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Abstract

Ethical issues in software engineering are becoming more important, however incorporating them into requirements engineering (RE) is still difficult. There are several methods and tools to help identify and discuss ethical requirements, although these approaches often focus in facilitating discussions rather than providing structured and automated processes. In addition, many of the existing methods tend to focus on specific situations, which makes them less flexible when it comes to addressing the evolving ethical concerns that can arise in different projects. This thesis aims to explore how we can systematically gather and define ethical requirements. By using a catalog-based approach, we offer a structured methodology for integrating ethical considerations into standard RE practices. Additionally, it looks into the potential role of large language models (LLMs) in automating parts of ethical requirement generation, consequently improving efficiency while maintaining ethical awareness.

Keywords: Ethical Requirements, Requirements Engineering, Software Ethics, Large Language Models

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Introduction

1.1 Context and Motivation

With the rapid advancements in technology, there is an increasing need to integrate ethical standards into software products [13]. Numerous controversial cases have emerged regarding ethics in the tech industry, particularly concerning the collection of personal data without consent — for example, South Korea's privacy watchdog recently fined Meta $15 million for unlawfully collecting sensitive personal data[25], and investigations in Australia have revealed that personal information is being shared repeatedly via ad-tracking systems without user consent[24].

Currently, the emphasis on ethical requirements is primarily directed at Artificial Intelligence (AI) systems, as the decisions made by these systems can significantly impact society; recent international efforts - including a legally binding treaty between the US, UK, and EU on AI standards - underscore this focus [30]. However, there is still a lack of research on how to effectively incorporate ethical requirements into software products in general, with most studies focusing on ethics for AI systems than the broader software development process [34].

Recent advancements in large language models (LLMs) for reading and interpreting human text [19] present an opportunity to more effectively extract stakeholder needs. We intend to leverage these models to improve the extraction of ethical requirements from stakeholders' textual data.

1.2 Problem Description

The lack of an efficient approach to identifying ethical requirements for software products presents a significant challenge. The rapid advancement of technology has led to a wide range of ethical issues that must be considered when designing software [13].

Ethical requirements are often implicit or abstract, making them difficult to identify and clearly define [6]. Furthermore, there is often a communication barrier between stakeholders—their understanding of ethical issues may vary due to differences in background,

culture, and personal beliefs—and the developer teams responsible for translating these concerns into software requirements [6]. Additionally, different stakeholders may hold varying perspectives, resulting in conflicting priorities. Finally, converting abstract ethical principles into specific, testable system requirements is complex and resource-intensive, often straining project timelines and available resources [13].

1.3 Objectives

Our objective is to develop a software tool that receives textual data from stakeholders, including detailed representations of their software product concepts. This tool will extract ethical requirements and generate a comprehensive specification of Ethical User Stories that effectively address these requirements.

The software will leverage large language models (LLMs) to analyze and interpret the input provided by stakeholders. Additionally, it will simulate human behavior, allowing for a deeper insight into potential ethical dilemmas and social implication associated with the project. This will empower teams to develop software products that align with ethical standards and social expectations.

1.4 Document Structure

This section outlines the structure of the remaining chapters in this thesis.

1. **Chapter 2** provides an overview of essential concepts and technologies pertinent to the study, including requirements engineering, large language models, and ethics.

2. **Chapter 3** presents the state of the art reasearch conducted to identify and evaluate existing approaches to gathering requirements and their limitations.

3. **Chapter 4** discusses the expected contributions of this thesis and our proposed tool.

Background

This section aims to provide information and context on the current state of topics related to the research, including Requirements Engineering, Ethics, Large Language Models, and Systematic Mapping Studies. Which serve as the basis for understanding the scope of this research.

2.1 Ethics and Ethical Requirements

The term "ethics" often refers to the investigation and analysis of moral principles and dilemmas. It can be considered as values that encompass the guidelines and standards that govern our decisions in our daily lives, as well as our emotinoal and conscientious actions.

In the context of ethical software engineering, these values can become actianable through strucutured frameworks that translate the abstract ethical principles into concrete requirements. [29]

Using the example of a driverless car [15], several ethical considerations must be taken into account. Beneficence entails ensuring that the car actively creates value for its users; for instance, it should select the quickest and safest route to the destination. Non-maleficence requires that the car does not cause harm to its users or others; therefore, it must stop whenever an object is in its path to prevent accidents and should exhibit a defensive driving style to enhance passenger safety. Autonomy requirements ensure that the car adheres to traffic laws, calculates the best route without human intervention (unless requested by the user), and cannot change the destination without the user's approval. Explicability, meaning that the car should be able to provide explanations for its actions. It needs to clarify why it chose a particular route or decided to overtake another vehicle. In summary, it should be transparent in its decision-making, especially in situations where it could put someone at risk.

2.1.1 Ethical Principles

There are several ethical guidelines published by different organizations, institutions and researchers. ECCOLA, a card-based tool to help stakeholders identify and discuss ethical requirements in software development [31], is based on the IEEE Ethically Aligned Design guidelines[1] and the EU Trustworthy AI guidelines[2].

IEEE Ethical Guidelines for Intelligent Systems

The ethical and values-based design, development, and deployment of autonomous and intelligent systems (A/IS), acccording to the IEEE Ethical Guidelines for IS, should adhere to the following general principles:

1. **Human Rights**
   Autonomous and intelligent systems shall be designed, developed, and operated in a manner that respects, promotes, and safeguards internationally recognized human rights.

2. **Well-being**
   The enhancement of human well-being shall serve as a fundamental criterion for the development of autonomous and intelligent systems.

3. **Data Agency**
   Developers of autonomous and intelligent systems shall empower individuals by ensuring their ability to access and securely share their personal data, thereby preserving their control over their identity.

4. **Effectiveness**
   The creators and operators of autonomous and intelligent systems shall provide demonstrable evidence of their effectiveness and suitability for their intended purpose.

5. **Transparency**
   The rationale underlying any decision made by an autonomous and intelligent system should always be discoverable and comprehensible.

6. **Accountability**
   Autonomous and intelligent systems shall be designed and operated in a manner that ensures clear and unambiguous justification for all decisions made.

7. **Awareness of Misuse**
   Developers of autonomous and intelligent systems shall take proactive measures to mitigate potential misuse and operational risks.

