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EXPLORING GENDER BIAS IN REQUIREMENTS ENGINEERING: CHALLENGES AND MITIGATION FROM SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Aim/Purpose	This study investigates gender bias, an important social dimension in Requirements Engineering (RE), with a special emphasis on identifying challenges and mitigation strategies through a Systematic Literature Review (SLR).
Background	Though an important activity, RE is heavily influenced by stakeholders' social dynamics, particularly gender bias in software requirements. The less represented genders in RE may negatively influence the process, including a lack of inclusiveness in software products and limited diversity of perspectives. However, researchers and practitioners are exploring a comprehensive understanding of gender bias across various RE activities, and this research area is still emerging.
Methodology	We conducted an SLR and explored the challenges and the mitigation strategies, techniques, and solutions reported in the literature to address gender bias in RE. This review investigates the ongoing challenges of gender bias in RE and the potential to mitigate them. Due to bias, the software design may lead to poorer outcomes, and the needs of diverse groups may be overlooked. The Kitchenham SLR guidelines are followed in this review to investigate relevant research studies, as they help identify the challenges, mitigation techniques, and the effectiveness of existing validation methods. During initial scanning, almost 3,889 studies on gender bias were found from computing sources. These studies are further screened for inclusion and exclusion criteria to select the most appropriate studies for formulating research questions. After applying the three major

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	steps of Kitchenham SLR guidelines, gender bias challenges and mitigation techniques are identified.
Contribution	The contribution of our work is multifaceted: (1) conducting a systematic review of existing literature, (2) identifying key challenges of gender bias in RE, and (3) highlighting the effectiveness of gender bias mitigation techniques to overcome the challenges.
Findings	The findings indicate the persistent challenges posed by gender bias in RE and highlight existing mitigation strategies. Furthermore, gender bias in RE can result in poorly designed software and neglected diverse user needs.
Recommendations for Practitioners	It is recommended that practitioners integrate inclusive practices across RE activities, adopt models and frameworks that cater to diverse users, and actively address gender bias.
Recommendations for Researchers	Researchers should further investigate the validation of available mitigation techniques that address gender bias in RE. Also, new methods are needed to address gender bias in RE-related activities to ensure equity and fairness in software products.
Impact on Society	The outcome of this study is helpful in addressing gender bias in RE, integrating inclusivity into software systems, and developing equitable systems well-aligned with the needs of diverse user groups.
Future Research	In the future, more empirical studies will be conducted to validate gender-inclusive methods and tools across different RE scenarios. Promote continuous gender-sensitization and awareness programs for all stakeholders involved in RE to ensure long-term impact.

Keywords	requirements engineering, gender bias, diversity and inclusion, societal values, systematic literature review

INTRODUCTION

Requirements Engineering (RE) comprises activities such as requirements gathering, modelling and analysis, specification, validation, and management (Dar et al., 2018). It serves as the foundation upon which subsequent stages of software development are built, ensuring the software product meets users' needs and expectations (Chakraborty et al., 2012). Effective RE contributes to higher user satisfaction, lower development costs, and increased software efficiency (Z. Wang et al., 2018). However, it is increasingly evident that RE processes are not insulated from broader social and psychological influences, including pervasive gender bias (Colomo-Palacios et al., 2010). Gender bias, broadly defined as unequal treatment or preference based on gender, can appear both subtly and overtly in technical fields like software engineering (SE) (Lytras et al., 2010). Traditionally, the engineering and technology areas have been male-dominated, and this gender imbalance is particularly acute in RE, where women remain significantly underrepresented (Hoeffel, 2007). Despite progress toward gender diversity (the presence of differences among people in a society) in other fields, such as medicine, law, and business, the gender gap in SE, particularly in RE, persists (Breese et al., 2020). This lack of gender diversity has tangible consequences, not only for women in the industry but also for the quality and inclusivity of the software products (Jaccheri, 2024).

Recent studies (Madampe et al., 2020; Rossi & Zacchiroli, 2022; Terrell et al., 2017; Y. Wang & Redmiles, 2019) highlight how gender bias affects the RE process by limiting the diversity of perspectives considered during RE. When women are underrepresented in RE teams, the resulting software may inadvertently perpetuate gender stereotypes or fail to address the needs of a diverse user base

(Jentzsch et al., 2019). For instance, a male- dominated team may overlook the unique requirements of female users or fail to consider how gendered social roles might influence user interactions with technology (Maro et al., 2024). Research suggests that diverse teams are more effective at problem-solving and innovation as they are better equipped to consider a wider array of user scenarios (Ioannides, 2010; Treude & Hata, 2023). Moreover, addressing gender bias in RE can lead to more inclusive software and more success in the market. Studies show that software products designed by diverse teams are more likely to meet the needs of a diverse user base, leading to higher user satisfaction and adoption rates (Patrício & Franco, 2022). When RE processes are inclusive, the resulting software is better positioned to serve all users, regardless of gender, and to avoid reinforcing harmful stereotypes.

