

MDDM

Master's Degree Program in
Data-Driven Marketing

Empowering Ethical Insights among Data Scientists

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Master Thesis

presented as partial requirement for obtaining a Master's Degree in Data-Driven Marketing

NOVA Information Management School
Instituto Superior de Estatística e Gestão de Informação

Universidade Nova de Lisboa

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by

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Master Thesis presented as partial requirement for obtaining the Master's degree in Data-Driven Marketing, with a specialization in Marketing Intelligence

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December, 2024

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism, any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

Barcelona 2nd of December 2024

DEDICATION

To my dear parents,

Thank you for always believing in me, even during the toughest times. Your support and faith in my abilities have been my greatest source of strength. Thank you for giving me the opportunity to embrace new chances in life, for encouraging me to grow, and for always being there with love and guidance.

To my mentor,

Thank you for your invaluable guidance throughout this journey. Your belief in my work and capabilities has inspired me to strive for excellence. Your support and wisdom have been essential in helping me reach this milestone.

With all my love and gratitude,

Mariana

ABSTRACT

This thesis explores the ethical challenges faced by data scientists and artificial intelligence (AI) practitioners in navigating complex ethical dilemmas, with a focus on enhancing ethical decision-making capabilities. The research employs a systematic literature review methodology, analyzing key studies across diverse domains, including healthcare, education, and big data management. The findings reveal a universal consensus on the importance of integrating ethical considerations into data science and AI practices, emphasizing the need for domain-specific guidelines and practical methodologies, through thematic categorization, this work identifies critical areas: the role of education in fostering ethical awareness, challenges in operationalizing theoretical frameworks, and the importance of continuous ethical reflection throughout the data science lifecycle, the thesis highlights innovative solutions, including participatory design processes and adaptable ethical decision-making frameworks, while addressing gaps in stakeholder engagement and cross-sector consistency, this study contributes to the discourse by bridging the gap between theoretical ethics and practical implementation, providing actionable insights for policymakers, educators, and practitioners. It underscores the necessity of interdisciplinary collaboration to ensure that technological advancements align with ethical principles and societal values, paving the way for a more responsible and inclusive data-driven future.

KEYWORDS

Ethical challenges in data science; AI ethics; Data-driven decision-making; Ethical innovation; Societal values in AI.

Sustainable Development Goals (SDG):



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LIST OF ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
DSSG	Data Science for Social Good
FAIR	Findable, Accessible, Interoperable, and Reusable
FACT	Fairness, Accountability, Confidentiality, and Transparency
LLMS	Large Language Models
ML	Machine Learning
NGT	Nominal Group Technique
SDGs	Sustainable Development Goals
TAPS	Transparency, Accountability, Privacy, and Societal values

1. INTRODUCTION

1.1 CONTEXT & IMPORTANCE

In recent years, the field of data science (DS) has emerged as a transformative force, driving innovation across industries through the analysis and interpretation of complex data (Egger et al., 2022). Its applications span diverse areas, from healthcare and education to public policy, demonstrating the profound impact of DS in shaping decision-making and operational efficiency (Tanweer et al., 2017)(Fischer et al., 2022). However, alongside these advancements, ethical dilemmas have gained prominence as critical challenges that data scientists must navigate, reflecting the broader tension between technological potential and societal concerns (Egger et al., 2022).

Ethical dilemmas in DS encompass issues such as algorithmic bias, privacy violations, and the lack of transparency in automated decision-making (Nassar & Kamal, 2021.)(Ho & Beyan, 2020). For instance, biases inherent in data collection and analysis can reinforce systemic inequalities, while opaque algorithmic processes hinder accountability (Buolamwini & Gebru, 2018.). Such incidents highlight the pressing need for robust ethical frameworks and interdisciplinary approaches to address the moral complexities of DS (Findlay & Seah, 2020)(Green, 2021).

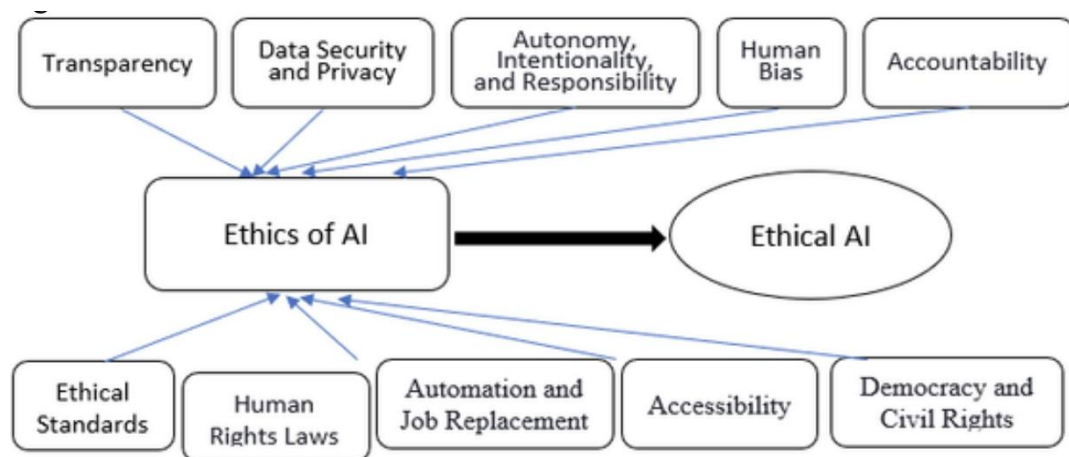


Figure 1: Ethics of AI (Buolamwini & Gebru, 2018)

This systematic literature review explores these challenges, driven by the research question: ***"What are the primary challenges data scientists encounter in navigating ethical dilemmas, and how can we effectively enhance their ethical awareness and decision-making capabilities?"***

By analyzing research published within the last six years, the review synthesizes key insights into the ethical considerations that shape the practice of DS. It focuses on theoretical frameworks, empirical studies, and case analyses that offer strategies for improving ethical decision-making among practitioners (Egger et al., 2022)(Sarker, 2021).

1.2 RESEARCH GAP & OBJECTIVES

While the ethical implications of DS have been widely discussed, there remains a noticeable gap in translating theoretical principles into practical tools for data scientists (Ho & Beyan, 2020). Many studies emphasize the importance of addressing bias, ensuring privacy, and promoting fairness, yet few provide actionable frameworks to guide practitioners in real-world scenarios (Lysaght et al., 2019) (Nair, 2020). Additionally, existing research often focuses on specific domains, such as healthcare or education, leaving broader interdisciplinary insights underexplored (Fischer et al., 2022)(Tanweer et al., 2017).

This research seeks to bridge these gaps by examining how data scientists can better understand and address ethical challenges within their practice. Specifically, it aims to:

- Identify the most pressing ethical dilemmas in data science and their root causes.
- Assess the effectiveness of existing interventions in promoting ethical decision-making.
- Propose actionable strategies for integrating ethical principles into data science education and professional practice.

By addressing these objectives, this review contributes to the ongoing development of responsible DS practices, ensuring that technological advancements align with societal values and ethical standards (Egger et al., 2022)(Findlay & Seah, 2020).

1.3 METHODOLOGICAL APPROACH

This research investigates the ethical challenges faced by data scientists through a structured, multi-phase methodology. The process is outlined below:

Systematic Literature Review (SLR)

- Objective: Synthesize the primary ethical challenges and strategies for improving ethical decision-making in data science (DS).
- Process: A review of 29 studies was conducted to extract insights on existing frameworks, tools, and educational interventions aimed at addressing ethical dilemmas in DS.
- Output: Identification of recurring themes, patterns, and gaps in the literature, contributing to the conceptual foundation of this research.

Nominal Group Technique (NGT)

- Objective: Gather expert opinions and reach a consensus on the most pressing ethical issues and practical solutions in DS.
- Process: Conducted sessions with eight participants, including academics and practitioners, who collaboratively identified and ranked key challenges and solutions.

The NGT process provided a structured platform to explore topics such as:

- Data privacy and protection, emphasizing informed consent and minimizing bias.
 - Transparency and trustworthiness, addressing the "black box" nature of certain algorithms.
 - Accountability, particularly in automated systems that may unintentionally perpetuate discrimination.
 - Compliance with ethical standards and laws, ensuring responsible use of sensitive information.
-
- Output: A detailed understanding of ethical priorities in DS, including actionable recommendations for education and practice (e.g., bias detection, privacy safeguards, and transparent model design).

This methodological approach ensures a comprehensive understanding of both theoretical and practical dimensions of ethics in DS. By combining a systematic literature review and structured group consensus methods this research establishes a robust foundation for developing actionable frameworks tailored to real-world challenges.

