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Critical Examination of Gender Equality in Responsible Research and Innovation context: A Bibliometric Analysis

Laura Bagočiūnė

Lithuanian Centre for Social Sciences
https://orcid.org/0000-0002-2331-135X

Abstract. *Introduction.* Responsible Research and Innovation (RRI) is increasingly crucial for addressing societal challenges and promoting sustainable economic growth. While RRI principles have been institutionalized in Europe, gender equality (GE) within this framework remains underexplored. GE policy in the European Union (EU), rooted in gender mainstreaming since 1999, addresses socially constructed roles shaped by intersecting factors like race and class. Recognized as a human right and vital for sustainable development, GE enhances participation, eliminates barriers, and integrates gender perspectives into research. This study examines the integration of GE within the RRI framework to address this gap.

Method. A two level bibliometric analysis was conducted using Scopus and Web of Science (WoS) databases, focusing on English-language, open-access articles published between 1985 and 2024. Following the application of exclusion criteria, a total of 2134 documents were analyzed, comprising 2045 in Phase 1 and 89 in Phase 2.

Analysis. The analysis revealed a significant underrepresentation of GE within the RRI discourse. Despite a growing interest in RRI, there is a lack of meta-analytical studies focusing on GE, with research predominantly addressing broader aspects of RRI.

Results. From the 2134 documents analyzed, only 89 explicitly addressed GE within the RRI context. Co-occurrence networks identified four primary RRI clusters emphasizing sustainability, governance, education and ethics. GE related keywords formed smaller, peripheral clusters, indicating marginal representation. The findings underscore a lack of systemic integration of GE into the broader RRI framework.

Conclusions. The study highlights the critical need to prioritize GE within the RRI agenda by embedding it across all its dimensions. Addressing this gap will enhance the inclusivity, societal relevance, and ethical alignment of RRI initiatives. Policymakers and institutional leaders must champion GE as a foundational element of RRI to advance sustainable and equitable innovation.

Keywords: Responsible research and innovation (RRI); Gender equality (GE); bibliometric analysis; VOS-viewer

Lyčių lygybė atsakingųjų mokslinių tyrimų ir inovacijų kontekste: bibliometrinė analizė

Santrauka. *Įvadas.* Atsakingieji moksliniai tyrimai ir inovacijos (AMTI) įgauna vis didesnę reikšmę sprendžiant šiuolaikinius visuomenės iššūkius ir siekiant tvaraus ekonomikos augimo. Nors AMTI principai Europoje jau yra institucionalizuoti, lyčių lygybės integracija į šią sistemą išlieka nepakankamai ištirta. Nuo 1999 m. Europos Sąjungoje (ES) yra vykdoma lyčių lygybės politika, kurios pagrindas – lyties aspekto integravimas, siekiant

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įveikti socialiai suformuotus vaidmenis, formuojamus tokių susikertančių veiksnių kaip rasė ir klasė. Lyčių lygybė, pripažinta pagrindine žmogaus teise ir būtina tvaraus vystymosi sąlyga, skatina dalyvavimą, šalina kliūtis bei integruoja lyties aspektą į mokslinius tyrimus. Šio straipsnio tikslas yra išanalizuoti lyčių lygybės konceptualizaciją AMTI kontekste, pasitelkiant mokslinės literatūros bibliometrinę analizę.

Metodas. Tyrimas atliktas pasitelkiant dviejų lygių bibliometrinę analizę, pagrįstą *Scopus* ir *Web of Science* (WoS) duomenų bazėmis. Analizuoti 1985–2024 m. anglų kalba publikuoti atvirosios prieigos straipsniai. Pritaikius pašalinimo kriterijus, į analizę įtraukti 2 134 dokumentai, iš kurių 2 045 buvo išanalizuoti 1 etape, o 89 – 2 etape.

Analizė. Tyrimo rezultatai atskleidė, kad lyčių lygybės tema AMTI diskurse yra nepakankamai reprezentuojama. Nepaisant didėjančio susidomėjimo AMTI, trūksta metaanalitinių tyrimų, skirtų lyčių lygybės klausimams. Moksliniai darbai dažniausiai orientuojasi į bendruosius AMTI aspektus, o lyties perspektyva lieka marginalizuota.

Rezultatai. Iš 2 134 dokumentų tik 89 aiškiai nagrinėjo lyčių lygybės temą AMTI kontekste. Bendro pasireiškimo tinklų analizė išskyrė keturias pagrindines AMTI grupes – tvarumo, valdymo, švietimo ir etikos. Lyčių lygybės tema sudarė nedidelius periferinius klasterius, atspindinčius ribotą šios temos integraciją. Rezultatai parodė, kad lyčių lygybė nėra nuosekliai integruota į AMTI sistemą, o jos reprezentacija dažnai apsiriboja siauru požiūriu.

Išvados. Tyrimas akcentuoja būtinybę teikti prioritetą lyčių lygybei kaip esminei AMTI darbotvarkei, ją integruojant į visas politikos ir praktikos sritis. Lyčių lygybės integracija turi potencialą reikšmingai sustiprinti AMTI iniciatyvų įtraukumą, padidinti jų visuomeninę reikšmę ir užtikrinti etinį suderinamumą. Politikos formuotojams ir institucijų vadovams rekomenduojama didinti paramą lyčių lygybei kaip pamatiniam AMTI elementui, siekiant skatinti tvarių ir teisingų inovacijų plėtrą.

Pagrindiniai žodžiai: atsakingieji moksliniai tyrimai ir inovacijos (AMTI); lyčių lygybė; bibliometrinė analizė; VOSviewer programa

Introduction

The concept of Responsible Research and Innovation (RRI) is increasingly recognized as a comprehensive approach to mitigating risks associated with innovation and research activities (Wiarda et al., 2021). It aims to address societal challenges and foster sustainable economic growth by minimizing negative externalities (Von Schomberg, 2013). RRI has gained prominence in EU and European Commission (EC) contexts since the 2010s (De Saille, 2015; Wiarda et al., 2021; Zwart et al., 2014), emerging from discourse on socio-technical integration within the EC's Science in Society program (Owen et al., 2012). Rooted in the notion of research and innovation as a public good (Felt, 2018), RRI entails anticipating and assessing consequences while aligning with societal expectations (Kalpazidou Schmidt, 2023). This involves fostering collaboration between science and society, transforming stakeholders into active participants in research and innovation processes (Srinivas, 2022).

While RRI has been institutionalized at the European level, efforts have been made to operationalize its principles, notably through the introduction of main so-called keys (Owen et al., 2021) such as gender equality (GE) in science, open access to research data and publications, research ethics and integrity, civic participation and science education, originally integrated with governance as the sixth key (EC, 2012). GE policy within the EU dates back to 1999, with gender mainstreaming integrated into research policy (EC, 2010). This established gender mainstreaming as a key strategy and integrated it with positive action measures (Durán Y Lalaguna, 2017). The concept of gender encompasses

socially constructed roles and expectations influenced by intersecting factors such as race, class, and age (Council of Europe, 2004). GE evolves over time through processes of socialization (EIGE, 2024) and is recognized as both a fundamental human right and a critical component of sustainable development (United Nations, 2024). Within the European Research Area (ERA), GE is framed as a multidimensional construct that seeks to enhance women's participation in research, eliminate structural barriers, and integrate gender perspectives into research content and educational practices (ERA, 2024). Furthermore, GE is considered indispensable for the advancement of human rights, economic growth, democratic governance, social cohesion, and overall societal well-being (OECD, 2024).