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[1]IEEE Ethical Guidelines: https://standards.ieee.org/industry-connections/activities/ieee-global-initiative/

[2]EU AI Guidelines: https://digital-strategy.ec.europa.eu/en/library/ethics-guidelines-trustworthy-ai

8. **Competence**

   Developers shall define, and operators shall adhere to, the requisite knowledge and skill levels necessary for the safe and effective operation of autonomous and intelligent systems.

EU Trustworthy AI guidelines

Based on the EU trustworthy AI guidelines, AI systems must adhere to the following key requirements:

1. **Human Agency and Oversight**

   AI systems should empower human beings, allowing them to make informed decisions while fostering their fundamental rights. Proper oversight mechanisms must be in place, which can be achieved through human-in-the-loop, human-on-the-loop, and human-in-command approaches.

2. **Technical Robustness and Safety**

   AI systems must be resilient and secure, ensuring fallback plans in case of failures. They should be accurate, reliable, and reproducible to minimize and prevent unintended harm.

3. **Privacy and Data Governance**

   AI systems must fully respect privacy and data protection while implementing robust data governance mechanisms. This includes ensuring data quality, integrity, and legitimized access to data.

4. **Transparency**

   AI systems should maintain transparency in data usage, system operations, and business models. Traceability mechanisms should be implemented to achieve this. Additionally, AI decisions should be explained in a stakeholder-adapted manner, and humans must be made aware of AI interactions and system capabilities.

5. **Diversity, Non-Discrimination, and Fairness**

   AI systems must prevent unfair biases that could marginalize vulnerable groups or exacerbate discrimination. They should be accessible to all individuals, regardless of disability, and involve relevant stakeholders throughout their lifecycle.

6. **Societal and Environmental Well-being**

   AI systems should benefit humanity, including future generations, by ensuring sustainability and environmental friendliness. Their social and societal impacts should also be carefully considered.

7. **Accountability**

   Mechanisms must be established to ensure responsibility and accountability for AI systems and their outcomes. Auditability, which assesses algorithms, data, and

design processes, is crucial, particularly in critical applications. Moreover, accessible redress mechanisms should be in place.

On the other hand the authors Mark Ryan and Bernd Stahl, published an impressive list of guidelines for developers and users[27] to provide guidence when developing ethically aligned AI systems. The following are the Key Ethical Principles from Mark Ryan and Bernd Stahl's guidelines:

Transparency

- AI should be transparent in its operation and decision-making process.

- Key aspects: explainability, interpretability, communication, disclosure.

- AI decisions should be reproducible and subject to external auditing.

Justice and Fairness

- AI should promote justice and fairness, avoiding biases and discrimination.

- Key aspects: inclusion, equality, non-bias, non-discrimination, accessibility.

- AI organizations should implement fairness-aware data processing methods.

Non-Maleficence

- AI should be designed to prevent harm to individuals and society.

- Key aspects: security, safety, prevention, integrity, protection.

- AI should not compromise human well-being or cause social dislocation.

Responsibility

- Developers and organizations must take responsibility for AI's impact.

- Key aspects: accountability, liability, integrity, redress mechanisms.

- Ethical training and internal auditing should be implemented.

Privacy

- AI should uphold privacy and data protection standards.

- Key aspects: personal data security, informed consent, data minimization.

- Compliance with legal frameworks such as GDPR is essential.

Beneficence

- AI should promote social good and well-being.

- Key aspects: public benefit, peace, common good, sustainability.

- AI should be used to address global challenges such as healthcare and environmental issues.

Freedom and Autonomy

- AI should respect human autonomy and decision-making.

- Key aspects: consent, liberty, empowerment, choice.

- AI should not manipulate individuals or limit personal freedoms.

Trust

- AI systems should be trustworthy and reliable.

- Key aspects: transparency, safety, accountability.

- Organizations should demonstrate security measures to build trust.

Sustainability

- AI should be developed with environmental sustainability in mind.

- Key aspects: energy efficiency, resource management, ecological impact.

- Organizations should prioritize minimizing AI's environmental footprint.

Dignity and Solidarity

- AI should uphold human dignity and social cohesion.

- Key aspects: societal bonds, fairness, non-discrimination.

- AI should not undermine social structures or democratic values.

These ethical principles collectively provide a foundation for the responsible development and deployment of AI systems. While these principles emphasize different aspects - such as human rights, transparency, accountability, and fairness - they converge on the common goal of ensuring that AI systems are aligned with societal values and human well-being.

By integrating these ethical considerations into AI developmenet, organizations can build trust, mitigate potential harms, and ensure that AI systems serve as beneficial tools rather than sources of risk.

Although this thesis is focused on a broader scope of software development, ecompassing not only AI systems. The ethical principles outlined above can be adapted and reused to guide the elicitation and specification of ethical requirements for software products.

2.2 Requirements Engineering

Requirements engineering can be tought as the systematic process of developing requirements by iteratively and cooperatively analyzing a problem, documenting observations in various representation formats, and checking the accuracy of the understanding gained. This process, which ultimately populates a requirements document, involves addressing a range of questions about the mehods, iterations, participants, documentation standards, and criteria for determining when the process is complete and the requirements are suffienctly accurate [20].

2.2.1 Requirements

Requirements are the formal statement of what a system must do or the conditions it must satisfy in order to meet the needs of its stakehodlers. In requirements engineering, a requirement is generally understood as a necessary condition or capability that a system must posses in order to solve a particular problem or achieve a specified objective [20]. Requirements serve as the "real-world goals" that guide the subsequent design, implementation, and validation activities in the system's life cycle [22].

2.2.1.1 Categories of Requirements

Requirements are typically divided into two broad categories:

Functional Requirements These requirements describe behaviours, functions, or services that a system must provide. They answer the "what" of a system's operation - for example, processing transactions, generation reports, or handling user input.

Non-Functional Requirements (NFRs) These requirements are also known as quality attributes, which specify how well the system performs its functions [22]. They include performance, usability, security, and other constraints that influence the system's overall quality. This categorization helps in balancing the design choices and ensuring that both the capabilities and the performance characteristics of the system are well understood [22].

2.2.2 Requirements Elicitation

Requirements Elicitation is a fundamental stage of requirements engineering that involves gathering, uncovering, and documenting the needs, expectations, and constraints of stakeholders for a software product and turn them into a structured set of requirements.