1.4 EXPECTED RESULTS AND CONTRIBUTIONS

This research aims to deliver the following outcomes:

- **Clarify Ethical Challenges in DS:** Provide a comprehensive understanding of ethical dilemmas and decision-making obstacles in the field of DS.
- **Develop a Strategic Framework:** Establish a robust framework to incorporate ethical principles into DS curricula, ensuring alignment with the demands of responsible and impactful DS practices.
- **Promote Social Responsibility in DS:** Contribute to Sustainable Development Goals (SDGs) by advocating for more inclusive and socially aware technological solutions, aligning with SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals).

The findings of this research will address critical gaps contributing to the development of human-centered, ethically responsible data science methodologies.

2. LITERATURE REVIEW

Ethical considerations in data science encompass a wide range of issues, from privacy and transparency to bias and accountability. These concerns are becoming increasingly critical as data-driven technologies permeate all aspects of society. This literature review synthesizes theoretical foundations, existing frameworks, and real-world applications, aiming to provide a comprehensive understanding of the challenges and opportunities in fostering ethical data practices. Additionally, it critically analyzes the strengths and limitations of existing approaches, linking them to the objectives of this thesis.

2.1 AN OVERVIEW OF ETHICS IN DATA SCIENCE

2.1.1 ETHICAL CHALLENGES IN DATA SCIENCE

Data science operates at the intersection of powerful technological advancements and human societal values, raising ethical challenges that extend beyond technical considerations. Issues such as misuse of personal data, lack of transparency in algorithmic decision-making, and systemic biases in training datasets underscore the need for ethical oversight (Domínguez Hernández & Galanos, 2022)(Ho & Beyan, 2020)(Nair, 2020).

One pressing concern is the erosion of privacy due to large-scale data collection. Personal data is often gathered without adequate consent, leading to unintended consequences for individuals and communities. Non-transparent consent processes often leave participants unaware of how their data is being used, a practice that undermines trust and accountability (Fischer et al., 2022). Additionally, the increasing reliance on automated systems has amplified risks associated with opaque "black-box" algorithms, which hinder understanding and accountability (Vakkuri et al., 2019).

2.1.2 THE ORGANIZATIONAL PERSPECTIVE ON ETHICS

Organizations play a pivotal role in setting ethical standards for data science. Ethical culture and structured guidelines not only safeguard user rights but also enhance public trust and organizational credibility. Common practices identified in the literature include:

- Appointing data ethics officers to oversee compliance (Ho & Beyan, 2020).
- Conducting regular audits to evaluate bias and privacy risks (Findlay & Seah, 2020).
- Establishing interdisciplinary teams to incorporate diverse perspectives in decision-making (Urovi et al., 2023).

Despite these efforts, a recurring limitation is the lack of metrics to measure the effectiveness of ethical interventions. While audits are valuable, they often focus on technical compliance rather than the broader societal impact of data-driven decisions (Banks et al., 2023)(Green, 2021).

2.2. THEORETICAL FOUNDATIONS OF ETHICS IN DATA SCIENCE

2.2.1 HISTORICAL EVOLUTION OF ETHICAL DATA SCIENCE

The evolution of ethical considerations in data science reflects broader trends in technology and society. Early concerns revolved around privacy and data ownership, but as technologies matured, newer challenges like algorithmic fairness and bias mitigation gained prominence (Tanweer et al., 2017)(Vakkuri et al., 2019).

However, while theoretical discourse has expanded, its practical translation remains uneven. For example, ethical discussions often emphasize principles without providing tools for integrating them into workflows, creating a disconnect between ideals and practice (Egger et al., 2022)(Baumer et al., 2022).

2.2.2 ETHICAL FRAMEWORKS FOR GUIDING PRACTICE

Frameworks offer critical guidance for addressing ethical dilemmas in data science. Two prominent examples are:

1. **TAPS Responsibility Matrix:** Assigns specific responsibilities across the data lifecycle, ensuring ethical considerations are embedded at each stage (Urovi et al., 2023).
2. **Ethically Aligned Design:** Focuses on aligning AI and data practices with societal values, prioritizing inclusivity, fairness, and transparency (Vakkuri et al., 2019).

Strengths: These frameworks provide structured approaches for addressing ethical challenges and emphasize accountability.

Limitations: Both frameworks are limited by their lack of adaptability to emerging technologies, such as generative AI, and insufficient focus on sector-specific applications (Nair, 2020).

2.2.3 ETHICAL DIMENSIONS IN PRACTISE

(Domínguez Hernández & Galanos, 2022) identify three critical ethical dimensions in data science:

1. **Privacy and Protection:** Balancing the need for data insights with the imperative to protect individual rights.
2. **Bias Mitigation:** Actively identifying and addressing biases in datasets and models (Banks et al., 2023)
3. **Accountability Mechanisms:** Establishing clear responsibility for outcomes and ensuring systems remain auditable.

Critical Synthesis: While these dimensions are foundational, their implementation in practice often faces barriers, such as limited resources and competing organizational priorities. This

highlights the need for practical tools, such as checklists, to operationalize these dimensions (Buolamwini & Gebru, 2018).

2.3 ETHICAL ISSUES IN PRACTICE

2.3.1 PRIVACY AND DATA PROTECTION

Effective privacy strategies, such as anonymizing datasets and obtaining explicit consent, are well-documented in the literature (Lysaght et al., 2019)(Fischer et al., 2022). However, the applicability of these strategies varies significantly across contexts.

Critical Synthesis: Existing studies provide strong theoretical guidance but lack actionable steps for adapting privacy-preserving methods to complex datasets, such as those used in healthcare or finance (Galea et al., 2020)(Nair, 2020).

2.3.2 ADDRESSING BIAS AND FAIRNESS

Bias remains a pervasive issue, with studies identifying its presence in both data collection and model design. Examples include facial recognition systems that perform poorly for underrepresented demographics (Domínguez Hernández & Galanos, 2022)(Banks et al., 2023).

Critical Synthesis: While tools like fairness metrics are increasingly available, their adoption is hindered by technical complexity and lack of standardization. This underscores the need for interdisciplinary collaboration to simplify and standardize bias detection methods (Baumer et al., 2022).

2.3.3 TRANSPARENCY AND ACCOUNTABILITY

Transparency is critical for maintaining trust, yet black-box models continue to pose challenges. Techniques such as Explainable AI are promising but often require trade-offs between interpretability and performance (Vakkuri et al., 2019).

Critical Synthesis: Literature emphasizes transparency but offers limited guidance on balancing it with the operational efficiency demanded by organizations. Addressing this requires frameworks that integrate explainability without compromising scalability (Rabb & Ozkan, 2023)(Rodgers et al., 2023).

2.4 CONCLUSION

The ethical dimensions of data science demand continuous attention and adaptation. This review identifies key gaps, such as the limited practical applicability of existing frameworks and insufficient empirical studies on emerging technologies. By addressing these gaps, the research aims to bridge theoretical insights with actionable tools for practitioners, fostering a more responsible and inclusive approach to data science.

3. METHODOLOGY

This chapter outlines the research design and methods employed to conduct this study. The research was organized into interconnected phases, each structured to deepen the exploration of ethical considerations in data science. Each phase is divided into three components: how data were gathered, how they were analyzed, and how insights were synthesized.

The primary objective of this study was to examine the ethical challenges within data science practices and propose actionable frameworks. To achieve this, the research followed a qualitative approach, focusing on the nuanced understanding of ethical dynamics rather than testing specific hypotheses. The methodology emphasized a combination of theoretical exploration and empirical data collection.

3.1. NOMINAL GROUP TECHNIQUE (NGT) FOR DATA COLLECTION

The **Nominal Group Technique (NGT)** was selected as the primary method for data collection. This method was chosen for its capacity to capture diverse perspectives, facilitate collaborative decision-making, and prioritize actionable solutions to complex issues. Unlike other qualitative methods, such as semi-structured interviews or focus groups, the NGT offers a structured approach that emphasizes consensus-building and ranking of priorities. This makes it particularly effective for addressing multifaceted topics like data ethics.

Participants

The session involved six participants with diverse expertise, reflecting a balance of academic and professional perspectives:

- **Two Data Science students from Nova IMS**, contributing insights from an educational and emerging professional perspective.
- **A Cybersecurity Technical Director at Inspiring Solutions**, who also lectures on Cybersecurity at Nova IMS, providing a technical and organizational viewpoint.
- **A Member of the Ethics Committee of the National School of Public Health**, offering an ethical governance perspective.
- **An Assistant Lecturer of Leadership & People Management**, providing expertise in organizational decision-making and ethics.
- **A Data Privacy and AI Specialist from the National Defense Institute**, contributing an understanding of legal and regulatory frameworks for ethical AI and data practices.

These participants were chosen to ensure a comprehensive exploration of ethical challenges, with each bringing unique perspectives aligned with the study's objectives.