Despite the institutionalization of RRI at the European level, there is a notable gap in the exploration of GE within the framework of RRI. While GE policies have been integrated into research agendas (Bührer & Wroblewski, 2019; O'Mathúna & Iphofen, 2022; Otero-Hermida & García-Melón, 2018), their conceptualization and representation within the RRI discourse remain limited and fragmented. This gap highlights the need for a comprehensive examination of how GE is conceptualized and addressed within the RRI framework in academic literature.

This study aims to clarify the conceptualization of GE within the framework of RRI by conducting a bibliographic analysis of academic literature. Specifically, the research seeks to identify and analyze the existing literature on GE within the RRI context, examining the conceptual dimensions and definitions of GE as depicted in academic discourse. Through the utilization of Scopus and Web of Science (WoS) databases (DBs), along with VOSviewer software for visualization, the study aims to provide insights into the current state of research on GE within RRI and contribute to filling the existing gap in scholarly literature.

The study will commence with a comprehensive literature review of both RRI and GE concepts as depicted in academic discourse. Subsequently, a meticulous bibliographical analysis will be conducted. Finally, the findings will be visually represented through the utilization of VOSviewer software, and the final chapter presents conclusions and discussion.

Theoretical Foundations of GE in the RRI context

Recent social science papers have employed the term RRI across diverse contexts (i.e. Burget et al., 2017; A. Declich, 2020; G. Declich et al., 2022; Schuijff & Dijkstra, 2020; Thapa et al., 2019). R. Von Schomberg's (2013) political framework for RRI, emphasizing transparent and interactive processes among societal actors and innovators to ensure ethical, sustainable, and socially desirable innovation, predominates in these papers (Von Schomberg, 2013). As a multidimensional framework, RRI emphasizes inclusivity, reflexivity, and anticipatory governance in aligning research and innovation (R&I) with societal values and ethical considerations. GE, a key RRI dimension, seeks to address structural disparities and integrate diverse perspectives into R&I processes (Kalpazidou Schmidt, 2023; Owen et al., 2012). RRI's origins lie in moral philosophy and the social

studies of science and technology (Stilgoe et al., 2013). Thinkers such as I. Kant (1785), J. Bentham (1781), and D. Hume (1777) provided ethical foundations, while later contributions by V. Bush (1945) and M. Polanyi (1962) debated the integration of science into societal frameworks. RRI, institutionalized by the EC under Horizon 2020 framework, integrates public engagement, open access, ethics, science education, governance, and gender equality to align research with societal needs (Stilgoe et al., 2013; Wiarda et al., 2021) A key challenge in analyzing the concept of RRI is distinguishing agendas from procedural components and determining their number. While some scholars identify four main process variables – anticipation, reflexivity, engagement, and responsiveness (Fitjar et al., 2019; Foulds et al., 2023; Schuijff & Dijkstra, 2020; Sipos & Åkerman, 2023) – others emphasize the interconnectedness of these components, linking diversity with inclusivity, openness with transparency, anticipation with reflexivity, and responsiveness with adaptability (Aibar et al., 2018; Panciroli et al., 2020; Tokalić et al., 2021; Wittrock et al., 2021). Further elucidation and analysis of RRI and its process dimensions are provided in the article by L. Bagočiūnė & A. Novelskaitė (2023) focusing on GE within the context of RRI in Lithuania. GE addresses systemic biases and underrepresentation of women in R&I, particularly in STEM fields, where stereotypes, precarious conditions, and inadequate policies persist (EC, 2021; Wroblewski et al., 2015). Feminist theories frame gender as a social construct, highlighting organizational and cultural factors perpetuating inequalities (Acker, 1990; Clavero & Galligan, 2021). The EC has promoted Gender Equality Plans (GEPs) to institutionalize structural change, yet implementation faces resistance (Bührer & Wroblewski, 2019). Key barriers include underrepresentation, limited work-life balance policies, gender-blind frameworks, and weak institutionalization of equality initiatives (Palmén et al., 2019; Sperber et al., 2023). Structural inequities in leadership roles and funding allocation remain pervasive (D'Agostino et al., 2022; Diehl & Dzubinski, 2016). Integrating GE in RRI involves inclusivity, reflexivity, structural transformation, and content integration. Inclusivity entails involving diverse groups in decision-making (Blok & Von Schomberg, 2023). Reflexivity requires assessing societal impacts of research (Popper, 2005; Schumpeter, 1934). Structural transformation focuses on addressing systemic biases with policies like GEPs (Garcia-Campa & Sanahuja, 2023). Content integration involves embedding gender dimensions in research design and analysis (Bates, 2022). GE enhances RRI's potential to address societal challenges by fostering inclusivity and structural change. Integrating gender perspectives ensures that innovation processes are ethically responsible and socially equitable, contributing to a more impactful research ecosystem (Bensaude Vincent, 2014; Kalpazidou Schmidt, 2023). This alignment between policy, practice, and cultural transformation is essential for sustainable progress in R&I.

Conceptual Foundations of GE in the RRI context

At a theoretical level, RRI is defined broadly in the academic literature (Burget et al., 2017; A. Declich, 2020; G. Declich et al., 2022; Schuijff & Dijkstra, 2020; Tassone et al.,

2018; Zwart et al., 2014). However, a notable gap exists in meta-analytical studies (only MoRRI (Wroblewski et al., 2015) and SUPER MoRRI (Lindner et al., 2024) reports are found) within this domain. Systematic literature reviews (SLRs) provide key insights into the trends, challenges, and opportunities shaping the development of RRI. M. Burget et al. (2017) comprehensively review and analyze the definition and concept of RRI, along with its six process dimensions, based on an analysis of 235 articles. M. Schuijff & A. M. Dijkstra (2020) cover four overarching themes derived from an evaluation of 52 articles, elucidating various values, dimensions, or attributes of RRI. These themes include practices of inclusive research and innovation, encouragement of broader research considerations, management of ethical, legal, and social issues, and institutionalized responsibility practices (Schuijff & Dijkstra, 2020). V. C. Tassone et al. (2018) contribute to the RRI policy agenda by addressing responsible approaches to sustainability challenges. Their paper proposes defining RRI within Higher Education Institutions (HEIs), providing pedagogical principles and a competence framework. They emphasize the need for HEIs to cultivate a more responsible ethos, particularly in teaching policies, to support RRI-focused curricula (Tassone et al., 2018).