This review systematically explores the impact of gender bias in RE. By reviewing existing literature, the proposed study investigates how gender bias influences the RE process and the broader outcomes of software development. While previous studies have explored gender bias in language models (Dar & Rahman, 2024) and grammatical biases in communication (Bordia & Bowman, 2019), these studies focus primarily on specific domains, such as open-source software or linguistic models, without fully examining how gender bias affects the entire RE process. The existing studies lack a comprehensive focus on how gender imbalance in RE teams influences inclusivity and the effectiveness of software products across all RE activities. This study aims to fill these gaps by specifically focusing on gender bias in RE, providing much-needed insights that can foster diversity and inclusivity within the field of SE, which, in turn, can lead to better software products and more equitable technology practices. The contribution of this study is as follows:

- identification of the key challenges of gender bias in RE;
- investigating the existing mitigation techniques to address gender bias in RE;
- exploring the effectiveness of existing solutions in addressing gender bias in RE.

The structure of this paper is divided into different sections and sub-sections. The next section presents related studies on gender bias in RE. The following section elaborates on the research methodology (a detailed SLR). The results are then presented, followed by the Discussion and Conclusion.

RELATED WORK

Gender bias in RE is an important area of study that reflects the broader issues of gender inequality in software development (SD) (Renström et al., 2022). Research shows that women remain significantly underrepresented in technical roles, with only about 24% of the workforce in SD being female (Meyer et al., 2021). This underrepresentation not only affects the workforce but also impacts the software products developed, leading to potential biases that may ignore or misrepresent female users' needs (Beede et al., 2011). For instance, biases in AI-driven recruitment systems can perpetuate unfair hiring practices, as Hersh (2000) highlights. They emphasize operationalizing diversity and inclusion principles to prevent such biases.

The dynamics within predominantly male development teams can contribute to the neglect of female perspectives during requirements elicitation. Studies indicate that male teams often lack awareness of women's distinct needs and preferences, leading to inadequate software solutions (Bano, Zowghi, Mourao, et al., 2024; Robillard, 2021). Inclusive teams that integrate diverse perspectives, including gender, perform significantly better at identifying and addressing a wider range of user requirements. A further study supports this (Rizvi et al., 2022), where the researchers advocate for embedding principles of inclusivity, gender-aware requirements elicitation, and equitable stakeholder representation throughout the software lifecycle to ensure fairness and mitigate gender bias in RE. Moreover, Bano, Ali, and Zowghi (2024) emphasize that societal and cultural biases often infiltrate the analysis phase if left unchecked. The authors recommend integrating diversity-focused methods early in the RE process to prevent the reinforcement of stereotypes and ensure that underrepresented groups' needs are fully captured.

The changing landscape of women's roles in engineering is critical to understanding gender bias in RE. While there have been strides in increasing women's participation, persistent cultural stereotypes and institutional barriers continue to hinder their advancement in technical fields (Hidellaarachchi et al., 2023; Shams et al., 2025). These challenges not only affect recruitment but also influence how women engage in the requirements process, often leading to their contributions being undervalued (Beede et al., 2011).

Cultural factors also play a significant role in shaping gender dynamics within RE teams. Traditional gender roles and expectations can limit women's participation in requirements elicitation sessions, which negatively impacts the diversity of input received (Hashmati, 2022). For instance, in multinational environments, the interplay between different cultural norms and expectations can create additional challenges for female team members, thereby affecting their contributions to the requirements-gathering process (Fernández-Sanz & Misra, 2012). Understanding and addressing these cultural influences is essential to fostering an inclusive environment where all team members can contribute effectively (Hidellaarachchi et al., 2023).

Additionally, the representation of gender in software systems often reflects the biases of development teams. The lack of gender diversity often leads to software products failing to address the needs of female users adequately. Addressing gender bias requires proactive approaches such as incorporating diverse perspectives and leveraging techniques like gamification to mitigate biases and ambiguity during the requirements elicitation phase (Holdcroft, 2007; Shanks et al., 2024). By incorporating diverse perspectives in requirements gathering, teams can significantly improve product quality and user satisfaction (Beede et al., 2011).

Gamification techniques highlighted in reducing requirements ambiguity also encourage collaboration and improved usability outcomes (Dar et al., 2022, 2023; Zowghi & Bano, 2024). Moreover, the Gender-Inclusive Requirements Engineering (GIRE) framework aims to address these biases by integrating gender perspectives throughout the RE process (Dar, 2020). To operationalize gender-inclusive practices, tools such as decision trees and diversity-focused repositories (Beckwith & Burnett, 2004) offer practical strategies to mitigate gender biases during requirements validation.

Mitigating gender bias in RE necessitates a multifaceted approach that considers team composition, cultural influences, and systemic barriers. Researchers have discussed how biases in prioritization often stem from gendered task stereotypes and systemic barriers. The authors suggest employing personas and frameworks to guide prioritization decisions, ensuring that critical features for underrepresented groups are not undervalued (Bano, Ali, & Zowghi, 2024). Implementing gender-inclusive practices, as outlined in frameworks such as GIRE, is essential for reducing bias and promoting equity in RE (Dar, 2020). Table 1 presents the factors of gender bias in RE activities. Factors refer to the causes of gender bias in RE activities.