By enganging in thorough preparation, using diverse techniques, and iteratively validating findings, organizations can significantly enhance the chances of project success. When done correctly, this process not only clarifies what needs to be built but also aligns the entire project team around a shared vision, ultimately leading to software that meets user and business needs. [22]

There are many techniques to elicit requirements such as interviewing stakeholders on one-on-one or group discussions, workshops and brainstorming in collaborative sessions to generate a wide range of ideas, surveys to capture feedback from a larger audience, and observing directly how users interact with the system [14, 22]. The results gathered from these techniques are then gathered and further analyzed and validated with stakeholders to ensure they reflect true needs.

2.3 Large Language Models & Generative AI

Large Language Models (LLMs) are AI systems designed to comprehend, generate, and manipulate human text. They form the foundation of generative AI, a technology that creates new content—such as text, images, or even music—by identifying patterns in extensive datasets.

LLMs are constructed using deep neural network architectures, most notably the transformer model as shown in figure 2.1. Transformers employ self-attention mechanisms that assess the relationships between words in a sentence, allowing the model to grasp context and long-range dependencies within the text [32]. By training on a vast corpus of text, these models learn the structure of language, gaining knowledge about grammar, facts, reasoning patterns, and even the subtle nuances of human communication.

Generative AI, which encompasses LLMs, utilizes this learned language model to produce new, contextually relevant text. When presented with a prompt, an LLM predicts and samples the next word (or sequence of words) from a probability distribution, resulting in coherent and often creative outputs.

The process begins with pre-training, wherein the model is exposed to large volumes of text data. During this phase, the model learns to predict the next word in a sentence, which compels it to capture patterns of syntax, semantics, and factual knowledge. After pre-training, the model may undergo fine-tuning on task-specific data to further refine its capabilities.

The core of their operation relies on the transformer architecture, which uses an encoder-decoder framework. Both the encoder and decoder consist of multiple identical layers built around self-attention mechanisms and feedforward networks. The encoder processes an input sequence, mapping it to a series of continuous representations. In contrast, the decoder generates an output sequence autoregressively, predicting one token at a time based on the encoder's output and the previously decoded tokens. At the heart of the Transformer is the *multi-head self-attention* mechanism. This allows each token to compute weighted relationships with all other tokens in the sequence through scaled dot-product

attention. As a result, the model efficiently captures long-range dependencies without the need for sequential computation, unlike recurrent networks. After the self-attention process, the output passes through a position-wise feedforward network, followed by residual connections and layer normalization. These components enhance stability a nd improve gradient flow. Because the model does not have built-in recurrence or convolution, positional encodings are added to the input embeddings to preserve the information about word order. In the decoder, masked self-attention ensures that predictions at each step depend only on previously generated tokens, which maintains autoregressive generation. By utilizing parallel computation and attention-based representations, the Transformer achieves state-of-the-art performance in tasks such as machine translation, text generation, and language understanding. This capability allows it to interpret complex prompts and generate detailed, human-like responses[8].

In simulating human behavior, large language models (LLMs) generate text that not only follows grammatical rules but also reflects human reasoning and stylistic patterns. They can imitate various conversational styles, adjust their tone based on context, and even simulate empathy in their responses. Research into emergent abilities has shown that as these models scale up, they start to display sophisticated behaviors that were not explicitly programmed. These behaviors can resemble human intuition and creativity [18]. This aspect can be particularly useful for extracting ethical requirements from stakeholder descriptions, as ethical requirements tend to be abstract and often require interpretation and discussion.

2.3.1 Generating Personas with LLMs

The use of LLMs in the generation of personas has gained traction as an effective method for representing diverse user needs and perspectives [4]. Personas, as synthetic representations of users, are instrumental in requirements engineering, product design, and AI fairness assessments. By leveraging the generative capabilities of LLMs, the creation of personas can be automated and diversified, enhancing their applicability in AI systems that require inclusivity and ethical considerations.

2.3.1.1 Automating Persona Generation

Traditional persona creation is a manual process that relies on user research, stakeholder interviews, and demographic analysis. LLMs provide a novel approach by generating detailed, realistic, and contextually rich personas based on vast linguistic and social knowledge. Given a set of prompts, an LLM can produce persona profiles that include demographics, behaviors, goals, and potential biases. This automation reduces the time and effort required for persona development while increasing the variety and representativeness of personas in AI-driven applications.
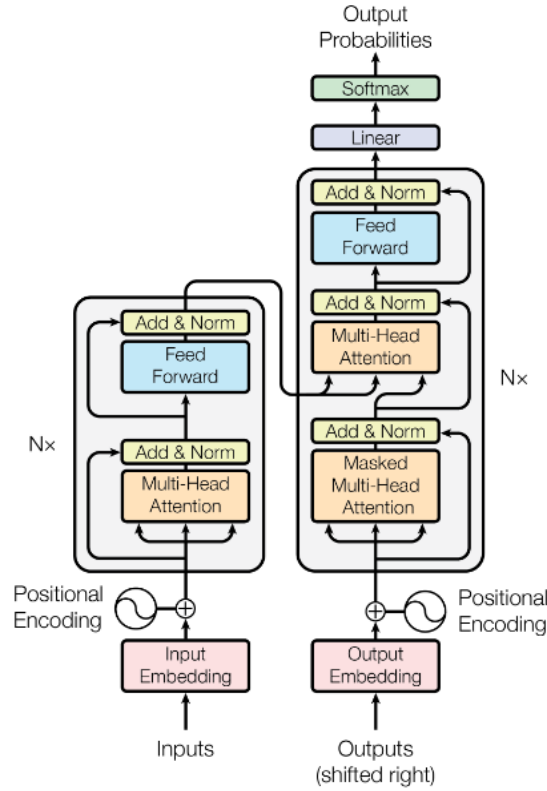
Figure 2.1: Transformer architecture

2.3.1.2 Enhancing Diversity and Inclusion

A key challenge in AI development is ensuring that systems are designed with inclusivity in mind. LLM-generated personas can be tailored to reflect underrepresented groups, mitigating biases in technology development. By conditioning LLM outputs on diverse datasets and ethical guidelines, personas can better represent different socio-economic backgrounds, cultural values, disabilities, and intersectional identities.

2.3.1.3 Use Cases in AI Requirements Engineering

The integration of LLM-generated personas into AI development workflows enables a structured method for eliciting diverse requirements. For instance, personas can be used to simulate user interactions, assess AI fairness, and guide system testing. In responsible AI engineering, chat-based interactions with virtual personas allow analysts to understand potential ethical concerns before deployment. This process contributes to refining AI-driven decision-making and ensuring that user-centric considerations are embedded from the early stages of development.

By harnessing the power of LLMs for persona generation, AI developers can create more representative and ethically responsible AI systems.