There are limited articles available in Scopus DB that offer a bibliographical analysis of the concept of RRI (Liu et al., 2022). A quantitative overview of RRI was conducted through a bibliometric analysis of 702 publications (Liu et al., 2022). It mapped the field's landscape through annual trends, journal distribution, disciplinary focus, and cocitation analysis. Additionally, it explored RRI's longitudinal development, identifying three phases and summarizing research themes. A. Mohammadi (2021) study employs scientometric analysis to explore the evolution and researcher network of responsible innovation and research concepts. Utilizing R software and SLR, author analyzes 572 articles from Web of Science, focusing on RRI. The investigation spans various dimensions, such as journals, collaboration networks, cocitation networks, and emergence of new concepts. It highlights challenges in ensuring that universities and academia remain accountable, particularly in developing country contexts, which tend to be predominantly state-owned. This approach would facilitate the identification of appropriate development paths and alleviate social and economic problems (Mohammadi, 2021). R. K. Thapa et al. (2019) conduct a SLR of 126 RRI conceptual papers, categorizing themes into four domains: drivers, tools, outcomes, and barriers. They apply these domains to regional innovation studies, elucidating RRI's relevance to sustainable regional development and identifying potential mutual benefits. The study's implications span theory, practice, and policy, providing insights into aligning innovation with sustainable development goals and advocating for inclusive decision-making processes (Thapa et al., 2019).

The scholarly investigation underscores a conspicuous paucity in the examination of GE within the framework of RRI, signaling its marginalization within the research domain. This assertion finds corroboration in the comprehensive literature review conducted by P. M. Loureiro & C. P. Conceição, (2019). Their study analyzes interpretations of RRI in academia and policy, highlighting common themes such as ethics and social engagement while noting gaps in areas like GE and open access. It attributes the divide between

academic and policy views on RRI to historical, disciplinary, and geographical factors, emphasizing an evolving discourse with increased focus on practical application and social engagement, yet facing challenges like ethical disconnects and ideological influences.

Similarly to RRI, 'gender' and 'gender equality' have been the subject of much theoretical work, but meta-analyses and SLRs are scarce. This is an overview of the GE SLR items. R. Raman et al. (2022) analyzed women's entrepreneurship and sustainable development over three decades (periods 1991–2000, 2001–2010, 2011–2021). Their SLR shows consistent research interest in economic development, employment, and gender roles and rights. The 2011–2021 period saw an increase in keywords, publications, and complex interrelated ideas. 'Sustainable development' became a key term, linked to information management, SMEs, technology, women entrepreneurs, and entrepreneurship education, highlighting the critical role of education and entrepreneurship awareness (Raman et al., 2022).

J. MacArthur et al. (2021) conducted SLR of GE literature spanning 2009 to 2019, revealing that the majority of studies concentrated on women's empowerment, with 58% identifying it as a primary component of gender inequality. This narrow framing neglects the inclusion of men and boys and fails to address the complexity of gender relations comprehensively. The review elucidated sectoral trends and conceptual frameworks in GE research, highlighting increased scholarly interest, diverse disciplinary perspectives, a balance between quantitative and qualitative methodologies, and a pronounced focus on South Asia and sub-Saharan Africa. Additionally, the study identified four theoretical conceptualizations of gendered change within this literature: human development, economic development, feminist development, and psychological development (MacArthur et al., 2021).

A. G. B. Yañez et al. (2023) conducted SLR on GE focusing on digital resources. This review examines digital resources, including video games, apps, and simulations, that address gender issues such as violence and stereotypes. The review categorizes these resources based on various characteristics, including development tools, platforms, location, and target audience. The primary aim is to present the current status of gender-focused digital resources and their evaluation studies, focusing on metrics, samples, acceptance, and impact. The findings indicate that most studies aimed to raise awareness about gender-based violence through serious games targeted at teenagers, but many lacked evaluation studies or were not openly accessible, limiting their societal impact and application (Yañez et al., 2023).

C. Silander et al. (2022) conducted SLR on GE in academic careers, concluding that persistent gender differences exist. Studies emphasize the importance of early career years, where small disparities can magnify over time, aligning with Merton's (1968) and Zuckerman's (2001) theory of cumulative advantages. Informal processes like networking and the 'Matthew effect' can hinder or promote careers. Despite institutional efforts to reduce gender discrimination, nepotism persists, suggesting that discrimination has decreased but not been eradicated (Silander et al., 2022).

GE is analyzed in diverse contexts, including entrepreneurship and sustainable development, women's empowerment, the digital resources, and higher education. However, there is a notable absence of studies examining GE in the context of RRI, despite it being a key dimension of RRI. Consequently, the academic literature lacks in-depth and detailed research on GE within the framework of RRI.

Methodology

A bibliometric analysis was conducted using two widely recognized academic DBs, Scopus (https://www.scopus.com/) and WoS (https://www.webofscience.com/WOS), to investigate the conceptual dimensions and definitions of GE within the framework of RRI. These DBs are esteemed within the research community and have been extensively utilized for bibliometric analyses in recent scholarly endeavors within the social sciences (Ghosh, 2024; Kruse, 2023; Pranckutė, 2021; Scotti Requena et al., 2024; Torres Madronero & Torres-Madronero, 2024). While it is customary for these DBs to be analyzed independently – Scopus (Jalal & Mukhopadhyay, 2022; Pradana & Elisa, 2023; Singh et al., 2023) and WoS (Batista & Helal, 2023; Quaiser & Pandey, 2023; Yanhao et al., 2024) –both offer comprehensive global and local coverage of scholarly journals, conference proceedings, and books, ensuring the inclusion of high-quality data (Ghosh, 2024). Moreover, the continuous evolution of Scopus and WoS is driven by robust competition and the substantial transition of academic literature to the digital, web-based domain (Pranckutė, 2021). This rationale underscores the meticulous selection of both databases for this analysis.

The analysis was conducted on 5 May 2024, employing a two level framework to identify GE links within the context of RRI. Results are presented in Figure 1 and Figure 2. The inclusion and exclusion criteria, detailed in Table 1, guided the initial data selection.

Table 1. **Inclusion and exclusion criteria**

Inclusion criteria	**Exclusion criteria**
First phase of analysis	
Documents containing the keywords *Responsible Research and Innovation*	Documents marked with retraction status
Documents within the search areas of ‚article title, abstract, and keywords‘	Duplicate documents
Documents published in English	
Open access documents	
Second phase of analysis	
Documents containing the keywords *Responsible Research and Innovation* and *Gender equality*	Duplicate documents
Documents within the search areas of ‘article title, abstract, and keywords’ for *Responsible Research and Innovation* and the search areas of ‘all fields’ *Gender equality*	
Documents published in English	

Phase 1. Step 1 utilized the keywords 'responsible research and innovation'. Only articles published in English and openly accessible were included. One article, retracted on 16 September 2022, was excluded using Zotero, the bibliographic management software applied in this study. After removing duplicates, the final dataset for Phase 1 comprised n=2,045 documents (2,036 from Scopus and 104 from WoS), spanning 1985–2024. The lack of a predefined publication period naturally extended the analysis to 1985, coinciding with the origins of RRI in moral philosophy and the social studies of science and technology (Stilgoe et al., 2013). Consistent with prior research (Pranckutė, 2021), Scopus demonstrated broader coverage than WoS, leading to the expected lower representation of WoS documents.

Phase 2. The final dataset for Phase 2 included n=89 documents (88 from Scopus and 3 from WoS), analyzed for the 'article title, abstract, and keywords' using 'responsible research and innovation' and the 'all fields'[1] term 'gender equality'. Duplicates were excluded, and the dataset covered the period 2005–2024.

