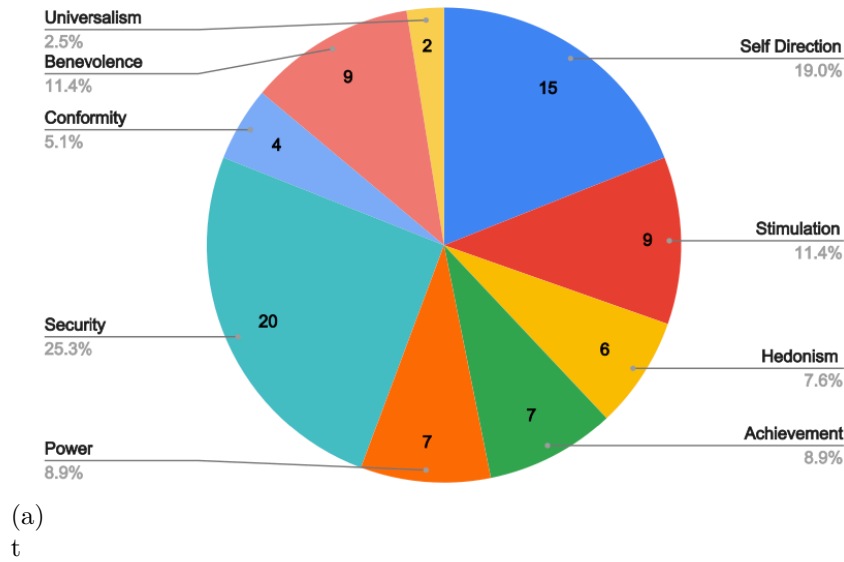


Figure 5.2: Values categories distribution in the elderly assistance project [1]

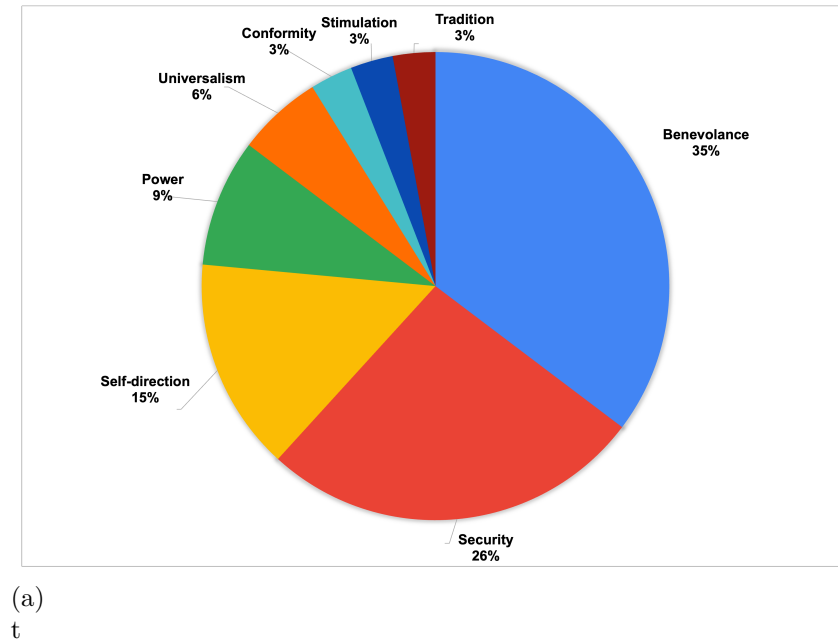


Figure 5.3: Values categories distribution in Sehhaty App elicited using valueBot

Figure 5.4: A visualization between the values elicited using valueBot and the values obtained through a thorough analysis of emotional goal models [1]

finding it enjoyable. All of the participants showed their willingness to use the bot again, and they highlighted that the most attractive aspect was the bot's ability

Comparing elicited values cross healthcare and well-being domains		
Sehhaty values -valueBot	Sehhaty values - Interview	Healthcare & Well-being(elderly assistant) [1]
Benevolence(helpful-responsible)	Benevolence	Security(Healthy, Sense of belonging)
Security(family security, Sense of belonging,Healthy)	Security	Self-direction(Independence, Self-respect, freedom)
Self-direction		
Self-direction(Independence, freedom,Choosing own goals)	Self-direction	Benevolence(true-friendship)
Power(social recognition, wealth, social power)	Conformity	Stimulation(Excitement in Life)
Universalism - world at peace	Stimulation	Power
Stimulation (novelty)	Power(social recognition, wealth, social power)	Achievements
Tradition - respect tradition	Universalism	Hedonism
		Conformity
		Universalism

- To ensure consistency with comparisons, we aligned the categorization from the Schwartz refined theory of basic values to the the basic framework of human values.

Table 5.1: Sehhaty values comparison with elicited values across healthcare and well-being Apps

to support their understanding of themselves.

For the analyst, it was asserted that this tool not only improves requirement engineering but also aids in understanding values. We conclude that an interactive approach facilitates the elicitation process in practice, supporting both end-user engagement and the elicitation process.