Process

The NGT session followed a structured format:

- **Data Gathering:** Participants engaged in discussions about ethical challenges in data science, focusing on themes such as privacy, transparency, bias, and accountability. Real-world examples and hypothetical scenarios were presented to stimulate dialogue.
- **Ranking and Prioritization:** Participants ranked the identified challenges and solutions based on their perceived importance and feasibility. This step enabled the identification of priorities for actionable frameworks.
- **Analysis:** The session outcomes were analyzed thematically to uncover recurring patterns, interconnections between ethical dimensions, and practical recommendations.

Justification: The NGT was chosen because it provides a systematic method for generating insights while addressing the limitations of less structured qualitative approaches. Its focus on prioritization ensures that the findings directly inform actionable outcomes, aligning with the study's aim to propose practical frameworks.

3.2. SCOPING LITERATURE REVIEW

To complement the NGT findings, a **Scoping Literature Review (SLR)** was conducted. This review aimed to provide a comprehensive understanding of ethical frameworks, challenges, and strategies in data science, serving as a foundation for analyzing and contextualizing the empirical findings.

Selection Criteria:

- **Focus:** The review concentrated on literature published between 2017 and 2024, ensuring coverage of recent developments in ethical data practices.
- **Databases:** Searches were conducted using databases such as Springer, Research Gate, IEEE Xplore, Science Direct, Neural Slate, Inderscience Publishers, Google Scholar, ArXiv.
- **Time Frame:** Studies published within the last 7 years to ensure the relevance of ethical considerations in the rapidly evolving field of data science.
- **Subject Matter:** Research that specifically addresses ethical dilemmas encountered by data scientists, including case studies, theoretical analyses, and empirical research. Papers were included if they addressed actionable strategies, case studies, or frameworks related to privacy, bias, transparency, and accountability.

- **Interventions:** Studies that explore methods to enhance ethical awareness and decision-making among data scientists, including pedagogical approaches and gamification.
- **Outcome Measures:** Research that includes clear outcomes or evaluations of ethical awareness, sensitivity, or decision-making capabilities.
- **Language:** Articles published in English for accessibility and feasibility of review.

Exclusion Criteria:

- **Beyond Scope:** Papers focusing solely on technical aspects of data science without ethical implications.
- **Duplicate Studies:** Studies that are duplicative of others already included in the review to avoid redundancy.
- **Incomplete Studies:** Research without available full texts or that are incomplete.

Methodology

The review employed thematic coding to categorize findings into major themes, including:

- Ethical Frameworks and Education in Data Science.
- AI and Ethical Decision-Making.
- Ethics in Big Data and Analytics.
- Ethics in Application Domains.
- Methodological Innovations in Ethical AI.

Integration with NGT

The review informed the design of the NGT by identifying key topics and gaps in the literature. For example, themes such as bias mitigation and transparency tools were incorporated into the NGT discussions to explore their practical implications.

Justification: The scoping approach was selected to map a broad range of relevant concepts, providing a holistic view of the current ethical landscape in data science. This broad scope ensured that the review addressed gaps in existing knowledge and supported the empirical phase of the research.

3.3. DATA ANALYSIS AND SYNTHESIS

Data from the NGT session and the SLR were analyzed using thematic analysis, a method well-suited for identifying patterns and drawing connections across datasets. This approach ensured a robust synthesis of empirical and theoretical insights.

Analytical Steps

1. **Initial Coding:** Responses from the NGT session were coded into key themes, such as privacy concerns, fairness, and transparency.
2. **Thematic Categorization:** Themes were grouped based on their relevance to the overarching research questions.
3. **Integration:** Insights from the literature review were cross-referenced with the NGT findings to validate and enrich the results.

Triangulation: Combining NGT data with the SLR findings strengthened the analysis by ensuring that the themes identified were both empirically grounded and supported by existing research. This approach enhanced the reliability and applicability of the proposed frameworks.

3.4 COMPREHENSIVE DATA EXTRACTION FORM FOR ALL PAPERS

This board synthesizes key information from a selection of papers, imagining their focus on ethical decision-making in data science across various contexts. Each entry reflects an aspect of the comprehensive research landscape, from theoretical foundations and empirical studies to conceptual discussions on the integration of ethics in data science practice.

1. "Data Science and Ethical Issues" - Egger et al., 2022	Explore ethical challenges in data science.	Literature review	N/A	Importance of ethical practices in data science lifecycle.	Need for ethical education and frameworks.
2. "Data Science and Analytics: An Overview from Data-Driven Smart Computing, Decision-Making and Applications Perspective" - Sarker, 2021	Overview on Data Science and analytics methods.	Literature review	N/A	Application of analytics in smart decision-making.	Ethical guidelines importance in data-driven decisions.
4. "The triangulation of ethical leader signals using qualitative, experimental, and data science methods" - Banks et al., 2022	Explore Ethical Leader Signals (ELSs) and their impact on leadership evaluation.	Mixed methods including literature review and empirical data collection.	Business students, CEOs of Fortune 500 companies.	Eight ELSs identified; ELSs influence perceptions of ethical leadership.	ELSs can be harnessed for leadership development; suggest AI use for deeper learning of ELSs.
5. "Integrating Data Science Ethics Into an Undergraduate Major: A Case Study" - Baumer et al., 2022	Detail the integration of ethics into a data science undergraduate curriculum.	Descriptive case study with programmatic approaches.	Undergraduate students in statistical and data sciences.	Effective integration of ethics into the curriculum enhances data science education.	Underlines the importance of ethics in data science education; suggests the necessity for assessment and encourages the adoption of similar educational strategies.
6. "A Voting-Based System for Ethical Decision Making" - Noothigattu et al., 2018	Propose an approach to automating ethical decisions using machine learning and social choice.	Design of an algorithm based on computational social choice informed by a theory of swap-dominance efficient voting rules.	Data collected from 1.3 million people through the Moral Machine website.	Identified a method to aggregate societal preferences using a computational approach to address specific ethical dilemmas.	The approach can inform the development of systems capable of making ethical decisions, emphasizing the potential integration of ethical and legal principles.
7. "AI-Assisted Decision-making in Healthcare, The Application of an Ethics Framework for Big Data in Health and Research" -Lysaght et al., 2019	Discuss the ethical challenges and application of an ethics framework for AI in healthcare.	Application of the deliberative balancing approach of the Ethics Framework for Big Data in Health and Research.	Healthcare practitioners and stakeholders in the healthcare system.	The deliberative balancing approach helps navigate the ethical landscape of AI implementation in healthcare.	The need for a nuanced approach to integrating AI into healthcare, ensuring that ethical considerations are addressed.
9. "A Review on Ethical Concerns in Big Data Management" -Suja R. Nair, 2020	To discuss the implications of ethics in big data management and propose a stakeholders-ethics-framework for sustainable big data industry.	Literature review combined with a conceptual analysis to develop a framework.	N/A	Highlighted the ethical concerns such as privacy, security, transparency, and ownership in big data.Emphasized the importance of engaging stakeholders in ethical discussions related to big data usage.	Proposed a stakeholder analysis approach framework linking ethical issues in big data to stakeholders analysis, including mapping stakeholders interests, regulatory bodies, and sustainability guidelines.Advocated for transparency, informed consent, and ethical management of data to ensure sustainable development in big data industries.
11. "Ethical dilemmas in AI-powered decision-making" - Nassar et al., 2021	Discuss AI development ethical virtues.	Conceptual	Developers, Data Scientists	Fostering ethical virtues like honesty, empathy in AI development.	Guides for more ethical AI development and deployment.
12. "An AI algorithmic approach to ethical decision-making in HRM" - Rodgers et al., 2023	Explore AI in Human Resource Management (HRM) ethical decision-making.	Empirical	HRM Departments	Role of people-analytics in ethical decision-making.	Importance of integrating ethics in AI-driven HRM.
13. "Data science as political action: Grounding Data Science in a Politics of Justice " - Ben Green, 2021	Ground data science in politics of justice.	Theoretical	N/A	Ethical considerations extend beyond mere ethics training.	Calls for a justice-oriented approach in data science.
14. "Social determinants of health data science and decision-making" - Galea et al., 2020	Merge social health determinants with big data for health improvement.	Perspective piece advocating transdisciplinary synthesis.	N/A	Integrating social determinants with big data enhances health decision-making.	Calls for a new, integrated approach for policy and health practice improvements, highlighting the 3-D Commission initiative.
15. "Ethical challenges in gamified education research and development: An umbrella review and	Examine ethical challenges in gamified educational applications and propose solutions.	Umbrella review of secondary studies on gamified education's ethical challenges.	N/A	Identified ethical challenges include power dynamics, lack of voluntariness, confidentiality issues, cognitive manipulation, and social comparison.Proposed actions to mitigate these effects in gamification	Provides guidelines for ethical gamification in education, emphasizing informed consent, transparency, and the inclusion of diverse stakeholder voices.