Table 1. Factors of gender bias in RE activities

Studies	Factors of gender bias	Re activity
Hashmati (2022), Malkawi et al. (2024)	Cultural	Elicitation
Z. Wang et al. (2018)	Societal	Analysis
Dar and Rahman (2024)	Economic	Prioritization
Shams et al. (2025)	Gendered Task Stereotypes	Management
Ioannides (2010)	Lack of Representation	All activities

Table 1 presents the cultural driver that is more active in elicitation (Hashmati, 2022; Malkawi et al., 2024). Similarly, other factors, such as societal and economic factors, are common in RE analysis and prioritization activities. Notably, some studies do not explicitly focus on RE but provide foundational

insights into the mechanisms of gender bias that further inform RE practices. We have used these studies to contextualize RE-specific gender bias rather than direct evidence.

METHODOLOGY

The research methodology provides a systematic approach to conducting research to achieve the research goal. This study follows the systematic and detailed steps outlined in the SLR guidelines by Kitchenham (Al-Sarayreh et al., 2021; Bozyiğit et al., 2021; Kitchenham & Charters, 2007). It consists of three major categories, each focusing on the specific research steps outlined in the review guidelines, as shown in Figure 1.

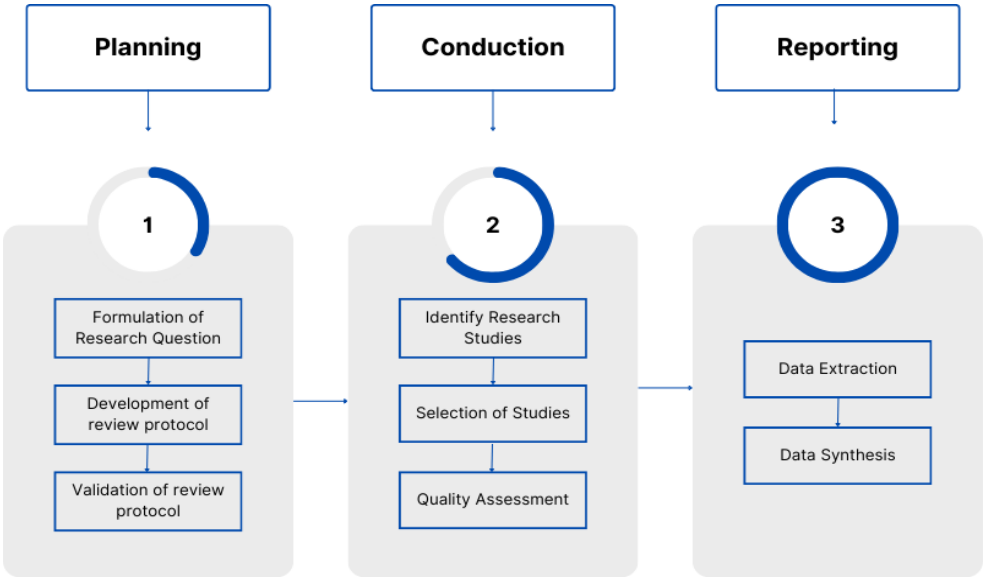

Figure 1. Step-wise SLR

The detailed protocol breakdown in Figure 1 is discussed below.

STEP-1: PLANNING

Research question formulation

Recent studies have focused on how women have been getting recognized in different areas (Diprete & Buchmann, 2006). To our knowledge, no studies have been conducted on women's involvement in RE. Keeping this in mind, the following RQs have been formulated:

RQ1: What challenges are associated with gender biases in requirements engineering?
RQ2: What methods or strategies are used to mitigate gender bias in requirements engineering?
RQ3: Are the existing solutions validated?
RQ4: How effective are the solutions implemented to address gender bias in requirements engineering?

Develop a review protocol

Search String & Strategy: The search strategy was tailored to capture the core topics relevant to each research question, focusing on keywords associated with gender bias and inclusivity in RE. Table 2 presents the composed search strings according to the given RQS.