2.4   Systematic Mapping Study

An SMS is a type of secondary research method that provides a comprehensive overview by identifying, categorizing, and documenting existing literature [23]. It aids researchers in understanding the scope of a research area, identifying trends, and highlighting gaps in knowledge [2]. Unlike a Systematic Literature Review (SLR), which seeks to provide a comprehensive and detailed synthesis of findings related to a well-defined research question [7], an SMS primarily focuses on classifying studies and offering a high-level overview of a research domain.

An SMS follows a rigorous process, typically involving the following steps [2]:

Defining Research Questions: The study begins by establishing research questions that guide the mapping process. These questions help determine the scope of the study, such as identifying existing methodologies, trends, or challenges within a given research field.

Developing Search Strategies: To ensure comprehensive coverage of the literature, researchers define search terms and select relevant databases. The search strategy must be broad enough to capture all relevant studies but focused enough to avoid unrelated results.

Applying Inclusion and Exclusion Criteria: After collecting a large number of studies, researchers filter them based on predefined criteria. This ensures that only relevant, high-quality papers contribute to the mapping process.

Data Extraction and Classification: The selected studies are analyzed and categorized based on key characteristics, such as research themes, methodologies used, application domains, and publication trends. These classifications help create an overview of the research landscape.

Analysis and Visualization: The final step involves summarizing findings, often using visual tools like charts, graphs, or tables to illustrate trends, gaps, and clusters within the research field.

Insights gained from an SMS can help researchers understand which topics are gaining attention and which are underexplored. It can also highlight areas that lack sufficient research, allowing researchers to make informed decisions based on a broad perspective of existing work and to organize studies into meaningful categories. This process assists researchers in identifying trends, gaps, and opportunities to guide their future research efforts.

Identifying which areas have received more attention can be challenging. An SMS aids in this process by highlighting gaps, limitations, and opportunities for improvement

in the current body of work. This, in turn, guides further research and informs decision-making. We began this process by formulating Research Questions (RQs) to direct the SMS, designing a search string (SR), and clearly defining our inclusion and exclusion criteria. Once we applied the SR across various libraries and gathered results, we conducted a high-level review by examining the titles, abstracts, and keywords of the works. Studies that did not meet any inclusion criteria or met exclusion criteria were discarded. The remaining studies proceeded to a second phase, where we read the introduction, conclusion, and relevant sections to address the formulated RQs. Those studies capable of answering at least one Research Question were classified as relevant and included in our final discussions to guide future research [23]. An example of this process can be seen in Figure 2.2.
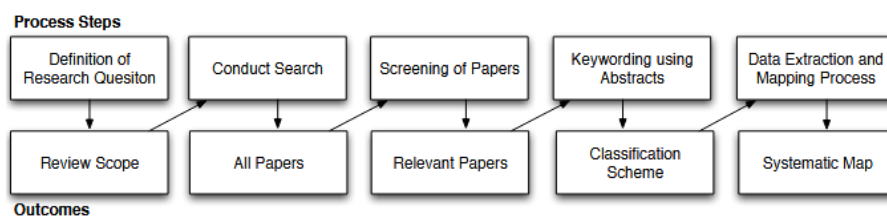

Figure 2.2: The systematic mapping Process

State of the Art

In this chapter we'll present our state of the art research. We performed a short Manual Search and a Systematic Mapping Study (SMS).

3.1 Manual Search

I this chapter we'll go over the manual research conducted, where we review relevant literature. We begin by examining articles related to existing approaches for requirements elicitation. As well as existing apporaches for ethical requirements elicitation. We also analyze articles related to the usage of AI to gather requirements. Lastly, we'll discuss the recent advancements in using LLMs for ethical requirements elicitation, highlighting their potential and limitations.

3.1.1 Card-Based and Catalog Approaches

This subsection covers methods that use modular tools (cards, catalogs) to support the elicitation process.

The approach outlined in [16] is the ECCOLA method [31], which is designed to help developers integrate AI ethics into the development of AI systems. This method offers a practical, modular, and sprint-based framework that fits within agile development practices. ECCOLA consists of 21 cards organized into 9 themes, including Transparency, Fairness, and Accountability. Each card describes an ethical issue, suggests actions that developers can take, and provides real-world examples. At the beginning of each sprint, developers select the relevant cards, use them during development, and document their ethical considerations. However, it is important to note that ECCOLA was specifically designed for AI and autonomous systems, so it may not be the most suitable approach for projects that do not focus on AI. Additionally, the card-based system requires training and familiarization, meaning teams must invest time in learning how to use the cards and incorporating them into their workflow. Furthermore, this approach does not provide straightforward answers but instead serves as a framework to encourage discussion and reflection on ethical issues throughout the development process. Additionally, many

users preferred to use ECCOLA's cards selectively, tailoring them to their immediate needs instead of repeating the full process as instructed. While this modular approach allows for flexibility, it risks missing critical ethical dimensions by not exhaustively addressing all possibilities in each iteration.

In the study [1], the authors introduced the RE4HCAI (Requirements Engineering for Human-Centered AI) framework, which emphasizes the integration of human-centered principles in requirements engineering (RE) for AI-based software. Traditional AI development often overlooks critical aspects such as ethics, bias, inclusivity, and user needs, which can lead to the creation of non-inclusive and biased systems [9]. The proposed framework aligns with existing industrial guidelines from companies like Google[1] and Microsoft[2], incorporating insights from systematic literature reviews (SLRs) and expert surveys. It utilizes a conceptual model that organizes the requirements process into key human-centered areas: user needs, model needs, data needs, feedback and user control, explainability and trust, and errors and failures. To support these areas, the authors developed a catalog to assist in eliciting and modeling requirements. The RE4HCAI framework consists of three layers: human-centered guidelines mapped into a reference model; a catalog for detailed requirements elicitation; and a modeling language with visual notations for presenting requirements. This framework enhances the understanding of human-centered requirements and underscores the iterative nature of RE for AI-based software, which requires continuous evaluation of user and system needs. Feedback from the study indicated that integrating human-centered values into RE improves inclusivity and reduces biases. However, the approach primarily provides a catalog focused on AI-based software requirements. This reliance on a static catalog may not address the dynamic nature of ethical challenges in the field. Additionally, its emphasis on AI may limit its applicability to other domains, raising concerns about subjectivity and a lack of broad empirical validation.

3.1.2 Agile Techniques: Ethical User Stories

In agile contexts, translating ethical principles into actionable user stories can bridge the gap between abstract guidelines and development tasks.