The bibliographic data were downloaded in RIS format[2] and uploaded to free software tool VOSviewer 1.6.20. Keyword co-occurrence network visualizations (Figures 1 and 2) were then performed to identify clusters (Appendix 1).

Results

The RRI keyword co-occurrence network visualization (Figure 1) with threshold (minimum number of occurrences of a keyword) 15 identifies four clusters: cluster 1 (red), cluster 2 (green), cluster 3 (blue), and cluster 4 (yellow). The keywords for each cluster are listed in Annex 1.

Cluster 1 the largest in the analysis, centers on the foundational concepts and definitions of RRI. It comprises 76 items and includes keywords such as 'innovation', 'responsible innovation', 'sustainability', 'sustainable development' and RRI keys like 'governance', 'ethics', 'public engagement', 'open science', and 'science education'. This cluster highlights the involvement of diverse stakeholders, including policymakers, researchers, and representatives from business and industry. Additional terms such as 'circular economy', 'climate change', and 'corporate social responsibility' underscore its focus on addressing global challenges. The cluster also emphasizes interdisciplinary collaboration, with terms like 'nanotechnology' and 'engineering education', reflecting the integration of RRI principles to promote sustainable and socially responsible innovation.

Cluster 2 comprising 55 items, emphasizes methodological approaches and the social implications of RRI. Key terms such as 'qualitative research', 'leadership', 'public health',

[1] Initially, an attempt was made to analyze the data using the search criteria 'article title, abstract, and keywords' with the keywords 'gender equality'. However, this approach yielded data unsuitable for analysis. Consequently, the search criteria were expanded to include 'all fields', enabling the retrieval of data appropriate for analysis.

[2] The RIS file format, created by Research Information Systems, uses two-letter tags to organize bibliographic data (e.g., Author, Title, Journal). Supported by tools like Zotero and EndNote, it is a common export option in scholarly databases for citation management (Marina, 2022).

and 'diffusion of innovation' highlight a focus on research methodologies and their application within social contexts. The presence of terms like 'health care policy', 'trust', and 'pandemic' underscores the cluster's relevance to public health and governance. Demographic keywords such as 'human', 'male', and 'female' reflect an emphasis on human-centered studies. Additionally, terms like 'interviews as topic' and 'thematic analysis' demonstrate the methodological rigor employed to explore the social dimensions of RRI.

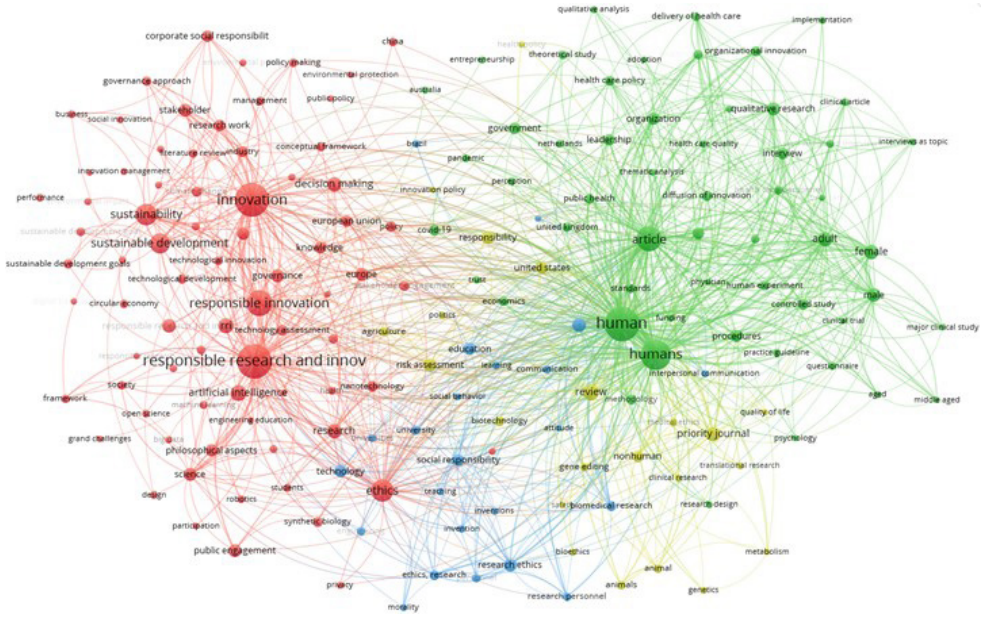

Figure 1. **RRI keyword Co-occurrence Network Visualization**

Cluster 3 comprising 23 items, focuses on the integration of education, communication, and ethics within the RRI framework. Keywords such as 'education', 'research ethics', 'teaching', and 'universities' highlight the role of academic and institutional contributions. Terms like 'interpersonal communication', 'social responsibility', and 'morality' emphasize the importance of fostering ethical and socially responsible practices in R&I. The inclusion of 'biomedical research' and 'medical ethics' points to a particular focus on the ethical considerations of scientific advancements. This cluster underscores the critical role of education and communication in enhancing ethical awareness and embedding responsible practices in RRI.

Cluster 4 comprising 22 items, focuses on the intersection of biotechnology, bioethics, and health policy. Keywords such as 'gene editing', 'bioethics', and 'biotechnology' emphasize its engagement with advanced scientific fields and their ethical dimensions. Terms like 'clinical research', 'health policy', and 'risk assessment' highlight its relevance to health-related research and policymaking. The inclusion of references to 'nonhuman',

'animals', and 'agriculture' reflects the cluster's broader scope beyond human-centered research. Additionally, keywords such as 'quality of life' and 'responsibility' underscore its commitment to addressing the ethical and societal implications of biotechnology and health policy.

The four clusters collectively highlight the extensive scope of RRI-related research. The red cluster provides a conceptual foundation, connecting with the green cluster's focus on social impacts and methodological rigor. The blue cluster complements these themes by prioritizing education and ethical frameworks, while the yellow cluster broadens the discussion to include biotechnology and health policy.

However, the network visualization reveals a notable gap: limited integration of gender-related keywords. This underrepresentation underscores the need to prioritize GE and diversity within the RRI framework. Enhancing inclusivity in this regard is crucial for strengthening the relevance and effectiveness of RRI initiatives.