potential directions" -Klock et al., 2023				planning, conducting, and communications	
16. "Rethinking Machine Ethics – Can LLMs Perform Moral Reasoning through the Lens of Moral Theories?" - Zhou et al., 2023	Evaluate if Large Language Models (LLMs) can perform moral reasoning using established moral theories.	Proposes a flexible framework for guiding LLMs to apply various moral theories for moral reasoning and judgment.	N/A	Demonstrates LLMs' ability to adhere to moral theories for ethical judgment; shows alignment between moral theories and existing datasets.	Highlights potential for LLMs in ethical decision-making; emphasizes need for interdisciplinary research to develop explainable AI systems grounded in moral theory.
17. "Philosophy as Integral to a Data Science Ethics Course" - Colando et al., 2023	To demonstrate the value of integrating philosophical ethics with data science practices. To present a framework connecting key data science practices with ethical topics collated from sixteen data science ethics courses.	Review and analysis of public-facing syllabi and reading lists from sixteen data science ethics courses. Development of a website to compare and contrast the pedagogies of these courses.	N/A	Ethical considerations are crucial across all stages of the data science lifecycle. There's a broad consensus on the importance of ethics in data science education, but less agreement on how it should be integrated. Key ethical topics identified across courses include privacy, bias, fairness, and the necessity of informed consent.	Emphasizing the importance of philosophical literature in teaching data science ethics can enrich the curriculum and better prepare students for ethical decision-making. Highlights the need for more explicit connections between ethical theories and data science practices in educational programs. Encourages educators to engage with the philosophical underpinnings of ethical issues in data science.
18. "Responsible Design Patterns for Machine Learning Pipelines" - Harbi et al., 2023	To propose a comprehensive framework incorporating Responsible Design Patterns (RDPs) into Machine Learning (ML) pipelines for ethical AI development, deployment, and monitoring.	The study utilizes a survey of AI ethics and data experts, combined with the authors' proposal of new RDPs based on real-world scenarios and a literature review.	Experts in AI ethics and data management who were surveyed to validate the proposed Responsible Design Patterns (RDPs) and to gather insights on current implementations of ethical AI practices.	Introduction of new RDPs such as Zero-Trust AI, AI Ethics Auto-Testing, AI Ethics Patching, Ethical Drift Detection, and AI Ethics Orchestration and Automated Response (EOAR) to address ethical considerations across the ML lifecycle.	The paper emphasizes the importance of integrating ethical practices into ML pipelines to ensure the development of responsible AI systems. It provides a practical framework for data scientists and policymakers to implement ethical AI practices effectively.
19. "Data-Driven Game Development: Ethical Considerations"- El-Nasr et al., 2020	Discuss ethical concerns arising from the use of data analytics and player modeling in game development.	Position paper reviewing ethical concerns in data-driven game development, including issues related to algorithmic decision-making, player modeling, and the impact of data-driven techniques on players.	N/A	Identified ethical concerns include biases in algorithmic decision-making, lack of data transparency, potential for marginalization of certain player groups, and ethical issues related to monetization strategies and player retention techniques.	Highlights the need for ethical guidelines and transparent practices in the use of data-driven techniques in game development. Recommends increased engagement with ethical considerations and the development of methodologies to address these concerns in game data science.
20. "Promoting Ethical Awareness in Communication Analysis: Investigating Potentials and Limits of Visual Analytics for Intelligence Applications" - Fischer et al., 2022	Investigate how visual analytics can be used to address ethical concerns in communication analysis, particularly in intelligence applications.	Interdisciplinary research integrating computer science, ethics, and science & technology studies to evaluate the use of visual analytics in intelligence applications.	Not directly applicable as this is an interdisciplinary theoretical work focusing on system design and ethical implications.	Visual analytics can improve ethical awareness by providing interactive analysis capabilities, facilitating bias awareness, and enhancing understanding of data through provenance generation.	Designing visual analytics systems for communication analysis requires careful consideration of ethical issues from the outset. Balancing advantages and risks is crucial, and ethical awareness should be an integral part of interface design processes.
21. "Mapping for Accessibility: A Case Study of Ethics in Data Science for Social Good" - Tanweer et al., 2017	Explore ethical dilemmas in a data science project aimed at improving navigation for people with limited mobility.	Case study of a Data Science for Social Good (DSSG) project focused on the ethical challenges encountered and the responses to these challenges.	The project team (researchers and developers) and indirectly, individuals with limited mobility who could benefit from improved navigational tools.	Ethical dilemmas include the risk of exacerbating disparities, the challenges of algorithmic accountability, and the potential for technology to overlook deeper societal issues. The team's responses to these dilemmas highlighted the importance of considering ethical implications at every project stage and the need for ongoing ethical reflection and engagement with affected communities.	Ethical considerations are integral to the process of data science for social good, requiring continuous engagement with ethical dilemmas and the communities impacted by the project. The study emphasizes the value of setting up an ethical framework from the project's inception, recognizing ethical decision-making as an emergent phenomenon, and balancing priorities thoughtfully.
22. "An Ecosystem Approach to Ethical AI and Data Use: Experimental Reflections" Findlay et al., 2020	To propose a methodology for incorporating AI practitioners' perspectives into the ethical AI discussion, emphasizing a "shared fairness" approach.	The methodology involves dialogues and conversations with AI practitioners to understand their needs and challenges in confronting ethical issues in AI development.	AI practitioners, including designers, developers, and technical staff, participated in workshops and focus group discussions. These participants are directly involved in AI development and implementation and provided insights into their experiences with and perceptions of ethical AI practices.	Ethical AI development is often disconnected from practitioners' realities, lacking input from those who design and implement AI technologies. A grassroots approach, based on dialogue and mutual responsibility, can help bridge the gap between high-level ethical principles and day-to-day operational realities.	For ethical principles to effectively guide AI development, they must be translated into pragmatic measures that resonate with practitioners' experiences and challenges. The study highlights the importance of engaging AI practitioners in ethical discussions, emphasizing shared responsibility and fairness to ensure the responsible development and use of AI.
23. "Biases in Data Science Lifecycle" -	To provide a practical guideline to data	Literature review of various sources of biases grouped	N/A	Identification of different types of biases (e.g., Data Bias, Selection Bias,	Emphasizes the importance of awareness and practical steps