In this study [17], the authors introduce "Ethical User Stories" (EUSs), a novel approach that integrates ethical considerations into the agile requirements engineering process. This method translates abstract ethical principles into actionable, concrete requirements. EUSs empower developers, even those without extensive backgrounds in ethics, to incorporate ethical considerations into their work. Developed through three iterations of design science research (DSR) and involving 659 user stories, this approach shows promise in bridging the gap between abstract ethical principles and their practical implementation in SE. The process of creating an EUS involves four main steps. First, there needs to be a motivation

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[1]Google AI Principles: https://ai.google/responsibility/principles/
[2]Microsoft Responsible AI: https://learn.microsoft.com/en-us/azure/machine-learning/concept-responsible-ai

for developing an ethical system, which may arise from customer concerns or stakeholder priorities. Additionally, the type of system being developed must be considered. Next, an appropriate ethical framework should be selected. This framework may consist of guidelines, a method, or even an ethical theory, but it must be relevant to the product being developed. After selecting the framework, ethical user stories can be created. These stories adhere to the same structure as traditional user stories: "As a <role>, I want to <goal>, so that <reason>." However, they must include an ethical reference that connects the story to the chosen ethical framework. The user stories should address the ethical issues identified through the framework. Finally, these ethical user stories are utilized to determine both functional and non-functional requirements for the system. The success of EUSs, however, hinges on having a suitable ethical framework to define issues and guide discussions.

3.1.3 AI-Assisted Approaches for Requirements Elicitation

Recent advances in AI have paved the way for techniques that augment traditional elicitation methods. This section discusses approaches where AI is used to discover requirements more efficiently.

3.1.3.1 Agent-Based Simulation

The study in [3] introduces a new approach that utilizes LLMs to enhance and partially automate RE. These models can simulate user interactions and perspectives to identify a broader range of needs, including latent or unarticulated ones. The research presents a framework called Elicitron, which employs LLMs to generate diverse user agents capable of role-playing in product experience scenarios. These agents produce structured outputs that are highly relevant to the RE process, enabling the discovery of needs that traditional methods may struggle to capture. This approach also allows for scalability; experiments demonstrate its effectiveness in generating both diverse and latent needs, often outperforming human interviews in this regard. While LLMs have potential drawbacks, such as a tendency to predict the most likely outcomes, the research argues that careful contextualization can guide them to generate outputs that assist designers in uncovering a broader range of user needs. The study also highlights the effectiveness of LLMs in analyzing interview data and classifying needs. However, this method mainly focuses on identifying design requirements, particularly latent needs, which can be non-obvious and only recognized in later stages of development. These types of requirements differ from ethical requirements, as they primarily concern the usability of the product under development. Nevertheless, with the recent advancements in LLMs and AI, a similar process could also be useful for identifying ethical requirements.

The authors in [33] investigate the potential of LLMs to automate user story refinement through an Autonomous LLM-based Agent System (ALAS). ALAS aims to enhance requirements management within agile environments. It functions through AI agents

that simulate agile roles and facilitate collaborative interactions. The task prompts were designed to mimic real project contexts. Initial prompts defined the agent's role, the task, and its context, while follow-up prompts guided subsequent subtasks. Two primary agent profiles were established—Product Owner (PO) and Requirements Engineer—each responsible for different aspects of user story quality. The agents utilized contextual documents, such as a Minimum Viable Product (MVP) outline and a product vision statement, to ensure alignment with project goals. After the experimentation phase, feedback from participants, which included experienced team members from six agile teams, indicated that while ALAS improved story coherence, additional input from POs and domain experts is necessary to avoid irrelevant out-of-scope details and to refine prompts for greater project-specific relevance. The study also observed that although adjusting the "Temperature" parameter of the model encouraged creativity, it could result in plausible yet irrelevant outputs. Hence, employing techniques like retrieval-augmented generation (RAG) may help maintain accuracy. In conclusion, while this method is not directly related to eliciting ethical requirements, its approach is quite similar to previously established methods for ethical requirements elicitation.

3.2 Systematic Mapping Study

In this section we'll discuss the performed SMS and the process followed to conduct it as well as our results. We used the study in [7] to guide and structure and our state of the art research.

3.2.1 Search Strategy

We plan to answer the research questions (RQs) present in table 3.1

Research Question	Motivation and Objective
RQ1: Which approaches already exist to specify ethical requirements?	We aim to identify existing approaches to elicit ethical requirements.
RQ2: What challenges and limitations do these approaches have?	We aim to have an understanding of the limitations that these approaches face to guide our further research.
RQ3: What are the characteristics of these approaches?	We aim to understand how these approaches operate and how they can be relevant to our goal.

Table 3.1: Research Questions and Motivations

The goal of these questions is to have an unserstanding of the existing approaches to elicit ethical requirements, their limitations and how they function, thus having clearer picture of what we can crete or improve upon with this research.

To develop our search string, we conducted several pilot searches to ensure that all terms aligned with our research goals. The search string is as follows:

```
software AND requirement AND ethics AND elicitation AND (approach
OR challenges OR limitations OR characteristics)
```

It consists of five mandatory terms, `software`, `requirement`, `ethics`, and `elicitation`, these terms try to guarantee that our search results are focused in this research topic, and the expression (`approach OR challenges OR limitations OR characteristics`), to cover the key aspects of our research questions.

3.2.1.1 Inclusion and exclusion criteria

The *inclusion criteria* used were:

- Studies published in peer-reviewed journals or presented at reputable conferences.

- Studies that address the research questions.

As *exclusion criteria* we have:

- Studies published before 2016.

- Studies not written in English.

- Duplicate studies or studies with insufficient methodological rigor.

- Secondary or tertiary studies.

3.2.2 Study Selection

This search was conducted with the help of Parsifal[3], a tool used to manage the study selection process and record decisions made at each stage.

The sources for this SMS were the libraries ACM[4], IEEE[5], ScienceDirect[6], and Springer[7]. These well-known libraries contain a vast collection of peer-reviewed scientific papers and articles. After applying our inclusion and exclusion criteria, we used quality assessment (QA) questions and assigned scores to filter the papers less relevant to our research problem. Ultimately, we addressed our research questions (RQs) and excluded studies that did not answer at least one of the RQs.