Table 2. Question-wise search strings

RQs	Search strings
RQ1	("women roles" OR "Gender Bias" OR "Gender Inclusivity") AN\D ("requirements engineering" OR "requirements gathering" OR "requirements analysis" OR "requirements elicitation" OR "requirement prioritization" OR "requirement management" OR "requirement validation") AND ("barriers" OR "problems" OR "challenges")
RQ2	("Method" OR "Way" OR "Strategy") AND ("Gender bias" OR "Gender inclusivity") AND ("Mitigate" OR "strategies" OR "address") AND ("requirements engineering" OR "requirement gathering" OR "elicitation")
	("Method" OR "Way" OR "Strategy") AND ("Gender bias" OR "Gender inclusivity") AND ("Mitigate" OR "strategies" OR "address") AND ("requirement prioritization" OR "requirement management" OR "requirements analysis")
RQ3	("Gender bias" OR "Gender inclusivity") AND ("tool performance" OR "evaluation" OR "validity") AND ("requirements engineering" OR "gathering" OR "elicitation")
	("Gender bias" OR "Gender inclusivity") AND ("tool performance" OR "evaluation" OR "validity") AND ("requirement prioritization" OR "requirement management" OR "requirements analysis")
RQ4	("Gender bias" OR "Gender inclusivity") AND ("effectiveness" OR "Impact assessment" OR "implementation success") AND ("requirements engineering" OR "requirements gathering" OR "elicitation")
	("Gender bias" OR "Gender inclusivity") AND ("effectiveness" OR "Impact assessment" OR "implementation success") AND ("requirement prioritization" OR "requirement management" OR "requirements analysis")

Table 2 presents the search string against each research question. Related terms addressing challenges, approaches, validation, and the effectiveness of the tools were also covered to further support researchers and requirements engineers. To identify relevant articles, synonyms, and logical expressions were incorporated into the search strings to improve precision and recall. Table 3 presents the synonyms of each research question.

Table 3. Question-wise synonyms

RQs	Synonyms
RQ1	Gender biases in requirements engineering, challenges, gender bias in requirement gathering, issues in gender bias, challenges, barriers
RQ2	Strategies to mitigate gender bias, methods to reduce gender bias in requirements engineering, and solutions to gender bias
RQ3	Validation of existing solutions, validating solutions for gender bias, and proven methods for reducing bias
RQ4	Effectiveness of solutions, impact of solutions on gender bias, and success of strategies to address gender bias

In addition to these search terms, synonyms were incorporated into the search queries. Using logical expressions between the keywords is crucial to creating effective search strings. For this study, each search string was carefully constructed using these expressions, considering database limitations to ensure precise results.

Data Source Selection: To carry out a thorough review, it was important to clearly define the data sources and search strategy. Scientific databases and search engines were used for search queries. The

digital databases were utilized to gather relevant material. These databases included ACM Digital Library (https://dl.acm.org/), Springer Link (https://link.springer.com/), Science Direct (https://www.sciencedirect.com/), Wiley Online Library (https://onlinelibrary.wiley.com/), Taylor & Francis Online (https://www.tandfonline.com/), Sage Journals (https://journals.sagepub.com/), IEEE Xplore (https://ieeexplore.ieee.org/Xplore/home.jsp), MIT Open Access Articles (https://libraries.mit.edu/), and Google Scholar (https://scholar.google.com/).

Inclusion and Exclusion Criteria: To ensure that only high-quality, relevant studies were included, specific inclusion (I) and exclusion (E) criteria were applied.

I-1: Papers related to requirements engineering and gender bias are included.
I-2: Research papers, articles, and journals are considered.
I-3: Studies published from 2014 to 2025 are included.
E-1: Papers available with only abstracts, but full-text not available, are excluded
E-2: Papers that are not written in English are excluded.
E-3: Letters, posters, position papers, and books are excluded.

Validate review protocol

Selection of Quasi-Gold Standard (QGS) Studies: For measuring the effectiveness of the search strategy, a QGS (Zhang & Babar, 2010) was established. QGS consists of foundational studies in the field selected through expert recommendations and literature analysis. These studies serve as a benchmark to determine the sensitivity of the search strategy. The QGS selection criteria included:

i. Relevance to gender bias in requirements engineering.
ii. High citation impact or expert recommendation.
iii. Publication in journals or conferences in the past decade.

A total of five studies (Díaz et al., 2021; Jentzsch et al., 2019; Maro et al., 2024; Nunes et al., 2023) were selected for the QGS, representing key literature that aligns closely with the objective of this study. While the number of studies discovered in this area is extremely small, it highlights a significant gap in software engineering that must be addressed. Future research studies, industry initiatives, and software vendors should actively address gender bias in requirements engineering to enhance the usability, dependability, and accessibility of software products.

Quasi-Sensitivity Calculation: The QGS provides a benchmark for calculating quasi- sensitivity (QS), which measures the proportion of QGS studies retrieved by the search strategy. This step ensures that the search approach is sensitive enough to capture essential studies. The quasi-sensitivity is calculated as follows (Zhang & Babar, 2010).

$$QS = \frac{(QGS\ Studies\ Retrieved) \times 100}{\text{Total QGS Studies}} \qquad (1)$$

Equation (1) refers to: Total QGS Studies = 5, QGS Studies Retrieved = 5, hence:

$$QS = (5/5) \times 100 = 100\%$$

The retrieval of selected studies was enabled due to the initial QS of 100%, thus meeting the set 80% threshold.