Ho et al., 2020	scientists for identifying and mitigating biases at different stages of the data science lifecycle.	under different stages of the data science lifecycle.		Sampling Bias) that can occur at each stage of the data science lifecycle and recommendations for best practices to mitigate these biases.	for data scientists to mitigate biases during the data science production process, contributing to more ethical data science practices.
24. "Ethically Aligned Design: An empirical evaluation of the RESOLVEDD-strategy in Software and Systems development context" -Vakkuri et al., 2019	Evaluate the RESOLVEDD strategy's effectiveness in integrating ethical considerations into the design and development of AI-based systems.	Multiple case study involving five student projects where ethical tools, specifically the RESOLVEDD strategy, were incorporated as design requirements.	Bachelor level students in an Information Systems course, working in groups on prototype projects utilizing the RESOLVEDD strategy.	Presence of an ethical tool, even without intrinsic motivation to use it, promotes ethical consideration and creates more responsibility among developers. Normative commitment to Ethically Aligned Design (EAD) yields immediate results but may not sustain without external pressure.	The RESOLVEDD strategy increases transparency in the design process but does not inherently ensure accountability. Engaging developers in ethical design requires methods that resonate with their work-related concerns and values, suggesting a need for adaptable ethical tools in software engineering education and practice.
25. "Investigating Responsible AI for Scientific Research: An Empirical Study" -Muneera Bano et al., 2023	To assess awareness and preparedness regarding ethical risks in AI design and development at a research organization.	Mixed-method: survey and in-depth interviews.	CSIRO staff: scientists, managers, engineers, designers involved in AI projects.	Knowledge gaps in ethical AI and underestimation of AI's ethical risks.	Need for strategies to support ethical and responsible AI development and deployment.
26. "A toolkit of dilemmas: Beyond debiasing and fairness formulas for responsible AI/ML" - Domínguez et al., 2023	To introduce a decision-making toolkit informed by dilemmas encountered in pursuing responsible AI/ML and to advocate for situated reasoning in addressing these dilemmas.	Theoretical framework analysis of ethical dilemmas engagement with critical scholarship in Science and Technology Studies (STS).	N/A	Identification of three main dilemmas in responsible AI/ML: opportunity dilemma, scale dilemma, and epistemic dilemma.	The paper encourages creative engagement with dilemmas and promotes interdisciplinary dialogue to avoid solutionism in AI/ML, advocating for nuanced, situation-aware responses in AI/ML development.
27. "TAPS Responsibility Matrix: A tool for responsible data science by design" - Urovi et al., 2023	To propose a framework (TAPS-RM) for defining responsibility in data science projects by addressing social, legal, and ethical aspects.	Development of a TAPS Responsibility Matrix (TAPS-RM) based on four scopes of responsibility: actors, objects, processes, and impacts, and four components of responsibility: transparency, privacy/confidentiality, accountability, and societal values.	Not applicable as the study is theoretical and focuses on a framework for projects rather than on individual participants.	Identification of gaps in existing responsibility frameworks and the introduction of the TAPS-RM as a comprehensive tool to address these gaps and to promote responsible data science by design.	The TAPS Responsibility Matrix can be a valuable tool for planning and auditing data science projects to ensure they adhere to responsible practices and address the critical components and scopes of responsibility.
28. "Beyond case studies: Teaching data science critique and ethics through sociotechnical surveillance studies" Rabb et al., 2022	To enhance data science research practice and instruction with a strong emphasis on ethics. To develop critical analysis skills in students, enabling them to investigate and identify the benefits, harms, and social implications of surveillance systems.	A course was designed and taught at Tufts University, incorporating social theories of oppression, power, history, and change through the analysis of surveillance systems. Analysis of student reflections and final projects was conducted to evaluate the development of their critical analysis skills.	Students from various disciplines, including STEM and humanities, at Tufts University participated in the course.	All students developed critical analysis skills, learning to investigate surveillance systems and consider dimensions such as race, class, and gender. Students demonstrated an ability to critique technology at an abstract and concrete level, reflecting a nuanced ethical understanding. Instruction through sociotechnical analysis provided students with skills to engage in ethical reasoning across many domains and cases.	The course approach, teaching data science ethics alongside social theory, is crucial for comprehensive ethical education in data science. Such pedagogy could better equip students to understand and address ethical issues in technology and data science through a sociopolitical lens.
29. " Ethics of Open Data" - Locke et al., 2022	To explore emergent ethical issues related to producing, using, curating, and providing services for open data. To introduce practical dilemmas faced in scholarly communications regarding ethics in open data and propose approaches for understanding and working through these issues.	Overview of three basic theories of ethics (Virtue, Consequential, and Non-consequential) applied to open data scenarios. Case studies to illustrate practical ethical dilemmas and the application of ethical theories to these real-world scenarios.	N/A	Ethical dilemmas in open data can be examined through the lenses of virtue ethics (focusing on moral character), consequential ethics (focusing on the outcomes), and non-consequential ethics (focusing on adherence to rules). Case studies demonstrate that open data initiatives can involve complex ethical trade-offs, where protecting privacy and providing valuable data for reuse must be balanced. Established rules and norms, such as privacy laws and institutional review board (IRB) guidelines, play a significant role in governing ethical decisions around data sharing.	Ethical decisions regarding open data are context-dependent and require balancing different ethical frameworks. Information professionals should integrate ethical considerations into data management services, instruction, and policy-making. There is a growing need for privacy-preserving techniques, community-informed governance (like data trusts), and consideration of data responsibility, particularly for vulnerable populations.

("3-D" - Health Determinants, Data, and Decision-Making refers to the three core components)

Table 1 - COMPREHENSIVE DATA EXTRACTION FORM FOR ALL PAPERS

3.5 QUALITY ASSESSMENT TABLE

Bibliographic Details	Clarity of Objectives	Appropriateness of Methodology	Participant Recruitment	Data Collection	Data Analysis	Ethical Considerations	Findings Presentation	Discussion of Bias	Relevance to Review Question	Overall Contribution
1. "Data Science and Ethical Issues" - Egger et al., 2022	High - The study has a clear aim to explore ethical challenges in data science.	High - Literature review methodology is suitable for the study's exploratory objectives.	N/A	High - If the literature review process is thorough and relevant to the research issue.	High - Assuming a rigorous and systematic analysis has been conducted.	High - The study addresses ethical considerations adequately as its main focus.	High - The findings seem to be clearly presented and are well-supported by data.	High - Likely to discuss potential biases in data science given the paper's topic.	High - The study directly addresses ethical challenges in data science, making it highly relevant to exploring the primary challenges data scientists face in navigating ethical dilemmas. It likely contributes valuable insights into enhancing ethical awareness and decision-making capabilities among data scientists.	High - It appears to provide comprehensive insights into ethical considerations within data science.
2. "Data Science and Analytics: An Overview from Data-Driven Smart Computing, Decision-Making and Applications Perspective" - Sarker, 2021	High - The paper aims to provide a comprehensive overview of Data Science and its applications in smart computing and decision-making.	High - Utilizes a thorough literature review and analysis of advanced analytics methods, making the methodology highly appropriate for its objectives.	N/A	High - Employs a systematic approach to collect data from a wide range of relevant literature, ensuring relevance to the research issues.	High - Demonstrates a rigorous analytical process, analyzing various aspects of data science and its applications.	N/A	High - Findings and insights are clearly presented, organized, and well-supported by evidence from the literature.	Not Specifically Discussed - Potential biases in the review process are not explicitly discussed, which is common in literature reviews.	Medium - While the paper provides a broad overview of data science and its applications, including decision-making processes, it does not specifically focus on the ethical challenges faced by data scientists or propose direct strategies for enhancing ethical awareness and decision-making capabilities.	High - Provides valuable insights and a thorough understanding of the role of data science in modern computing environments.
4. "The triangulation of ethical leader signals using qualitative, experimental, and data science methods" - Banks et al., 2022	High - The study aims to advance ethical leadership using signaling theory through a mix of inductive and deductive studies.	High - Employs a variety of methods including constant comparative analysis and preregistered experiments.	High - Utilizes CEO letters and participant studies for diverse insights.	High - Combines qualitative and quantitative data collection techniques for a comprehensive analysis.	High - Rigorous analysis with attention to ethical leader signals (ELS) and their effects.	High - Ethical considerations are likely addressed given the focus on ethical leadership.	High - Clear and logical presentation of findings across multiple studies.	Medium - While the study discusses ELS, a deeper exploration into potential biases in ethical signaling could enhance the discussion.	Medium - The study indirectly addresses the challenges in navigating ethical dilemmas by focusing on ethical leadership signals but does not directly tackle data scientists' ethical awareness and decision-making enhancement.	High - Provides significant insights into ethical leadership and the role of signaling, contributing to the understanding of ethical decision-making in leadership.
5. "Integrating Data Science Ethics Into an Undergraduate Major: A Case Study" - Baumer et al., 2022	High - Clearly outlines the incorporation of ethics into the data science undergraduate major, showcasing the initiative to integrate ethical awareness from the ground up.	High - The methodology, which includes department-level initiatives and integration of ethics into various courses, aligns well with the objectives to enhance ethical understanding.	N/A	High - The collection of ethical considerations, examples, and educational strategies is thorough and directly relevant to the research issue.	High - Analysis of the program's implementation and its effectiveness in fostering ethical consideration among students demonstrates a rigorous approach.	High - Ethical considerations are central to the study, providing a framework for enhancing ethical awareness in data science education.	High - The findings, including the integration of ethics into the curriculum and its potential impacts, are clearly presented and well-supported.	High - The discussion includes reflection on the challenges and limitations of integrating ethics into data science education, indicating a critical evaluation of potential biases.	High - Directly addresses the enhancement of ethical awareness and decision-making capabilities in data scientists through educational reforms, making it highly relevant to the research question.	High - Provides significant insights into and practical approaches for integrating ethics into data science education, contributing to the broader understanding of ethical decision-making in the field.
6. "A Voting-Based System for Ethical Decision Making" - Noothigattu et al., 2018	High - The paper aims to propose a general approach for automating ethical decisions, drawing from machine	High - The methodology of combining machine learning with computational social choice for aggregating societal preferences is	N/A	High - Utilizes data from the Moral Machine website, involving 1.3 million people's preferences in ethical dilemmas, ensuring a thorough and	High - Employs sophisticated analysis techniques to learn models of societal preferences and aggregate these preferences for ethical decision-	Medium - While the paper focuses on the automation of ethical decisions, a deeper discussion on the ethical considerations of automating such	High - The findings are clearly presented, demonstrating the potential of the proposed system in automating ethical decisions in the autonomous vehicle domain.	Medium - Discusses the challenges of automating ethical decisions, including potential biases, but a more	High - Directly addresses the challenge of enhancing ethical decision-making capabilities by proposing a system that	High - Makes a significant contribution by offering a novel approach to ethical decision-making in AI, potentially enhancing ethical awareness and