5.5 Thesis Contributions:

Four contributions were provided in this thesis:

1. The value elicitation and verification interactive approach.
2. The valueBot conversational agent that was an implementation of the proposed approach to elicit and verify the value.
3. The evaluation of the approach implementation (valueBot) includes an assessment of its effectiveness in eliciting values and an evaluation of the users' experience.

5.6 Future Work

This thesis opens the door for several research directions that could be discovered in values elicitation approaches and more specifically practical elicitation approaches.

- **Enhancing ValueBot Capabilities to recognize values:** In the current implementation, we are revealing the Dialogflow NLU capability and using only the values measurement for intents training. We recommend expanding it by using value synonyms and app reviews highlighting value violations or support. Alternatively, you can create your own model to identify the values. Additionally, currently bots are becoming more human, so we recommend improving the bot's ability to generate human-like responses for better engagement. This, we anticipate, will enhance users' capacity to report and articulate their values. Add other communication methods, for example, voice record instead of texting to support various user groups.

provide languages to allow users to express values effectively in their native language.

- **Focus on Enhancing Requirements Identification:** In this study, the requirements elicitation and verification process relied on a rule-based approach. We relied on checking the context of the conversation and the format; we don't consider the quality and correctness of the requirements. This is because requirements elicitation and verification were only to show one way of how values would support the practitioners. BTU values identification in reality supports practitioners to know which to focus on, what users are expecting, and can be used for marketing strategies.
- **Expanding Experimentation and Evaluation:** The current approach was evaluated using existing app features. Future research could explore evaluating the methodology with: feature scenarios to simulate complex interactions, Prototypes to observe the elicitation process in real-world settings, and value-driven storytelling to describe features in ways that resonate with user perspectives and emotional connections. which then can be used to start triggering users with values probing questions to identify the values. Another, evaluate the approach again and the value of probing questions with a different group of users and in a different application context.

5.7 Conclusion

In this thesis, we analyzed the existing literature in both requirements engineering and social science to understand what values mean and what approaches have been introduced. This supported us to summarize the main attributes for the values and the main aspects or elements for values in requirements engineering. This led us to design two value probing questions, which have been evaluated in an interview study to trigger users describing their values. These questions succeeded in triggering users to speak about values, although understanding human values of the end-users was challenging. In addition to general interview limitations, which are time-consuming, affected by interviewee personality and aspect, and privacy concerns.

This motivated proposing an interactive approach supported by a tool to elicit the values and then verify the values with the end users. This verification process is important to ensure understanding of the values. The proposed approach tackles challenges to understanding values by focusing on engaging the end-user, and then to verify these values.

This approach was later designed on a conversational agent integrated on a tool, developed mainly to support both the analyst and the end-user engaging the elicitation. This implementation was to tackle the other left gaps, which are the lack of tool support, end-user privacy concerns, and practitioner challenges to understand values. We designed an experiment to evaluate the valueBot's effectiveness in identifying values between two groups of participants. All were

introduced to the same features, but one group was educated about values and the other was not. The results showed that valueBot were able to elicit values more effectively with the educated group than the uneducated group, where the bot was able to identify value clearly. This was expected as the bot was trained on the same value framework that was provided to users. Also, the end-user experience was reported. in fact, analyst were presented by the elicitationhub tool to evaluate the effectiveness of the tool in practice. Both analyst and end-users results were encouraging and motivation showing the effectiveness of the approach in practice.

APPENDIX A

SUPPLEMENTARY

MATERIAL

A.1 Appendix: Interview Design to Understand Most Important Values of End-Users in the Health-Care Domain

- App features analysis: [click here](#)
- Recruitment Form Access Link: [click here](#)
- Informed Consent Form Access Link: [click here](#)

A.2 Values Definition Attributes Identified from Existing RE Literature

A.3 Implementation Code Repository

- Project link on GitHub: [click here](#)
- valuBot intents training phrases and entities : [click here](#)

A.4 Tool Testing Attachment Detailed Analysis of Tool Capability

- Testing results -participant 1: [click here](#)
- Testing results -participant 2: [click here](#)

A.5 Evaluation Design Materials

A.5.1 Feature chosen for evaluation

- App features analysis: [click here](#)

A.5.2 Experiment Running

- Participant Recruitment Form: [click here](#)

- Informed Consent Form - end-user access: [click here](#)
- Informed Consent Form - elicitationHub - analyst version access: [click here](#)
- Participant Instruction File - non-educated group - access link: [click here](#)
- Participant Instruction File - Educated group- access link: [click here](#)
- Tool Access: [click here](#)
- User Experiment Questionnaire (UEQ) end-user access: [click here](#)
- User Experiment Questionnaire (UEQ)-requirements engineering practitioners - access: [click here](#)

A.6 Implementation Evaluation Result

- Full educated group evaluation results dataset: [click here](#)
- Full non-educated group evaluation result dataset: [click here](#)

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