Limitations of QGS: Although the QGS helped to attain the reliability of this study, it has the following limitations:

- *Scope:* It is possible that the initial set of studies, by calculating QGS, may exclude some current or trending research. For this purpose, comprehensive coverage is required.
- *Variations in Database:* Another limitation is the variability in indexing across different databases. It can have a negative impact on retrieval rates, thus impacting quasi-sensitivity.
- *Selection Bias:* There is a possibility that the expert recommendations may introduce subjectivity in the review process. To avoid this, an additional systematic criterion may be helpful.

STEP-2: CONDUCTION

Identification of studies

The identification of studies is a crucial step in SLR. It starts with executing search queries across the selected databases listed in Table 4. We carefully composed search strings that combine keywords and their synonyms, such as "gender bias," "requirements engineering," and "mitigation." Also, Boolean Operators, i.e., AND, OR, are used to identify studies, as suggested in Kitcheham's guidelines. The studies were applied in three search cycles. In the first search result, 3,889 articles were retrieved.

Selection of studies

In the next step, the titles and abstracts of identified studies were reviewed to determine which articles were relevant and aligned with the study's objectives. As a second step, it was checked whether the full texts of these studies were available. To avoid duplication, the repeated articles were excluded from the report.

Quality assessment of studies

A quality assessment (QA) criterion in this review ensures the quality and reliability of selected studies. By assessing aspects such as clarity of the problem, relevance of the studies, soundness of the methodology, adequacy of the related work, and validation of the outcomes, Kitchenham's QA criteria ensure that the quality of the studies is assessed. Furthermore, all included studies were scored according to the criteria to ensure the quality of the selected studies.

STEP-3: REPORTING

Data composition plan

The data composition plan covers data synthesis and extraction. During the selection process, we synthesized the results from the collected data. The articles collected from selected databases were compiled into a final compilation. The process of running search strings across various databases and retrieving data was an intensive task. The process spanned almost two months.

The data collected for each RQ. For instance, 474 studies were extracted for RQ1, while 953 were collected for RQ2. Similarly, for RQ3, we yielded 1,735 articles, and for RQ4, we initially yielded 727 studies. We have further represented the data collection process in Figure 2, which illustrates the systematic approach adopted for retrieving, screening, and refining research articles.

The process was divided into three main phases. The first phase involved defining the research scope and developing a systematic approach for data retrieval. This included:

- Formulating the research questions.
- Developing a structured search strategy, which included identifying keywords and constructing search strings. However, this search was conducted between October 2024 and February 2025. For each digital library, search strings were used to account for differences in query syntax and indexing mechanisms. Among all databases, Google Scholar returned the largest number of results due to its broad indexing scope and interdisciplinary coverage. I/E criteria were applied, along with QA criteria, to mitigate noise.
- Establishing predefined inclusion and exclusion criteria to filter studies based on relevance, year, and quality.

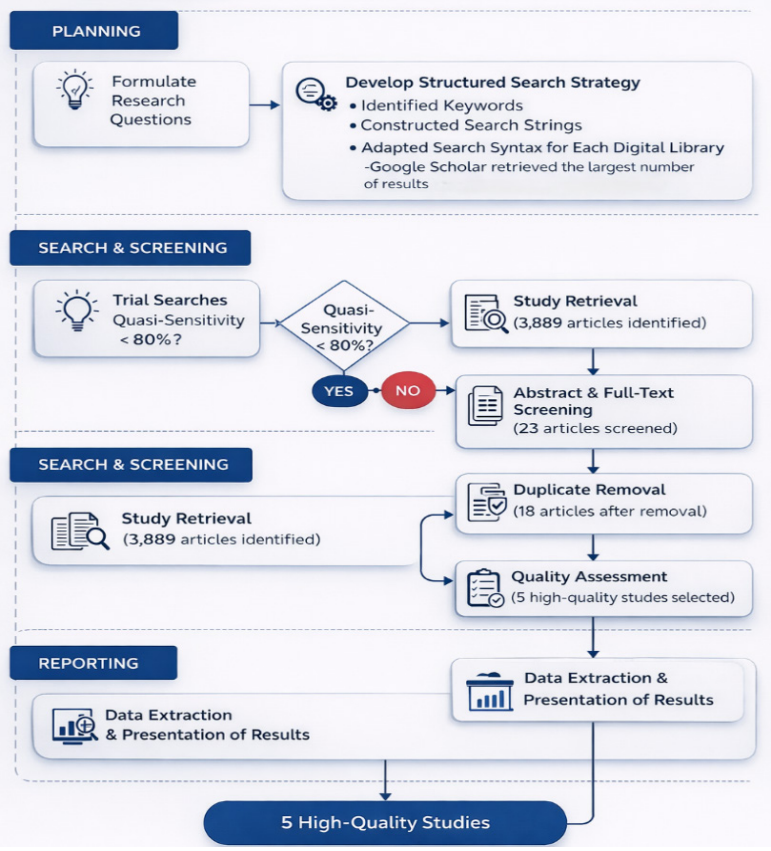

Figure 2. Strategic research synthesis flowchart

Once the planning was complete, the search and screening process was carried out systematically:

- *Trial Searches:* Before the full-scale search, trial searches were conducted. If the quasi-sensitivity of the retrieved studies fell below 80%, iterative keyword refinements were applied to improve accuracy.
- *Study Retrieval:* A total of 3,889 articles were identified across multiple databases.
- *Abstract and Full-Text Screening:* 1st filter, Studies were reviewed for relevance, reducing the selection to 23 articles.
- *Duplicate Removal:* In the second filter, Duplicate studies were removed, leaving 18 articles combined.
- *Quality Assessment:* The remaining studies underwent a detailed evaluation for methodological rigor, relevance, and credibility. In QA, a five-criterion checklist was adapted from Kitchenham's guidelines, such as clarity of research objectives, relevance to gender bias (in RE), methodology, validation, and findings. The scoring mechanism was as follows: if a study fulfilled all criteria, it was scored 1; if not, it was scored 0, with 1 representing 'Yes' and 0 representing 'No'. This process helped in selecting methodologically sound, more relevant studies.

In the final phase, the dataset was refined, and 5 high-quality studies that met all necessary inclusion criteria were selected for data extraction and analysis. These studies formed the basis for the final presentation of results. Table 4 provides a detailed breakdown of the article refinement process, illustrating the number of studies retained at each stage.

Table 4. List of retrieved articles

Data sources	Initially scanned				1st filter				2nd filter				Final selection			
	RQ1	RQ2	RQ3	RQ4	RQ1	RQ2	RQ3	RQ4	RQ1	RQ2	RQ3	RQ4	RQ1	RQ2	RQ3	RQ4
ACM	15	35	131	23	0	0	0	0	0	0	0	0	0	0	0	0
Springer	10	44	509	27	0	0	0	0	0	0	0	0	0	0	0	0
Science Direct	2	248	355	91	1	1	1	0	1	1	1	0	1	1	1	0
Wiley	2	16	59	8	0	0	0	0	0	0	0	0	0	0	0	0
Taylor & Francis	0	4	43	1	0	0	0	0	0	0	0	0	0	0	0	0
Sage	0	5	44	1	0	0	0	0	0	0	0	0	0	0	0	0
IEEE	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
MIT	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0
Google Scholar	445	599	594	576	5	5	4	4	4	3	3	4	4	3	3	4
Total	474	953	1735	727	6	8	5	4	5	5	4	4	5	4	4	3

A large reduction was observed in studies that show the early stage of explicit gender bias within RE research, rather than gender concerns in SE in the wider context. Furthermore, the most excluded studies in this research discussed gender bias in educational, organizational, or general software development areas, without having a direct link to RE-related activities. Only 23 studies explicitly discussed RE phases after the abstract screening process. During the full-text screening and QA assessment, only 5 studies met all the I/E criteria, particularly regarding gender bias in one or more requirements-related activities.

FINDINGS & RESULTS

Through this systematic approach, only the most relevant and high-quality research articles were included in the final dataset. As shown in Table 5, selected articles against each research question are presented.

Table 5. Selected research articles

No.	RQ1	RQ2	RQ3	RQ4	Year
1.		(Jentzsch et al., 2019)			
2.	(Maro et al., 2024)				
3.	(Nunes et al., 2023)				
4.	(Nunes et al., 2021)				
5.	(Gama, 2024)				

First, data on gender bias in RE is analyzed from primary studies. The studies highlight the challenges posed by key gender issues that affect the RE process. It includes biases in team composition, stakeholder engagement, and feedback mechanisms. The occurrence of these identified challenges was measured, and the frequency percentage of studies addressing each issue was assessed. From the above research works (Gama, 2024; Jentzsch et al., 2019; Maro et al., 2024; Nunes et al., 2021, 2023), the major issues are:

- *Understanding of Binary gender:* RE processes often assume a binary gender model, excluding diverse identities.
- *Neutral gender assumptions:* Software is frequently designed without considering gender-specific needs, leading to non-inclusive systems.
- *Lack of diversity in RE teams:* This issue is particularly evident when diverse stakeholder input is important during the elicitation phase.

- *Gender stereotypes in task assignments:* Women are often assigned specific roles, reinforcing traditional biases.
- *Biased requirement prioritization:* Features relevant to underrepresented groups may be undervalued.
- *Absence of gender-inclusive RE tools:* No widely accepted tools exist to integrate gender inclusivity into RE processes systematically (Bano, Zowghi, Mourao, et al., 2024).

Furthermore, cultural and societal values in RE influence how feedback is handled and decisions are made, often reinforcing existing biases in RE activities. The main findings highlight that gender bias is a crucial challenge that occurs in almost all RE-related activities, but it is more common in the elicitation and prioritization phases. It is necessary to adopt gender-inclusive practices to develop equitable and representative software systems (Bano, Zowghi, & Gervasi, 2024; Shanks et al., 2024).