After applying the search string we retrieved a total of 3,321 papers, 3,887 from ACM, 14 from IEEE, 11,314 from ScienceDirect, and 655 from Springer. We then applied different filters for each library:

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[3]Parsifal: https://parsif.al/
[4]ACM: https://dl.acm.org/
[5]IEEE: https://ieeexplore.ieee.org/
[6]ScienceDirect: https://www.sciencedirect.com/
[7]ScienceDirect: https://link.springer.com/

- **IEEE and ACM**:

  - Years: 2016 - 2025.

- **Springer Link**:

  - Years: 2016 - 2025.

  - Content type: Chapter, Article, Research article, Conference Paper.

  - Languages: English.

  - Subjects: Software engineering, computer ethics, engineering ethics, ethics of technology.

  - Disciplines: Computer Science.

  - Subdisciplines: Software engineering/programming and operating systems, software engineering, Computer applications, Programming techniques

- **ScienceDirect**:

  - Years: 2016 - 2025

  - Article type: Research articles, Book chapters, Practice guidelines, Software publications

  - Subject areas: Computer Science

After applying the filters our study population was trimmed down to more specific works. It resulted in 3,225 studies from ACM, 11 from IEEE, 28 from ScienceDirect, and 57 from Springer. Since we still had a large ammount of results from the ACM library, we only used to first 50 results ordered by cited plus the first 50 results ordered by recency. So in total 100 results from the ACM library, gathering 195 studies.

We removed the duplicates using the Parsifal tool, resulting in 193 articles. After applying the inclusion and exclusion criteria we gathered 36 studies. We also used Parsifal for this papers as seen in the image 3.2. A visualization of the study selection process can be seen in figure 3.1

3.2.3 Quality Assessment

The QA's goal is to measure the level of valuableness of the resulting papers. QA questions are asked to each paper and by reading their introduction, conclusion and relevant chapters, we provide an answer. There are three answers available: Yes, Parcially, and No. Each answer with an attributed score, 1, 0.5, 0 respectively.

All papers were asked the following QA questions:

- Did the author presented their difficulties?

- Was the solution properly tested?
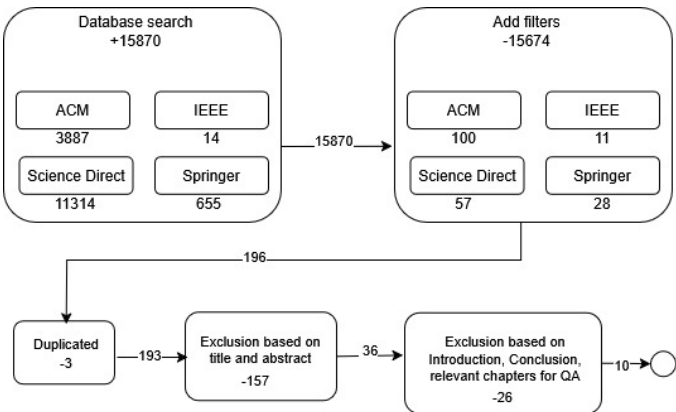
Figure 3.1: Steps for the Study Selection Process
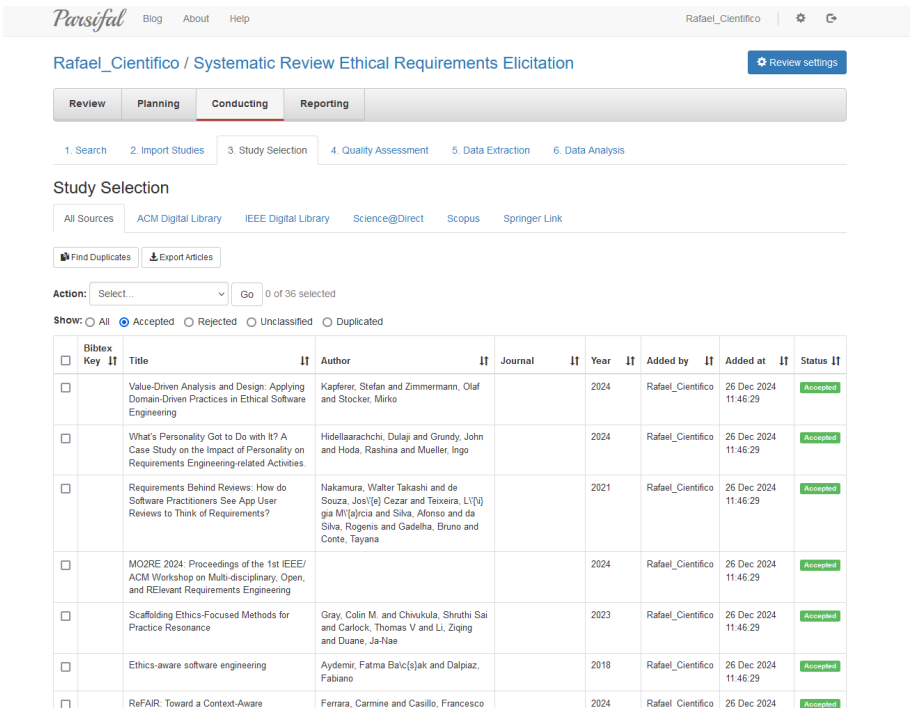

Figure 3.2: Accepted Studies after applying inclusion and exclusion criteria

- Is the method clearly explained?

The final quality score for each paper is calculated by summing scores for each question. The scores for each paper can be seen in the table 3.2

Paper Title	Quality Score
IEEE Draft Model Process for Addressing Ethical Concerns During System Design	0.0

Paper Title	Quality Score
Toolkit for specification, validation and verification of social, legal, ethical, empathetic and cultural requirements for autonomous agents	1.5
Eliciting Ethicality Requirements Using the Ontology-Based Requirements Engineering Method	2.5
A Framework for Privacy and Security Requirements Analysis and Conflict Resolution for Supporting GDPR Compliance Through Privacy-by-Design	0.0
Incorporating Ethical Aspects in Information Systems Requirements Engineering	0.0
Do You Own a Volkswagen? Values as Non-Functional Requirements	0.0
Advancing Requirements Engineering Through Generative AI: Assessing the Role of LLMs	0.0
Value-based requirements engineering: method and experience	0.0
An ontology-based approach to engineering ethicality requirements	3.0
Theme section on model-driven requirements engineering	0.0
Explainable software systems: from requirements analysis to system evaluation	0.0
The Impact of Personality on Requirements Engineering Activities: A Mixed-Methods Study	3.0
How mature is requirements engineering for AI-based systems? A systematic mapping study on practices, challenges, and future research directions	0.0
Using i* to Analyze Ethicality Requirements Following Ontology-Based Requirements Engineering	0.5
Stakeholder Inclusion and Value Diversity: An Evaluation Using an Access Control System	0.0
Managing Ethical Requirements Elicitation	0.0
Trustworthiness Requirements: The Pix Case Study	2.0
Chapter 12 - Assessing and implementing trustworthy AI across multiple dimensions	0.5
Requirements engineering for artificial intelligence systems: A systematic mapping study	0.0