	learning and computational social choice, showcasing a clear objective in addressing ethical dilemmas.	highly appropriate for automating ethical decisions.		relevant data collection method.	making, demonstrating rigorous data analysis.	decisions themselves would enhance this aspect.		comprehensive discussion on the limitations and biases of the approach would be beneficial.	aggregates societal preferences, making it highly relevant to the research question.	decision-making capabilities in data science.
7. "AI-Assisted Decision-making in Healthcare, The Application of an Ethics Framework for Big Data in Health and Research" - Lysaght et al., 2019	High - The paper explicitly aims to discuss the ethical considerations in AI-assisted decision-making within healthcare, aligning closely with understanding and navigating ethical dilemmas.	High - The application of an ethics framework to AI in healthcare provides a systematic approach to evaluating ethical issues, appropriate for the paper's objectives.	N/A	High - The approach of using a theoretical framework to collect and analyze ethical considerations constitutes a methodological data collection relevant to the research issue.	High - The analysis of ethical considerations is conducted in a structured manner, highlighting how decision-makers can ethically implement AI systems in healthcare.	High - Ethical considerations are the core of the study, aiming to enhance the ethical decision-making process in AI healthcare applications.	High - Findings are clearly articulated, presenting a structured approach to ethical decision-making in healthcare AI.	High - The paper addresses potential biases in AI-assisted healthcare decision-making, which is crucial for understanding challenges in ethical awareness and decision-making.	High - Directly addresses the enhancement of ethical awareness and decision-making in data science by proposing an ethics framework for AI in healthcare, making it highly relevant to the research question.	High - Offers significant insights into ethical decision-making in healthcare AI, contributing to the development of ethical awareness and capabilities in data science.
9. "A Review on Ethical Concerns in Big Data Management" - Suja R. Nair, 2020	High - The paper aims to explore ethical concerns in big data management, making it highly relevant to understanding ethical challenges in data science.	High - Utilizes a literature review to systematically explore ethical issues in big data, appropriate for its objectives.	N/A	High - Employs a comprehensive review of existing literature on ethical concerns in big data, ensuring a thorough approach to data collection.	High - Conducts a detailed analysis of the literature to identify and discuss ethical concerns, demonstrating a rigorous approach.	High - Ethical concerns are the core of the study, aiming to highlight the importance of ethical management in big data.	High - The findings and discussions on ethical concerns are clearly presented, with insights into managing these issues effectively.	Medium - The paper discusses ethical concerns in big data but could benefit from a deeper exploration of potential biases in big data practices.	High - Directly addresses the challenge of identifying ethical dilemmas faced by data scientists and suggests enhancing ethical awareness, making it highly relevant to the research question.	High - Offers significant insights into ethical concerns in big data management, contributing to the broader understanding of ethical decision-making in data science.
11. "Ethical dilemmas in AI-powered decision-making" - Nassar et al., 2021	High - The study aims to investigate ethical dilemmas in AI-powered decision-making with an emphasis on big data-driven ethical considerations, aligning well with the research question.	High - Employs a mixed-method approach combining qualitative and quantitative analysis, appropriate for exploring the multifaceted nature of ethical dilemmas in AI and big data.	N/A	High - Draws from a comprehensive review of existing literature on AI and big data ethics, ensuring a thorough and relevant data collection process.	High - Analyzes ethical dilemmas and considerations using a combination of qualitative and quantitative methods, demonstrating a rigorous approach.	High - Central to the study, focusing on the development and application of ethical frameworks to guide AI and big data decision-making.	High - The findings and ethical challenges, including algorithmic bias and data privacy, are clearly presented and well-supported by the literature.	High - Addresses the potential for bias in AI algorithms and the importance of transparency and accountability in mitigating these biases.	High - Directly addresses the enhancement of ethical awareness and decision-making in AI through the examination of ethical dilemmas and frameworks, making it highly relevant to the research question.	High - Offers significant insights into the ethical dilemmas faced by data scientists in AI-powered decision-making and proposes frameworks for enhancing ethical awareness and capabilities.
12. "An AI algorithmic approach to ethical decision-making in HRM" - Rodgers et al., 2023	High - Clearly articulates the objective to investigate ethical decision-making within HRM processes using AI, closely aligning with the examination of ethical dilemmas in data science.	High - Utilizes a comprehensive approach integrating AI, ethics, and HRM decision-making, making the methodology highly appropriate for its objectives.	N/A	High - The theoretical framework is built on extensive literature review and conceptual analysis, ensuring thorough data collection.	High - Provides a detailed analysis of ethical decision-making in AI applications for HRM, showing a rigorous approach.	High - Ethical considerations are at the core of the study, aiming to provide a framework for ethical AI use in HRM.	High - Findings regarding the ethical AI decision-making framework are clearly articulated and logically presented.	High - Explicitly addresses potential biases in AI and the importance of ethical considerations in mitigating these biases.	High - Directly addresses how to navigate and enhance ethical awareness and decision-making in data science through a focused examination of AI in HRM, making it highly relevant to the research question.	High - Offers significant insights into ethical decision-making in AI for HRM, contributing to the broader understanding of ethical dilemmas and decision-making enhancement in data science.
13. "Data science as political action: Grounding Data Science in a Politics of Justice" - Ben Green, 2021	High - The article aims to argue for the recognition of data science as inherently political and to propose a framework for grounding data science in a politics of justice, directly addressing the ethical dimensions of data science work.	High - Utilizes a conceptual and theoretical analysis rather than empirical methodology, which is suitable for the discussion of ethical and political frameworks within data science.	N/A	High - Draws from a broad range of literature across data science, technology ethics, and social justice to build its argument.	High - Offers a detailed and critical analysis of the role of politics in data science and the need for a justice-oriented approach.	High - Ethical considerations are central to the study, critically examining the ethical implications of apolitical stances in data science and advocating for an ethics of engagement and justice.	High - Clearly presents the argument and framework for a politically engaged data science, supported by extensive references to existing literature and theory.	High - Explicitly discusses the bias inherent in claims of neutrality within data science and argues for the necessity of acknowledging and addressing these biases.	High - Directly addresses the need to enhance ethical awareness and decision-making in data science by proposing a shift towards recognizing and engaging with its inherent political nature, making it highly relevant to the research question.	High - Makes a significant theoretical contribution to the discourse on ethics and politics in data science, advocating for a shift towards a more justice-oriented and politically engaged practice.
14. "Social determinants of health data science and decision-making" - Galea et al., 2020	High - The paper aims to bridge the gap between the understanding of social determinants of health and the burgeoning field of health data science, aligning with the	High - Advocates for a transdisciplinary synthesis of social determinants of health and data science to inform decision-making, appropriate for highlighting ethical	N/A	High - Builds on a comprehensive review of literature and theoretical discussion on social determinants and health data science, ensuring a thorough	High - Engages in a conceptual analysis rather than empirical data analysis, offering a structured discussion on integrating social science into health data science for	High - Ethical considerations are central to the discussion, emphasizing the importance of integrating social determinants of health into data science to enhance ethical decision-making.	High - Clearly presents a call for a transdisciplinary approach to health data science, supported by a solid foundation of literature and conceptual argumentation.	High - Addresses the need to overcome biases and ethical dilemmas in data science by acknowledging and integrating social determinants	High - Directly addresses the challenge of enhancing ethical awareness and decision-making in data science by proposing an integration of social	High - Makes a significant contribution by proposing a framework for enhancing ethical decision-making in health data science through a better understanding and integration of