DISCUSSION

ANSWERING RQ1

The data shows that the research addresses *gender stereotypes* in software roles, such as associating requirements elicitation with women. This challenge primarily affects early phases, such as elicitation, and reinforces traditional stereotypes. The studies also emphasize the *lack of awareness about diversity and inclusion in requirements engineering*, which impacts multiple stages of the process and limits inclusivity. Table 6 highlights issues of gender bias in RE.

Table 6. Challenges related to gender bias in RE

Challenges	Titles	Authors	Year	Data source
Gender stereotypes	The impact of gender sensitization on requirements elicitation: A controlled experiment.	Maro et al.	2024	https://scholar.google.com/
Lack of awareness about diversity and inclusion in requirements engineering	On the awareness about diversity and inclusion being integrated to requirements engineering.	Gama	2024	https://scholar.google.com/
Absence of gender-inclusive considerations in requirements elicitation	Semantics derived automatically from language corpora contain human-like moral choices.	Jentzsch et al.	2019	https://scholar.google.com/
Insufficient integration of gender-inclusive practices in requirements engineering	GIRE: Gender-inclusive requirements engineering.	Nunes et al.	2023	https://scholar.google.com/
Limited conceptual models addressing gender inclusivity in requirements	Conceptual modeling of gender-inclusive requirements.	Nunes et al.	2021	https://www.sciencedirect.com/

Additionally, the research highlights the *lack of gender-inclusive considerations during requirements elicitation,* resulting in gaps in addressing diverse user needs. Similarly, *insufficient integration of gender-inclusive practices* in requirements engineering is observed, showing a consistent lack of emphasis on inclusivity throughout the RE process.

Lastly, some studies point to the limited availability of conceptual models for *gender-inclusive* requirements engineering. This gap hinders the development of structured frameworks ensuring gender-sensitive RE practices. The findings in Table 6 indicate the need for more targeted efforts to address gender bias across all requirements in the engineering phases.

ANSWERING RQ2

To answer RQ2, these strategies include the Gender-Inclusive Conceptual Model (GIRE), which integrates multiple perspectives on gender into the requirements process. It is further observed that GIRE is a significant strategy, as evidenced by multiple studies (Nunes et al., 2021, 2023). Another strategy for detecting and resolving gender biases in user personas is *gender personas* (e.g., GenderMag), which have been identified in several studies (Jentzsch et al., 2019; Nunes et al., 2023). Table 7 summarizes different mitigation techniques reported in the five primary studies collected, and directly addresses RQ2 of our study.

Table 7. Identified mitigation strategies

Mitigation strategies	Titles	Authors	Year	Data source
Gender Sensitization Training	Semantics derived automatically from language corpora contain human-like moral choices.	Jentzsch et al.	2019	https://scholar.google.com/
Gender Personas (e.g., GenderMag)	Semantics derived automatically from language corpora contain human-like moral choices.	Jentzsch et al.	2019	https://scholar.google.com/
	GIRE: Gender-inclusive requirements engineering.	Nunes et al.	2023	https://scholar.google.com/
Gender-Inclusive Conceptual Models	GIRE: Gender-inclusive requirements engineering.	Nunes et al.	2023	https://scholar.google.com/
	Conceptual modeling of gender-inclusive requirements.	Nunes et al.	2021	https://libraries.mit.edu/
Bias Detection through Language Models	The impact of gender sensitization on requirements elicitation – a controlled experiment.	Maro et al.	2024	https://scholar.google.com/

For bias detection, language models are used as they aid in the correction and identification of gendered language in requirements (Maro et al., 2024). The *gender sensitization training* (Jentzsch et al., 2019) helps extend awareness of gender biases within software teams. Although the authors do not explicitly discuss RE, their findings on gendered semantics are quite relevant to the RE artifact, i.e.,

elicitation, which heavily relies on NL. Moreover, the language is refined to exclude gender-biased words through pronoun correction and back-translation.

ANSWERING RQ3

This section responds to RQ3, which highlights the validation methods used to assess the performance of existing systems. Gender-inclusive design methods incorporate diverse user personas into requirements collection; nevertheless, RE is not specifically validated. In one of the works (Jentzsch et al., 2019), the researchers conducted a controlled study to measure the impact of gender sensitization on requirements elicitation. It further integrates gender inclusion in the early stages of software development. As shown in Table 8, the *participant evaluation* (Nunes et al., 2023) has validated the value of these approaches, although this is not clear for RE.

Table 8. Identified validation methods

Method	Title	Author/s	Data source
Controlled Experiments	Semantics derived automatically from language corpora contain human-like moral choices	Jentzsch et al. (2019)	https://scholar.google.com/
Participant Evaluation	GIRE: Gender-inclusive requirements engineering	Nunes et al. (2023)	https://scholar.google.com/
Data Mining and Language Analysis	The impact of gender sensitization on requirements elicitation – A controlled experiment	Maro et al. (2024)	https://scholar.google.com/
Empirical Validation	Semantics derived automatically from language corpora contain human-like moral choices	Jentzsch et al. (2019)	https://scholar.google.com/
	GIRE: Gender-inclusive requirements engineering	Nunes et al. (2023)	https://scholar.google.com/
	Conceptual modeling of gender-inclusive requirements.	Nunes et al. (2021)	https://www.sciencedirect.com/

The literature indicates that language models are commonly used in data mining and language analysis (Maro et al., 2024) to identify implicit gender bias in software tasks, yet empirical support remains limited. The majority of results rely on particular scenarios, though (Jentzsch et al., 2019; Nunes et al., 2021, 2023). These approaches show how gender-inclusive practices in RE require additional confirmation.