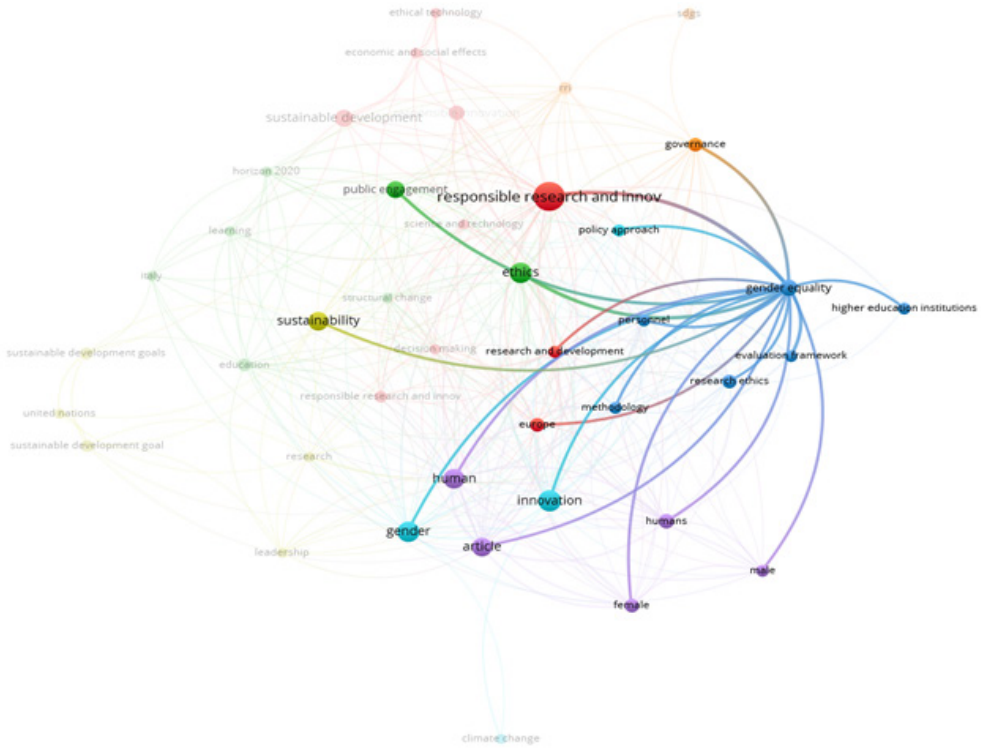

Figure 2. **RRI and GE Keyword Co-occurrence Network Visualization**

The RRI and GE keyword co-occurrence network visualization (Figure 2) with threshold (minimum number of occurrences of a keyword) 3 identifies seven clusters: cluster 1 (red), cluster 2 (green), cluster 3 (blue), cluster 4 (yellow), cluster 5 (purple), cluster 6 (light blue) and cluster 7 (orange). The keywords for each cluster are listed in Annex 1.

Cluster 1 represents the core of the RRI discourse, containing 10 keywords including 'responsible research and innovation', 'science and technology', 'responsible innovation' and 'decision-making'. This cluster underscores the foundational principles of RRI, which aim to align scientific research and technological innovation with societal needs and ethical considerations. Notably, it connects with 'economic and social effects' and 'sustainable development', emphasizing the importance of RRI in addressing global challenges such as environmental sustainability and social equity. Despite its centrality, the integration of gender specific keywords within this cluster is minimal, pointing to a potential gap in fully embedding GE into the core RRI framework.

Cluster 2 focuses on education, ethics, and structural change, highlights the transformative potential of RRI in fostering public engagement and learning. Keywords such as 'Horizon 2020', 'Italy', and 'public engagement' suggest a geographical and programmatic focus, particularly on European initiatives. The inclusion of 'ethics' and 'structural change' underscores the importance of embedding ethical considerations into education and institutional frameworks. While this cluster connects to broader RRI themes, it does not prominently feature GE, suggesting that structural changes in education and ethics have not sufficiently integrated gender perspectives.

Cluster 3 focuses explicitly on GE, research ethics, and evaluation frameworks. Keywords such as 'higher education institutions', 'methodology', and 'personnel' indicate a focus on institutional mechanisms and research practices. This cluster is crucial for understanding the intersection of GE and RRI, as it highlights how GE is operationalized within research environments. However, the relatively small size of this cluster reflects the underrepresentation of GE in the broader RRI discourse, as noted in the bibliometric analysis. The keywords also suggest a strong institutional focus, emphasizing the role of higher education in advancing gender sensitive research practices.

Cluster 4 addresses themes of sustainability and global frameworks, with keywords such as 'sustainable development goals', 'United Nations', and 'leadership'. This cluster situates RRI within the context of global policy agendas, emphasizing its alignment with sustainability and leadership objectives. While 'research' and 'sustainability' feature prominently, the absence of gender specific keywords suggests a lack of integration of GE into sustainability focused RRI initiatives. This omission represents a missed opportunity to leverage gender perspectives in achieving global development goals.

Cluster 5 explores the human-centered aspects of GE, incorporating keywords such as 'male', 'female', 'human', and 'article'. It highlights the biological dimension of gender. The inclusion of 'article' suggests a focus on academic publications, which may explore the theoretical and empirical dimensions of gender issues. However, the cluster's relatively small size indicates that gender specific themes are not yet central to the broader RRI discourse.

Cluster 6 connects themes of climate change, gender, innovation, and policy approaches. The inclusion of 'climate change' and 'policy approach' reflects the intersection of environmental and social dimensions within the RRI framework. This cluster underscores the need for gender sensitive policies in addressing climate related challenges. However, the

limited number of keywords suggests that the integration of gender considerations into climate and innovation policies remains an emerging area of focus.

The smallest cluster 7 centers on governance, RRI, and Sustainable Development Goals (SDGs). Keywords such as 'governance' and 'SDGs' highlight the strategic alignment of RRI with global governance frameworks. However, the absence of gender specific keywords points to a significant gap in integrating GE into governance discussions. Considering the critical role of governance in shaping research agendas, this gap underscores the urgency for more inclusive and gender sensitive policy frameworks.

Conclusions and discussion

The bibliometric analysis conducted in this study highlights the fragmented integration of GE within the RRI framework. Despite RRI's core emphasis on inclusivity, ethics, and sustainability, GE remains marginalized, as evidenced by its peripheral presence in co-occurrence analyses. Gender related keywords are often isolated from foundational themes such as governance, ethics, and sustainability, reaffirming systemic oversight noted in prior studies (Kalpazidou Schmidt, 2023; Loureiro & Conceição, 2019). This disconnection undermines RRI's goal of aligning R&I with societal needs.

The bibliometric network analysis reveals thematic gaps, particularly the limited integration of gender perspectives into core RRI clusters like sustainability, ethics, and public engagement. The relatively small GE specific cluster, focused on institutional policies and mechanisms, highlights the lack of systemic integration into broader RRI processes. This finding aligns with previous calls for gender mainstreaming in R&I frameworks (Clavero & Galligan, 2021; EC, 2021). Additionally, the underrepresentation of gender in RRI process dimensions such as anticipation and reflexivity demonstrates missed opportunities to enhance these processes through GE.

To address these gaps, interdisciplinary approaches that embed GE into diverse fields of R&I must be prioritized. For instance, incorporating GE into sustainability focused innovation could bolster efforts to tackle global challenges like climate change and social equity (Garcia-Campa & Sanahuja, 2023; Kalpazidou Schmidt, 2023). Policymakers and institutional leaders should advocate for GE as a foundational RRI element by revising frameworks, establishing clear metrics, and promoting training on gender sensitive approaches. The European Commission's Gender Equality Strategy 2020–2025 and Horizon Europe provide valuable starting points for these efforts.

This study's limitations, including its reliance on two bibliometric databases (Scopus and WoS), restrict the generalizability of findings. Future research should expand the dataset to include additional databases and explore GE more comprehensively, using it as a starting point before introducing RRI concepts. Such an approach would deepen insights and contextualize RRI within the broader GE discourse.