Paper Title	Quality Score
Applying Human Values Theory to Software Engineering Practice: Lessons and Implications	0.0
IEEE/ISO/IEC International Standard–Systems and software engineering–Life cycle management–Part 7000: Standard model process for addressing ethical concerns during system design	0.0
IEEE Standard Model Process for Addressing Ethical Concerns during System Design	0.0
A roadmap for ethics-aware software engineering	2.0
Teaching Requirements Engineering for AI: A Goal-Oriented Approach in Software Engineering Courses	2.5
Ethical Requirements Stack: A framework for implementing ethical requirements of AI in software engineering practices	0.5
Implementing AI Ethics: Making Sense of the Ethical Requirements	0.0
The Influence of Human Aspects on Requirements Engineering-related Activities: Software Practitioners' Perspective	0.5
Interaction design and requirements elicitation integrated through SPIDe: a feasibility study	3.5
ReFAIR: Toward a Context-Aware Recommender for Fairness Requirements Engineering	3.5
Ethics-aware software engineering	0.0
Scaffolding Ethics-Focused Methods for Practice Resonance	0.0
MO2RE 2024: Proceedings of the 1st IEEE/ACM Workshop on Multi-disciplinary, Open, and RElevant Requirements Engineering	0.0
Requirements Behind Reviews: How do Software Practitioners See App User Reviews to Think of Requirements?	0.0
What's Personality Got to Do with It? A Case Study on the Impact of Personality on Requirements Engineering-related Activities.	0.0
Value-Driven Analysis and Design: Applying Domain-Driven Practices in Ethical Software Engineering	0.0

Paper Title	Quality Score
The Use of OpenEHR Archetypes in Requirements Elicitation: Best Practices for Engaging Domain Experts in Healthcare Software Development	2.5

Table 3.2: Scoring of each paper in Quality Assurance phase

Studies with a score below 1 were were excluded.

3.2.4 Threats to Validity

In this section we discuss threats to the validity of our SMS. We followed the guidelines in [21].

Search String: We developed our search string by experimenting with various query formulations and validating the outcomes. To address our research questions, we incorporated key terms such as "ethics", "elicitation", "requirements", "challenges", and "characteristics". Due to ScienceDirect's limitation of allowing only eight Boolean connectors per field, our query was restricted to eight terms. Although this approach was intended to limit the number of results for a manageable review, it may have inadvertently excluded some relevant studies.

Publication Bias: We initiated our search using four libraries (see Section 3.2.1), which may have resulted in missing studies available in other databases. During our manual search, we discovered additional relevant articles in other sources, such as arXiv[8]. Nonetheless, we included all the papers from our search results for analysis to capture every possible relevant study. Unfortunately, some papers were inaccessible and had to be excluded, although they might have contained relevant data.

Selection of Primary Studies: We selected papers for the final analysis by assessing how well each paper addressed the RQs. This process was initially carried out by a single researcher, which introduced the potential for subjective bias and the possibility of overlooking relevant studies. To mitigate this risk, we implementedn a QA step to ensure that only pertinent articles were included in the final stage. We established clear inclusion and exclusion criteria and, at this stage, did not rely solely on titles or abstracts; instead, we conducted a comprehensive review of each paper, focusing on the introduction, conclusion, and relevant sections that could help answer the QA or RQs.

3.2.5 Results

In this section we present our results for each search question.

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[8]arXiv: https://arxiv.org

3.2.5.1 RQ1: Which approaches already exist to specify ethical requirements?

Numerous approaches exist for eliciting requirements in software engineering, including approaches with focus on ethical requirements. These include Ontology-based methids such as ObRE [15], which provide structured frameworks for establishing ethical principles, and goal-ariented apporaches, like GORE [5], which refine ethical requirements through the KAOS methodology, which organizes the RE process through goal decomposition and visualization. Participatory and user-centered methods, like SPIDe [26] and OpenEHR archetypes [28] include stakeholders in the design process to guarantee that ethical considerations align with user needs. Automated techniques, for instance ReFAIR [11], that leverages NLP and machine learning to analyze user stories and classify fairness-realted issues in requirements. Finnaly, formal verification approaches, namely SLEEC-TK [12], which integrates ethical complience checks into system design. Each method varies in focus, from structured moedeling to user participation, automation, and compliance verification. Table 3.3 represents a the selected papers that answered RQ1.

Table 3.3: Selected Sudies for RQ1

Study	Year	Category	Approach
Renata Guizzardi et al.[15]	2023	Ethical Requirements Elicitation	ObRE
Beatriz Braga Batista et al.[5]	2024	Requirements Elicitation	GORE
Jean C. S. Rosa et al.[26]	2020	Requirements Elicitation	SPIDe
José Vitor de Abreu Silva & André Araújo[28]	2024	Requirements Elicitation	OpenEHR archetypes
Carmine Ferrara et al.[11]	2024	Requirements Classifier	ReFAIR
Sinem Getir Yaman et al.[12]	2024	Requirements Elicitation	SLEEC-TK

3.2.5.2 RQ2: What challenges and limitations do these approaches have?

During this study we could identify that some of these approaches struggle with scalability and adaptability across different scenarios or large scale projects [15]. Context dependency is another common issue, as classification models and structured frameworks often rely on predefined ontologies [28, 11], fainess-critical domains, or user involvement that may not generalize well . Stakeholder involvment can result in some difficulties, in particular in methods that require participation from users or domain experts [26, 28]. This is due to factors such as participant synchronization, limited expertise, and resistance to change can hinder the effectiveness of the approach. Furthermore, approaches that rely on ontology-based reasoning or structured requirement modeleing usually requires significant prior knowledge, training, or expertize [5, 15]. Automated and NLP-focused approaches can be problematic due to their standardized frameworks, which may create time constraints when adjustments are needed [11, 5]. In addition, the iterative nature of some methods can slow down development processes, making them difficult to implement in fast-paced

environments [15]. Finally, ethical requirement elicitation approaches may overlook regulatory complexities which may limit their adaoptability in real-world contexts.