ANSWERING RQ4

In this section, we have discussed RQ4, which highlighted the effectiveness of gender-inclusive solutions in RE. The *gender sensitization training* has outperformed in identifying inclusive requirements during the requirements elicitation activity (Jentzsch et al., 2019). The use of GenderMag - *gender personas* helped in improving inclusiveness in software. It also reduces the gender gap, though wider adoption is needed (Jentzsch et al., 2019).

Conceptual models of gender-inclusive RE, another helpful but moderately difficult-to-understand set, were found to serve as guiding sources for gender inclusiveness in RE (Nunes et al., 2023). Furthermore, other similar conceptual models that explicitly address gender issues, counter binary assumptions, and diversity during requirements elicitation are present (Nunes et al., 2021), as shown in Table 9.

Table 9. Effectiveness of solutions

Solution type	Title	Author and year	Data source
Gender Sensitization Training	Semantics derived automatically from language corpora contain human-like moral choices	Jentzsch et al. (2019)	https://scholar.google.com/
Use of Gender Personas (e.g., GenderMag)	Semantics derived automatically from language corpora contain human-like moral choices	Jentzsch et al. (2019)	https://scholar.google.com/
	GIRE: Gender-inclusive requirements engineering	Nunes et al. (2023)	https://scholar.google.com/
Conceptual Models for Gender-Inclusive RE	Conceptual modeling of gender-inclusive requirements	Nunes et al. (2021)	https://scholar.google.com/

The solutions displayed in Table 9 demonstrate moderate to strong effectiveness. On the other hand, these solutions are hard to implement. They must address implicit biases by ensuring long-term impact, because the reinforcement of these solutions is not always constant or consistent.

THREATS TO VALIDITY

- *Manual Selection*: The process may also have included bias through manual study selection. This was minimized by involving all authors to validate the inclusion and exclusion process to reduce subjectivity and maintain consistency during study selection.
- *Database Variability*: Results may vary depending on which database is accessed, leading to inconsistent outcomes. To avoid this threat, the search string was run by multiple authors.
- *Limited Number of Studies:* The small number of articles retrieved can limit the generalizability of the results.
- *Quasi-Gold Standard Sensitivity:* The quasi-gold standard method employed for search validation may not identify all relevant studies, potentially overlooking important literature.
- *Narrow Scope of Study:* The research focuses solely on Requirements Engineering, a shallow discipline within software engineering. Broadening the scope to Software Engineering could yield more comprehensive and meaningful results.
- *Adjacent-Level Studies:* Another limitation is the inclusion of studies that address gender bias at adjacent levels, such as language or conceptual models, rather than industrial practice. However, this limitation highlights the scarcity of empirical studies focusing on RE rather than selection bias.

CONCLUSION

This SLR suggests that gender bias in the area of requirements engineering remains a pervasive challenge, which is driven by a lack of awareness, societal stereotypes, and limited gender-inclusive practices, particularly in requirements elicitation activity. Although a small number of primary studies were identified, our findings indicate that gender personas and conceptual models offer the most promising results: personas provide practical, immediate enhancements, while conceptual models offer long-term, structured guidance. Moreover, both techniques require strong empirical validation and broader industry adoption before reaching a solid conclusion. The findings further highlight that this SLR should be interpreted as exploratory but not definitive. The need is to integrate inclusivity frameworks more systematically, with continuous sensitization efforts and more robust validation methods used in real development environments. After reviewing the literature, the study concludes

that gender bias exists in RE-related activities and highlights promising mitigation approaches that strengthen gender-inclusive practices in RE. These findings underscore the need for detailed empirical research and industry validation before making strong generalizations.

Future Directions

Researchers are exploring different yet interesting dimensions of RE (Guan et al., 2024; Kaur & Kaur, 2024; Rauf et al., 2023). While conducting this study, we found that gender bias in RE is not only a significant problem but also an interesting research area. Therefore, future directions can be pursued.

- By expanding this research, we are developing a unified framework for RE practitioners that guides the avoidance of gender biases at each stage of the RE process.
- Develop an EDI (Equity, Diversity, and Inclusivity) framework using large language models and AI to minimize the impact of gender bias in RE.
- Empirical studies will further validate gender-inclusive methods and tools in different RE scenarios. Promote continuous gender-sensitization and awareness programs for all stakeholders involved in RE to ensure long-term impact.
- Performance evaluation metrics for assessing the effectiveness of addressing gender bias on platforms shall be designed.

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