Overall, the findings emphasize the critical need for a paradigm shift in how GE is conceptualized and operationalized within RRI. The academic community, policymakers and practitioners must recognize GE as essential to fostering socially inclusive and ethi-

cally responsible R&I. Addressing these gaps and barriers will pave the way for a more equitable and just RRI framework. Continued exploration of GE in the RRI context, with expanded datasets and refined methodologies, will support the development of policies and practices that advance equality and inclusivity at all levels.

References

Acker, J. (1990). Hierarchies, Jobs, Bodies: A Theory of Gendered Organizations. *Gender and Society*, *4*(2), 139–158.

Aibar, E., Bes Garcia, M., Cripps, E., Heras, M., Kuh, V., & Müller, J. (2018). *Responsible Research & Innovation (RRI) for researchers. An introduction, february 2018*. https://openaccess.uoc.edu/handle/10609/76886

Bagočiūnė, L., & Novelskaitė, A. (2023). Lyčių lygybė atsakingųjų mokslinių tyrimų ir inovacijų kontekste Lietuvoje / Laura Bagočiūnė, Aurelija Novelskaitė. In *Lietuvos socialinė raida: Socialinės grupės ir visuomenės kaita* (Vol. 12, pp. 9–26). Lietuvos socialinių mokslų centro Sociologijos institutas. https://lstc.lt/wp-content/uploads/2024/04/Lietuvos_socialine_raida_2023_12.pdf

Bates, T. (2022). Rethinking how we work with Acker's theory of gendered organizations: An abductive approach for feminist empirical research. *Gender, Work & Organization*, *29*(4), 1041–1064. https://doi.org/10.1111/gwao.12795

Batista, L. F., & Helal, D. H. (2023). Education and social innovation: A framework based on a systematic review. *Innovation: The European Journal of Social Science Research*, *36*(3), 407–433. https://doi.org/10.1080/13511610.2023.2217522

Bensaude Vincent, B. (2014). The politics of buzzwords at the interface of technoscience, market and society: The case of 'public engagement in science.' *Public Understanding of Science*, *23*(3), 238–253. https://doi.org/10.1177/0963662513515371

Bentham, J. (1781). *An Introduction to the Principles of Morals and Legislation*.

Blok, V., & Von Schomberg, L. (2023). Introduction. In V. Blok (Ed.), *Putting Responsible Research and Innovation into Practice* (Vol. 40, pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-031-14710-4_1

Bührer, S., & Wroblewski, A. (2019). The practice and perceptions of RRI—A gender perspective. *Evaluation and Program Planning*, *77*, 101717. https://doi.org/10.1016/j.evalprogplan.2019.101717

Burget, M., Bardone, E., & Pedaste, M. (2017). Definitions and Conceptual Dimensions of Responsible Research and Innovation: A Literature Review. *Science and Engineering Ethics*, *23*(1), 1–19. https://doi.org/10.1007/s11948-016-9782-1

Bush, V. (1945). *Science The Endless Frontier*. United States Government Printing Office. https://webusers.imj-prg.fr/~david.aubin/cours/Textes/Bush_00.pdf

Clavero, S., & Galligan, Y. (2021). Delivering gender justice in academia through gender equality plans? Normative and practical challenges. *Gender, Work & Organization*, *28*(3), 1115–1132. https://doi.org/10.1111/gwao.12658

Council of Europe. (2004). *Gender mainstreaming. Conceptual framework, methodology and presentation of good practices*. Directorate General of Human Rights Council of Europe. https://rm.coe.int/1680596135

D'Agostino, M., Levine, H., Sabharwal, M., & Johnson-Manning, A. C. (2022). Organizational Practices and Second-Generation Gender Bias: A Qualitative Inquiry into the Career Progression of

U.S. State-Level Managers. *The American Review of Public Administration*, *52*(5), 335–350. https://doi.org/10.1177/02750740221086605

De Saille, S. (2015). Innovating innovation policy: The emergence of 'Responsible Research and Innovation.' *Journal of Responsible Innovation*, *2*(2), 152–168. https://doi.org/10.1080/23299460.2015.1045280

Declich, A. (2020). *RRI IMPLEMENTATION IN BIOSCIENCE ORGANISATIONS - GUIDELINES FROM THE STARBIOS2 PROJECT*.

Declich, G., Berliri, M., & Alfonsi, A. (2022). Responsible Research and Innovation (RRI) and Research Ethics. In D. O'Mathúna & R. Iphofen (Eds.), *Ethics, Integrity and Policymaking* (Vol. 9, pp. 13–27). Springer International Publishing. https://doi.org/10.1007/978-3-031-15746-2_2

Diehl, A. B., & Dzubinski, L. M. (2016). Making the Invisible Visible: A Cross-Sector Analysis of Gender-Based Leadership Barriers. *Human Resource Development Quarterly*, *27*(2), 181–206. https://doi.org/10.1002/hrdq.21248

Durán Y Lalaguna, P. (2017). The CEDAW's Reception in Spain. The Gap between Law and Practice. *Deusto Journal of Human Rights*, *9*, 53. https://doi.org/10.18543/aahdh-0-2011pp53-66

ERA. (2024, September 20). *Gender equality in research and innovation—European Commission*. ERA. https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/democracy-and-rights/gender-equality-research-and-innovation_en

European Commission. Directorate General for Research and Innovation. (2012). *Responsible research and innovation: Europe's ability to respond to societal challenges.* Publications Office. https://data.europa.eu/doi/10.2777/11739

European Commission. Directorate General for Research and Innovation. (2021). *She figures 2021: Gender in research and innovation : statistics and indicators.* Publications Office. https://data.europa.eu/doi/10.2777/06090

European Commission. Directorate-General for Research, Marchetti, M., & Raudma, T. (2010). *Stocktaking 10 years of "women in science" policy by the European Commission 1999-2009*. Publications Office. https://data.europa.eu/doi/10.2777/74036

European Institute for Gender Equality. (2024). *What is gender mainstreaming | European Institute for Gender Equality*. https://eige.europa.eu/gender-mainstreaming/what-is-gender-mainstreaming?language_content_entity=en

Felt, U. (2018). *Responsible research and innovation*. Routledge Handbooks Online. https://doi.org/10.4324/9781315451695-14

Fitjar, R. D., Benneworth, P., & Asheim, B. T. (2019). Towards regional responsible research and innovation? Integrating RRI and RIS3 in European innovation policy. *Science and Public Policy*, *46*(5), 772–783. https://doi.org/10.1093/scipol/scz029

Foulds, C., Khalid, R., Jensen, E. A., Sule, O., & Lorenz, L. (2023). Social responsibility in research and innovation practice and policy across global regions, institutional types, and fields: Interview data and qualitative content analysis outputs revealing the perspectives and experiences of professionals. *Open Research Europe*, *3*, 65. https://doi.org/10.12688/openreseurope.15688.1

Garcia-Campa, S., & Sanahuja, R. (2023). Gender Mainstreaming and RRI: The Double Challenge. In E. González-Esteban, R. A. Feenstra, & L. M. Camarinha-Matos (Eds.), *Ethics and Responsible Research and Innovation in Practice* (Vol. 13875, pp. 188–202). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-33177-0_12

Ghosh, M. (2024). Exploring gender discourses in entrepreneurship: A bibliometric analysis. *Cogent Social Sciences*, *10*(1), 2299140. https://doi.org/10.1080/23311886.2023.2299140

Hume, D. (1777). *Enquiries Concerning the Human Understanding and Concerning the Principles of Morals*.