	exploration of ethical dilemmas in data science.	considerations in data science.		approach to data collection.	ethical decision-making.			into health decision-making processes.	determinants into health data science practices, making it highly relevant to the research question.	social determinants of health.
15. "Ethical challenges in gamified education research and development: An umbrella review and potential directions" - Klock et al., 2023	High - Investigates ethical challenges in gamified educational applications and proposes solutions based on an umbrella review.	High - Conducts an umbrella review to analyze secondary studies for comprehensive insights into ethical challenges in gamified education.	N/A	High - Utilizes secondary studies to gather data on ethical challenges in gamified education.	High - Analyzes data from secondary studies to identify and propose recommendations on ethical challenges.	High - Focuses on ethical challenges such as power dynamics, lack of voluntariness, confidentiality, cognitive manipulation, and social comparison.	High - Clearly presents detailed recommendations for addressing ethical challenges in gamified education.	High - Acknowledges various ethical considerations and potential biases in gamified education.	High - Directly addresses the primary challenges data scientists encounter in ethical dilemmas and enhancement of ethical awareness in gamified education.	High - Provides significant insights and practical recommendations for overcoming ethical challenges in gamified educational research and development.
16. "Rethinking Machine Ethics – Can LLMs Perform Moral Reasoning through the Lens of Moral Theories?" - Zhou et al., 2023	High - The study aims to explore if and how Large Language Models (LLMs) can perform moral reasoning based on established moral theories, directly addressing the computational aspect of navigating ethical dilemmas in AI.	High - Proposes a flexible framework for guiding LLMs in moral reasoning using moral theories from interdisciplinary research, an approach well-suited for exploring ethical decision-making capabilities.	N/A	High - Utilizes existing datasets derived from moral theories and commonsense morality, providing a robust foundation for analyzing LLMs' moral reasoning capabilities.	High - Demonstrates the LLMs' ability to align with various moral theories through detailed experiments, showcasing rigorous data analysis.	High - Central to the study, highlighting the potential of LLMs to contribute to ethical AI development and the importance of grounding AI ethics in moral philosophy.	High - Clearly presents the methodology, experiments, and findings, effectively communicating the potential of LLMs in ethical decision-making.	High - Addresses potential biases in moral judgment systems and the significance of transparent and explainable AI ethics, aligning with the discussion on bias mitigation.	High - Directly addresses the challenges of enhancing ethical awareness and decision-making in data science by proposing an innovative approach to integrating moral theories with AI, making it highly relevant to the research question.	High - Makes a significant contribution to the field of AI ethics by offering a novel method for enhancing the moral reasoning capabilities of LLMs, potentially paving the way for more ethical AI systems.
17. "Philosophy as Integral to a Data Science Ethics Course" - Colando et al., 2023	High - Aims to integrate philosophy into data science ethics education, highlighting the importance of philosophical underpinnings in understanding ethical dilemmas in data science.	High - Utilizes a comprehensive review of data science ethics courses to develop a framework that bridges data science practices with ethical topics from a philosophical perspective.	N/A	High - Collects and analyzes syllabi from multiple data science ethics courses, providing a thorough examination of how ethics is currently taught.	High - The analysis is geared towards identifying common ethical topics and how they align with data science practices, showing a systematic approach.	High - Ethical considerations are the core focus, with a special emphasis on the need for philosophical grounding in ethical education for data scientists.	High - Presents a novel framework for integrating philosophical ethics into data science education, clearly outlining how ethical considerations can be woven throughout the data science lifecycle.	High - Acknowledges the diversity of ethical perspectives and the potential for bias in selecting which philosophical theories to incorporate into data science education.	High - Directly addresses how to enhance ethical awareness and decision-making among data scientists by grounding ethics education in philosophy, making it highly relevant to the research question.	High - Offers a significant contribution to the field of data science education by proposing a method to enhance ethical awareness through philosophical engagement, potentially impacting how ethics is taught to future data scientists.
18. "Responsible Design Patterns for Machine Learning Pipelines" - Harbi et al., 2023	High - The study aims to integrate ethical practices into AI development processes, particularly focusing on machine learning pipelines. It outlines a comprehensive framework incorporating Responsible Design Patterns (RDPs) for ML pipelines to address ethical concerns effectively.	High - The methodology involves a survey of AI ethics and data experts, combined with a comprehensive review of existing literature, which is highly appropriate for gathering insights and validating the proposed RDPs within real-world scenarios.	N/A	High - Utilizes surveys among experts and a thorough review of literature to collect data on ethical considerations in AI, demonstrating a comprehensive approach to understanding current practices and challenges.	High - Conducts a detailed analysis of survey responses and literature to identify key ethical concerns and validate the proposed RDPs, showing a rigorous analytical approach.	High - Ethical considerations are central to this study, aiming to address and mitigate risks associated with AI, such as biases, through the development and implementation of RDPs.	High - The findings, including the proposed framework for RDPs in ML pipelines, are clearly presented, contributing to the discourse on ethical AI development.	High - Directly addresses potential biases in AI development and deployment, offering RDPs as solutions to ensure fairness and ethical integrity.	High - Directly addresses the enhancement of ethical awareness and decision-making in data science by outlining a framework for integrating RDPs into ML pipelines, making it highly relevant to the research question.	High - Offers significant insights into the integration of ethical considerations into AI development processes, contributing to the broader understanding of ethical decision-making in data science.
19. "Data-Driven Game Development: Ethical Considerations"- El-Nasr et al., 2020	High - The paper provides an in-depth analysis of the ethical implications associated with data-driven game development, focusing on player modeling, monetization strategies, and the potential for addiction.	High - Through a thorough review of literature and case studies, the methodology is appropriately tailored to explore the multifaceted ethical issues within the gaming industry.	N/A	High - Draws from a wide range of sources to collate concerns and recommendations regarding the ethical use of data in game development.	High - Offers a critical analysis of how data-driven techniques could potentially lead to unethical outcomes in gaming, such as reinforcing biases or encouraging addictive behaviors.	High - Ethical considerations are the central focus, with the paper advocating for responsible design and transparency in data utilization.	High - The findings are clearly presented, with the paper systematically discussing various ethical concerns and suggesting potential mitigation strategies.	High - Acknowledges the inherent biases in data-driven decision-making and the importance of addressing these to avoid reinforcing negative stereotypes or unfair practices.	High - Directly addresses the core research question by highlighting the ethical challenges data scientists face in the gaming industry and proposing ways to enhance ethical awareness and decision-making.	High - Makes a significant contribution to the discourse on ethics in data science within the gaming industry, providing a comprehensive overview of the issues at hand and suggesting paths forward.
20. "Promoting Ethical Awareness in Communication Analysis: Investigating Potentials and	High - The study aims to address ethical awareness in communication analysis through the lens of visual	High - The methodology, which integrates visual analytics with ethical considerations, is well-suited for	N/A	High - Data collection involves a thorough review of existing technologies and ethical	High - The data analysis, focused on visual analytics and its potential for promoting ethical awareness, is	High - Ethical considerations are central to the study, with a significant focus on addressing and mitigating	High - The findings are clearly presented, with detailed discussions on the role of visual analytics in enhancing ethical	High - The study acknowledges and discusses potential biases and limitations, emphasizing	High - Directly relevant, as it specifically addresses the challenges of navigating ethical	High - The study makes a significant contribution by bridging the gap between visual analytics and