Table 3.4: RQ2: Challenges and Limitations of the Approaches

Approach	Scalability/ Adaptability	Adaptability to Different Domains	Stakeholder Involvement	Knowledge/ Training Requirement	Other Limitations
ObRE	Yes	Yes (ontology-based)	–	High (ontology expertise)	Slow in fast-paced environments
GORE	–	Yes (structured goals)	Yes (user feedback required)	Moderate	–
OpenEHR archetypes	Yes (healthcare-focused)	Yes (domain-specific)	Yes (medical experts needed)	Moderate	Limited generalization
SLEEC-TK	–	–	–	High (formal methods)	–
SPIDe	–	–	Yes (co-design requires alignment)	Low	–
ReFAIR	Yes (NLP-based)	Yes (predefined fairness concepts)	–	Low (automated)	High time constraints for updates

3.2.5.3 RQ3: What are the characteristics of these approaches?

We observed that many of these approaches have structured and systematic processes. For instance, ObRE follows a clear methodology that uses ontologies [15], on the other hand GORE and OpenEHR archetypes are structured frameworks used to identify requreiments systematically [5, 28]. Similarly, SLEEC-TK employs formal methods to ensure compliance with ethical rules [12].

A strong focus on user-centered design is also present in several methods. SPIDe, for example, treats users as co-designers, fostering collaboration and creativity [26]. Thus, integrating their perspectives in the design process. OpenEHR archetypes, involve healthcare professionsals in the requirements elicitation process [28]. GORE incorporates Human-Centered AI principles like explainability, transparency, and feedback mechanisms, to address ethical and usability concerns in AI systems [5]. This approach also focuses in capturing and refining system goals into functional and non-functional requirements.

Some methods, like ReFAIR, are automated and scalable, using NLP and machine learning techniques to analyze user stories and classify fairness-related issues across various domains [11]. Additionally, flexibility and adaptability are common traits. ObRE's ontology-based approach is domain-agnostic and modular, which allows it to be adapted to different fields, as well as SPIDe's lightweight techniques that require minimal resources. While OpenEHR archetypes can be adapted to different healthcare needs.

In summary, these methods combine structured methodologies, user participation, automation, flexibility, and compliance with ethical principles.

Table 3.5: RQ3: Characteristics of the Approaches

Approach	Structured Process	User Participation	Automation/Scalability	Flexibility/Adaptability	Ethical Compliance
ObRE	Yes	–	–	Yes	Yes
GORE	Yes	Yes	–	–	Yes
OpenEHR archetypes	Yes	Yes	–	Yes	–
SLEEC-TK	Yes (formal methods)	–	–	–	Yes
SPIDe	–	Yes	–	Yes (lightweight)	–
ReFAIR	–	–	Yes	–	Yes (fairness classification)

3.2.6 Discussion

In conclusion, several studies examine approaches to elicit requirements, however there is a noticeable lack of studies focused in ethical requirements. Of the identified methods (fig 3.3) only four approaches have any sort of tool support such as a software, with the majority of the tools being for modeling processes or to promote discussions between colaborators in order to identify ethical requirements. Most of these approaches do not present easy accassibility, requiring prior technical knowledge. Additionally, ontology-based methods require input from experts and are nut easily scalable, card-based and catalogue methods, while practical, may neglect emerging ethical concerns, AI-assisted techniques don't have focus on ethical requirements. Our goal is to propose an approach that is more accessible and flexible, capable of adapting to evolving needs.

Approaches	Does it have Focus on Ethical Requirements?	Does it have tool support?	Is it accessible and easy to use?	Does it use LLMs?	Does it offer a clear answer?
ObRE	✓	✗	✗	✗	✗
GORE	✓	✗	✓	✗	✗
OpenEHR archetypes	✗	✗	✗	✗	✗
SLEEC-TK	✓	✓	✗	✗	✓
SPIDe	✗	✗	✓	✗	✓
ReFAIR	✓ (focused in fairness for ML-bsed systems)	✓	✗	✗	✓
ECCOLA	✓	✗	✓	✗	✓
Elicitron	✗	✓	✗	✓	✓
RE4HCAI	✓	✗	✗	✗	✗
ALAS	✗ (focused in user story quality)	✓	✗	✓	✓

Figure 3.3: State of the Art Research Results

3.2.7 Summary

In this chapter, we reviewed existing approaches for eliciting ethical requirements. We examined ontology-based frameworks, card-based methods, and agile techniques like Ethical User Stories. Additionally, we explored AI-assisted methods for requirements elicitation, such as agent-based simulations and LLM-driven user story refinement. Each approach was analyzed for its strengths and limitations, highlighting challenges related

to scalability, adaptability, and automation. This analysis lays the groundwork for our proposed solution, which aims to address these gaps by utilizing AI to create a dynamic catalog of ethical user stories.

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A

*NOVA*THESIS COVERS SHOWCASE

This Appendix shows examples of covers for some of the supported Schools. When the Schools have very similar covers (e.g., all the schools from Universidade do Minho), just one cover is shown. If the covers for MSc dissertations and PhD thesis are considerable different (e.g., for FCT-NOVA and UMinho), then both are shown.

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imperdiet sit amet, quam. Quisque scelerisque dapibus nibh. Nam enim. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Nunc ut metus. Ut metus justo, auctor at, ultrices eu, sagittis ut, purus. Aliquam aliquam.

A.1 A section here

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Etiam ac leo a risus tristique nonummy. Donec dignissim tincidunt nulla. Vestibulum rhoncus molestie odio. Sed lobortis, justo et pretium lobortis, mauris turpis condimentum augue, nec ultricies nibh arcu pretium enim. Nunc purus neque, placerat id, imperdiet sed, pellentesque nec, nisl. Vestibulum imperdiet neque non sem accumsan laoreet. In hac habitasse platea dictumst. Etiam condimentum facilisis libero. Suspendisse in elit quis nisl aliquam dapibus. Pellentesque auctor sapien. Sed egestas sapien nec lectus. Pellentesque vel dui vel neque bibendum viverra. Aliquam porttitor nisl nec pede. Proin mattis libero vel turpis. Donec rutrum mauris et libero. Proin euismod porta felis. Nam lobortis, metus quis elementum commodo, nunc lectus elementum mauris, eget vulputate ligula tellus eu neque. Vivamus eu dolor.

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B

Appendix 2 Lorem Ipsum

This is a test with citing something [10] in the appendix.

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Annex 1 Lorem Ipsum

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