Jalal, S. K., & Mukhopadhyay, P. (2022). Gender differences, data carpentry and bibliometric studies in Mathematics. *COLLNET Journal of Scientometrics and Information Management*, *16*(2), 465–476. https://doi.org/10.1080/09737766.2022.2090873

Kalpazidou Schmidt, E. (2023). Creating a developmental framework for evaluating RRI implementation in research organisations. *Evaluation and Program Planning*, *100*, 102350. https://doi.org/10.1016/j.evalprogplan.2023.102350

Kant, I. (1785). *Ground work for the Metaphysic of Morals*.

Kruse, M. (2023). On sustainability in regional innovation studies and smart specialisation. *Innovation: The European Journal of Social Science Research*, 1–22. https://doi.org/10.1080/13511610.2023.2208294

Lindner, R., Woolley, R., Berghäuser, H., Brasil, A., Bührer-Topçu, S., Flipse, S., Griessler, E., Kjeldager Ryan, T., Llorente Lopez, C., Meijer, I., Revuelta de la Poza, G., Rommetveit, K., Stack, S., Strand, R., & Yaghmaei, E. (2024). *D1.4: SUPER MoRRI final report*. https://doi.org/10.5281/ZENODO.10653903

Liu, J., Zhang, G., Lv, X., & Li, J. (2022). Discovering the Landscape and Evolution of Responsible Research and Innovation (RRI): Science Mapping Based on Bibliometric Analysis. *Sustainability*, *14*(14), 8944. https://doi.org/10.3390/su14148944

Loureiro, P. M., & Conceição, C. P. (2019). Emerging patterns in the academic literature on responsible research and innovation. *Technology in Society*, *58*, 101148. https://doi.org/10.1016/j.techsoc.2019.101148

MacArthur, J., Carrard, N., & Willetts, J. (2021). Exploring gendered change: Concepts and trends in gender equality assessments. *Third World Quarterly*, *42*(9), 2189–2208. https://doi.org/10.1080/01436597.2021.1911636

Marina. (2022, September 8). *The RIS (File Format) Explained | MSK Library Blog*. https://library.mskcc.org/blog/2022/09/the-ris-file-format-explained/

Merton, R. K. (1968). The Matthew Effect in Science: The reward and communication systems of science are considered. *Science*, *159*(3810), 56–63. https://doi.org/10.1126/science.159.3810.56

Mohammadi, A. (2021). Responsible Research and Innovation (RRI): Scientometric Analysis. *European Public & Social Innovation Review*, *6*(2), 64–77. https://doi.org/10.31637/epsir.21-2.5

OECD. (2024). *Gender equality*. OECD. https://www.oecd.org/en/topics/gender-equality.html

O'Mathúna, D., & Iphofen, R. (Eds.). (2022). *Ethics, Integrity and Policymaking: The Value of the Case Study* (Vol. 9). Springer International Publishing. https://doi.org/10.1007/978-3-031-15746-2

Otero-Hermida, P., & García-Melón, M. (2018). Gender Equality Indicators for Research and Innovation from a Responsible Perspective: The Case of Spain. *Sustainability*, *10*(9), 2980. https://doi.org/10.3390/su10092980

Owen, R., Macnaghten, P., & Stilgoe, J. (2012). Responsible research and innovation: From science in society to science for society, with society. *Science and Public Policy*, *39*(6), 751–760. https://doi.org/10.1093/scipol/scs093

Owen, R., Von Schomberg, R., & Macnaghten, P. (2021). An unfinished journey? Reflections on a decade of responsible research and innovation. *Journal of Responsible Innovation*, *8*(2), 217–233. https://doi.org/10.1080/23299460.2021.1948789

Palmén, R., Schmidt, E. K., Striebing, C., Reidl, S., Bührer, S., & Groó, D. (2019). Measuring gender in R&I – theories, methods, and experience. *Interdisciplinary Science Reviews*, *44*(2), 154–165. https://doi.org/10.1080/03080188.2019.1603873

Panciroli, A., Santangelo, A., & Tondelli, S. (2020). Mapping RRI Dimensions and Sustainability into Regional Development Policies and Urban Planning Instruments. *Sustainability*, *12*(14), 5675. https://doi.org/10.3390/su12145675

Polanyi, M. (1962). THE REPUBLIC OF SCIENCE: Its Political and Economic Theory. *Minerva*, *1*(1), 54–73. JSTOR.

Popper, K. (2005). *The Logic of Scientific Discovery* (2nd ed). Taylor and Francis.

Pradana, M., & Elisa, H. P. (2023). Metaverse in education: A systematic literature review. *Cogent Social Sciences*, *9*(2), 2252656. https://doi.org/10.1080/23311886.2023.2252656

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The Titans of Bibliographic Information in Today's Academic World. *Publications*, *9*(1), 12. https://doi.org/10.3390/publications9010012

Quaiser, R. M., & Pandey, S. K. (2023). Design thinking enabling innovation: A literature review. *Innovation: The European Journal of Social Science Research*, *36*(4), 579–601. https://doi.org/10.1080/13511610.2023.2238910

Raman, R., Subramaniam, N., Nair, V. K., Shivdas, A., Achuthan, K., & Nedungadi, P. (2022). Women Entrepreneurship and Sustainable Development: Bibliometric Analysis and Emerging Research Trends. *Sustainability*, *14*(15), 9160. https://doi.org/10.3390/su14159160

Schuijff, M., & Dijkstra, A. M. (2020). Practices of Responsible Research and Innovation: A Review. *Science and Engineering Ethics*, *26*(2), 533–574. https://doi.org/10.1007/s11948-019-00167-3

Schumpeter, J. (1934). *The Theory of Economic Development*.

Scotti Requena, S., Pirkis, J., Currier, D., Nicholas, A., Arantes, A. A., & Armfield, N. R. (2024). The Origins and Evolution of the Field of Masculinity and Suicide: A Bibliometric and Content Analysis of the Research Field. *Archives of Suicide Research*, *28*(1), 20–34. https://doi.org/10.1080/13811118.2022.2151956

Silander, C., Haake, U., Lindberg, L., & Riis, U. (2022). Nordic research on gender equality in academic careers: A literature review. *European Journal of Higher Education*, *12*(1), 72–97. https://doi.org/10.1080/21568235.2021.1895858

Singh, S., Sharma, C., Bali, P., Sharma, S., & Shah, M. A. (2023). Making sense of glass ceiling: A bibliometric analysis of conceptual framework, intellectual structure and research publications. *Cogent Social Sciences*, *9*(1), 2181508. https://doi.org/10.1080/23311886.2023.2181508

Sipos, R., & Åkerman, M. (2023). Introducing the Critical Making Responsibility framework for analyzing responsible innovation processes in grassroots practices. *Innovation: The European Journal of Social Science Research*, *36*(4), 652–672. https://doi.org/10.1080/13511610.2023.2195583

Sperber, S., Täuber, S., Post, C., & Barzantny, C. (2023). Gender Data Gap and its impact on management science—Reflections from a European perspective. *European Management Journal*, *41*(1), 2–8. https://doi.org/10.1016/j.emj.2022.11.006

Srinivas, K. R. (2022). Responsible Research and Innovation and India: A Case for Contextualization and Mutual Learning. In D. O'Mathúna & R. Iphofen (Eds.), *Ethics, Integrity and Policymaking* (Vol. 9, pp. 29–48). Springer International Publishing. https://doi.org/10.1007/978-3-031-15746-2_3

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. *Research Policy*, *42*(9), 1568–1580. https://doi.org/10.1016/j.respol.2013.05.008

Tassone, V. C., O'Mahony, C., McKenna, E., Eppink, H. J., & Wals, A. E. J. (2018). (Re-)designing higher education curricula in times of systemic dysfunction: A responsible research and innovation perspective. *Higher Education*, *76*(2), 337–352. https://doi.org/10.1007/s10734-017-0211-4

Thapa, R. K., Iakovleva, T., & Foss, L. (2019). Responsible research and innovation: A systematic review of the literature and its applications to regional studies. *European Planning Studies*, *27*(12), 2470–2490. https://doi.org/10.1080/09654313.2019.1625871

Tokalić, R., Buljan, I., Mejlgaard, N., Carrió, M., Lang, A., Revuelta, G., & Marušić, A. (2021). Responsible research and innovation training programs: Implementation and evaluation of the HEIRRI project. *Forensic Sciences Research*, *6*(4), 320–330. Scopus. https://doi.org/10.1080/20961790.2021.1970319

Torres Madronero, E., & Torres-Madronero, M. C. (2024). The use of information and communication technologies in teaching-learning processes of social science in higher education: A systematic review. *Innovations in Education and Teaching International*, 1–14. https://doi.org/10.1080/14703297.2024.2333387

United Nations. (2024). United Nations: Gender equality and women's empowerment. *United Nations Sustainable Development*. https://www.un.org/sustainabledevelopment/gender-equality/

Von Schomberg, R. (2013). A Vision of Responsible Research and Innovation. In R. Owen, J. Bessant, & M. Heintz (Eds.), *Responsible Innovation* (pp. 51–74). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118551424.ch3

Wiarda, M., Van De Kaa, G., Yaghmaei, E., & Doorn, N. (2021). A comprehensive appraisal of responsible research and innovation: From roots to leaves. *Technological Forecasting and Social Change*, *172*, 121053. https://doi.org/10.1016/j.techfore.2021.121053

Wittrock, C., Forsberg, E.-M., Pols, A., Macnaghten, P., & Ludwig, D. (2021). About This Book and the RRI-Practice Study. In C. Wittrock, E.-M. Forsberg, A. Pols, P. Macnaghten, & D. Ludwig, *Implementing Responsible Research and Innovation* (pp. 1–4). Springer International Publishing. https://doi.org/10.1007/978-3-030-54286-3_1

Wroblewski, A., Bührer, S., Leitner, A., & Fan, C. (2015). *Monitoring the Evolution and Benefits of Responsible Research and Innovation (MoRRI). Analytical report on the gender equality dimension* (Sub-Task 2.5, Analytical Report, Deliverable D2.3). European Commission. https://morri.netlify.app/reports/2015-04-01-d2.3

Yañez, A. G. B., Alonso-Fernández, C., & Fernández-Manjón, B. (2023). Systematic literature review of digital resources to educate on gender equality. *Education and Information Technologies*, *28*(8), 10639–10664. https://doi.org/10.1007/s10639-022-11574-8

Yanhao, C., Mustafa, H., & Ling, T. P. (2024). Mapping the research of travel live streaming: A bibliometric analysis using Vosviewer. *Cogent Social Sciences*, *10*(1), 2285254. https://doi.org/10.1080/23311886.2023.2285254

Zwart, H., Landeweerd, L., & van Rooij, A. (2014). Adapt or perish? Assessing the recent shift in the European research funding arena from 'ELSA' to 'RRI.' *Life Sciences, Society and Policy*, *10*(1), 11. https://doi.org/10.1186/s40504-014-0011-x

Annex 1

Cluster	Keywords
RRI concept clusters	
Cluster 1 76 items (red)	Anticipation, artificial intelligence, automation, big data, business, china, circular economy, climate change, commerce, conceptual framework, corporate social responsibility, decision making, design, digital transformation, economic and social effects, emerging technologies, engineering education, environment, environmental impact, environmental impact, environmental policy, environmental protection, ethics, Europe, European union, framework, future prospect, governance, governance approach, grand challenges, health, health care, higher education, industry, innovation, innovation management, knowledge, literature review, machine learning, management, nanotechnology, open innovation, open science, participation, performance, philosophical aspects, policy, policy making, privacy, public engagement, public policy, research, research and development, research work, responsible innovation, responsible research, responsible research and innovation, responsible research and innovation (rri), robotics, rri, science, science and technology, social innovation, society, stakeholder, stakeholder engagement, students, sustainability, sustainable development, sustainable development goal, sustainable development goals, synthetic biology, systematic review, technological development, technological innovation, technology adoption, technology assessment.
Cluster 2 55 items (green)	Adoption, adult, aged, article, Australia, clinical article, clinical practice, clinical trial, controlled study, covid-19, delivery of health care, diffusion of innovation, economics, entrepreneurship, female, funding, government, health care delivery, health care personnel, health care policy, health care quality, human, human experiment, humans, implementation, interview, interviews as topic, leadership, major clinical study, male, mass communication, methodology, middle aged, Netherlands, organization, organization and management, organizational innovation, pandemic, patient care, perception, physician, practice guideline, procedures, psychology, public health, qualitative analysis, qualitative research, questionnaire, research design, semi structured interview, standards, thematic analysis, theoretical study, trust, United kingdom.
Cluster 3 23 items (blue)	article, biomedical research, brazil, communication, cooperation, education, engineering, ethics, research, interpersonal communication, invention, inventions, learning, medical research, morality, personnel, research ethics, research personnel, social behavior, social responsibility, teaching, technology, universities, university.
Cluster 4 22 items (yellow)	Agriculture, animal, animals, bioethics, biotechnology, clinical research, gene editing, genetics, health policy, innovation policy, medical ethics, metabolism, nonhuman, politics, priority journal, quality of life, responsibility, review, risk assessment, safety, translation research, United states.
RRI and GE concept clusters	
Cluster 1 10 items (red)	Decision making, economic and social effects, ethical technology, Europe, research and development, responsible innovation, responsible research and innovation, responsible research and innovation (RRI), science and technology, sustainable development.
Cluster 2 7 items (green)	Education, ethics, horizon 2020, Italy, learning, public engagement, structural change.

Cluster 3 6 items (blue)	Evaluation framework, gender equality, higher education institutions, methodology, personnel, research ethics.
Cluster 4 6 items (yellow)	Leadership, research, sustainability, sustainable development goal, sustainable development goals, united nations.
Cluster 5 5 items (purple)	Article, female, human, humans, male.
Cluster 6 4 items (light blue)	Climate change, gender, innovation, policy approach.
Cluster 7 3 items (orange)	Governance, RRI, sdgs.