Limits of Visual Analytics for Intelligence Applications" - Fischer et al., 2022	analytics, offering a comprehensive approach to understanding and enhancing ethical decision-making in data science.	exploring the nuances of ethical dilemmas in data science and proposes practical solutions for enhancing ethical awareness.		challenges in communication analysis, ensuring a solid foundation for the study's arguments.	conducted rigorously, contributing valuable insights into the interplay between technology and ethics.	ethical dilemmas encountered by data scientists through visual analytics.	awareness and decision-making in data science.	the importance of ethical reflexivity in the application of visual analytics.	dilemmas in data science and proposes visual analytics as a means to enhance ethical awareness and decision-making capabilities.	ethical considerations in data science, providing a novel perspective on enhancing ethical decision-making.
21. "Mapping for Accessibility: A Case Study of Ethics in Data Science for Social Good" - Tanweer et al., 2017	High - Aims to foreground the ways ethics are implicated in the day-to-day work of data science, focusing on a "data science for social good" (DSSG) project aimed at improving navigation for people with limited mobility. This directly addresses the ethical challenges and dilemmas encountered in data science projects.	High - Uses a case study approach to explore ethical dilemmas arising in a DSSG project, appropriate for deepening understanding of ethical considerations in data science.	N/A	High - Draws from the team's experiences, decisions, and ethical dilemmas encountered throughout the project, providing a rich source of data for analysis.	High - Analyzes how the DSSG team responded to ethical dilemmas and how those responses led to more dilemmas, demonstrating a thorough examination of ethical decision-making in practice.	High - Ethical considerations are at the core of the study, with a focus on the conscientious response to ethical challenges in data science for social good.	High - Clearly presents the case study and the ethical dilemmas encountered, along with the team's responses and the ensuing dilemmas, offering insights into ethical practice in data science.	High - Discusses the potential for data-driven projects to exacerbate disparities, algorithmic accountability, and the challenges of subjective and value-laden interpretations, among others, highlighting the importance of addressing bias and ethical considerations.	High - Directly relevant, as it examines the ethical challenges encountered in a DSSG project and provides lessons for ethical data science practice, addressing how to navigate and enhance ethical awareness in data science.	High - Offers valuable lessons for ethical data science practice that can be applied across DSSG projects, contributing to the broader discussion on enhancing ethical decision-making in data science.
22. "An Ecosystem Approach to Ethical AI and Data Use: Experimental Reflections" Findlay et al., 2020	High - The paper aims to explore the ethical considerations and challenges faced by AI practitioners in their work, emphasizing the importance of incorporating their perspectives into the development of ethical AI practices.	High - The paper employs a qualitative approach, focusing on dialogues and discussions with AI practitioners to elicit their experiences and challenges in dealing with ethical dilemmas, which is appropriate for understanding the nuances of ethical practice in the field.	N/A	High - Data collection is based on facilitated conversations and workshops with AI practitioners, offering deep insights into their ethical considerations and challenges.	High - Analyzes the discussions and feedback from AI practitioners to highlight the gaps between high-level ethical principles and practical, operational challenges faced in the AI development process.	High - Ethical considerations are central to the study, with a focus on understanding how AI practitioners navigate ethical dilemmas and how ethical principles can be more effectively integrated into AI development practices.	High - The findings and discussions on the ethical challenges faced by AI practitioners and the proposed 'shared fairness' methodology are clearly presented, offering valuable insights into the integration of ethical practices in AI development.	High - The paper acknowledges the potential biases and power dynamics within organizations that may affect the implementation of ethical practices and aims to address these through its proposed methodology.	High - Directly addresses the enhancement of ethical awareness and decision-making in data science by exploring the perspectives of AI practitioners and proposing a methodology for integrating ethical considerations into their work.	High - Offers significant contributions by highlighting the importance of including AI practitioners in the ethical AI discourse and proposing a methodology to bridge the gap between ethical principles and practical application in AI development.
23. "Biases in Data Science Lifecycle" - Ho et al., 2020	High - Aims to provide a practical guideline to data scientists for identifying and mitigating biases across different stages of the data science lifecycle, aligning directly with the exploration of ethical dilemmas in data science.	High - Conducts a comprehensive review of literature on sources of biases and maps them to different stages of the data science lifecycle, making the methodology highly suitable for its objectives.	N/A	High - Employs a thorough literature review process to collect data on biases, ensuring a comprehensive understanding of the ethical challenges in data science.	High - Analyzes biases within the data science lifecycle thoroughly, offering insights into how these biases can affect the data science process.	High - Ethical considerations are at the forefront of the study, aiming to increase awareness among data scientists about biases and their implications.	High - Clearly presents the types of biases that can occur at each stage of the data science lifecycle, supported by examples and best practices for mitigation.	High - Acknowledges the wide range of biases that can influence data science projects, emphasizing the importance of ethical considerations.	High - Directly tackles the enhancement of ethical awareness and decision-making among data scientists by identifying and suggesting mitigations for biases, making it highly relevant to the research question.	High - Offers significant contributions by systematically identifying biases in the data science lifecycle and proposing guidelines for their mitigation, thus addressing ethical dilemmas and enhancing ethical decision-making in data science.
24. "Ethically Aligned Design: An empirical evaluation of the RESOLVEDD-strategy in Software and Systems development context" - Vakkuri et al., 2019	High - The study aims to empirically evaluate the RESOLVEDD strategy for ethically aligned design in the context of software and systems development, directly addressing the integration of ethical considerations into practice.	High - Employs a multiple case study approach to test the RESOLVEDD strategy in student projects, making it appropriate for assessing its practical application and effectiveness.	N/A	High - Data collection involves analyzing the application of the RESOLVEDD strategy across five student projects, providing insights into its practical use and impact.	High - Analyzes the effects of implementing an ethical tool on ethical considerations and decision-making in the design process, showing a rigorous approach to evaluating ethical tools in practice.	High - Ethical considerations are central to the study, focusing on the practical application of ethical tools to enhance ethical alignment in design processes.	High - The findings regarding the impact of the RESOLVEDD strategy on ethical considerations and design decisions are clearly presented, offering valuable insights into its effectiveness.	Medium - Discusses the potential impact of introducing an ethical tool on developers' considerations but could explore broader biases in ethical tool adoption and its perceived value.	High - Directly relevant, as it investigates the effectiveness of an ethical tool (RESOLVEDD strategy) in enhancing ethical awareness and decision-making among developers, aligning closely with the research question.	High - Provides important empirical evidence on the use of the RESOLVEDD strategy in software and systems development, contributing to the understanding of how to better integrate ethical considerations into the development process.
25. "Investigating Responsible AI for Scientific Research: An Empirical Study" -Muneera Bano et al., 2023	High: Clearly defined objectives to assess awareness and preparedness regarding the ethical risks in AI design and development.	High: Mixed-method research approach using a survey and interviews is suitable for exploring the current state of ethical AI practices.	High: Selection of a diverse range of participants from different roles within AI projects, ensuring a comprehensive view.	High: Data collection through surveys and interviews was systematically executed and relevant to the research questions.	High: Thorough analysis, including frequency analysis for closed questions and thematic analysis for open-ended responses.	High: Emphasized throughout the study, with a focus on responsible AI as the main subject of the research.	High: Findings are presented clearly, demonstrating gaps in ethical AI practices and highlighting areas for improvement.	Moderate: The study acknowledges potential biases in AI development but could elaborate more on the biases within the research process itself.	High: Directly addresses the review question by exploring challenges and suggesting enhancements in ethical awareness and decision-making in AI.	High: Provides valuable insights into responsible AI practices and offers a foundation for improving ethical AI in scientific research.
26. "A toolkit of dilemmas: Beyond debiasing and	High: Objectives to explore dilemmas in responsible	High: The paper employs a theoretical framework	N/A	N/A	N/A	High: Ethical considerations are the core subject of the	High: The presentation of the tripartite decision-making toolkit	High: The paper critically discusses biases in the	High: Directly addresses the review question by examining	High: Provides an original contribution to the discourse on

fairness formulas for responsible AI/ML" - Domínguez et al., 2023	AI/ML are clearly presented and argued for.	drawn from critical data studies, which is appropriate given its conceptual focus.				paper, with a critical approach to existing methods in responsible AI.	informed by dilemmas is clear and structured.	development and deployment of AI/ML systems and the importance of addressing them.	dilemmas faced by AI/ML practitioners in responsible innovation.	ethical AI by proposing a decision-making toolkit informed by specific dilemmas, challenging the existing narratives in fair AI literature.
27. "TAPS Responsibility Matrix: A tool for responsible data science by design" - Urovi et al., 2023	High: Clearly articulated goal to create a framework (TAPS-RM) that delineates the responsibilities across different scopes in data science projects.	High: Development of the TAPS-RM is well-reasoned and tested against existing ethical frameworks (FAIR, FACT, Datasheets for Datasets).	N/A	N/A	High: Thorough comparative analysis between TAPS-RM and other frameworks like FAIR, FACT, and Datasheets for Datasets, identifying coverage and gaps.	High: Central to the development of TAPS-RM, focusing on integrating ethical considerations into data science projects by design.	High: Findings are clearly presented with logical mapping of TAPS-RM against existing frameworks to demonstrate its comprehensiveness.	Moderate: While the paper discusses addressing bias within data science, it could explore potential biases within its own methodology further.	High: Directly addresses the review question by providing a tool (TAPS-RM) to navigate ethical dilemmas and enhance ethical decision-making.	High: Contributes a novel, structured matrix (TAPS-RM) that has the potential to significantly improve the integration of responsibility in data science projects.
28. "Beyond case studies: Teaching data science critique and ethics through sociotechnical surveillance studies" Rabb et al., 2022	High: The paper clearly articulates its objective to critique the current approach to teaching ethics in data science by emphasizing the need for incorporating sociotechnical surveillance studies.	High: The method of integrating critical data studies and surveillance theory into data science pedagogy is highly suitable for addressing the identified gap in ethics education.	N/A	N/A	High: Reflections and projects from the students were used to assess the effectiveness of the educational approach, demonstrating an appropriate method of analysis for the paper's goals.	High: Ethics is the core subject of the paper, and the study thoroughly integrates ethical considerations into its analysis and recommendations for data science education.	High: Findings are presented through the lens of student feedback and project outcomes, providing evidence of the course's impact on students' ability to critique and understand the ethical dimensions of data science.	Moderate: The paper discusses the need to overcome biases in traditional data science ethics education but does not extensively detail potential biases in the educational approach itself.	High: Directly relevant, as it proposes a new approach to data science education that could enhance ethical awareness and decision-making capabilities.	High: Offers a significant pedagogical contribution to the field of data science ethics education, aiming to prepare students to tackle ethical dilemmas with a more nuanced and critical perspective.
29. " Ethics of Open Data" - Locke et al., 2022	High: The chapter has a clear aim to explore ethical challenges and practical dilemmas related to open data in scholarly communications.	High: Theoretical exploration using a literature review and case studies is suitable for the study's objectives, providing a comprehensive look at ethical frameworks and their application in real-world scenarios.	N/A	N/A	High: Analysis is conducted through the examination of various ethical theories and real-world case studies, which is an appropriate approach for the objectives stated.	High: Ethical considerations are the chapter's central theme, thoroughly addressed throughout the document.	High: The findings and discussions are presented systematically, tying back to the ethical theories discussed earlier in the chapter.	High: The chapter acknowledges the complexity of ethical decision-making and discusses how biases can affect data openness and usage.	High: Directly addresses challenges related to ethical dilemmas in data science, offering insights into enhancing ethical awareness and decision-making capabilities.	High: The chapter contributes a significant discussion to the discourse on open data ethics, providing valuable insights and frameworks that can guide ethical decision-making in scholarly communications.

Table 2 - QUALITY ASSESSMENT TABLE

4. RESULTS AND DISCUSSION

This chapter presents a detailed analysis of the findings from both the systematic literature review and the Nominal Group Technique (NGT) session. The results are organized thematically, providing a critical comparison of the studies and highlighting the interactions between key themes. Visual aids in the form of conceptual diagrams are included to illustrate the relationships among the themes. The broader implications of these findings for policymakers and data scientists are also discussed.

4.1. THEMATIC CATEGORIZATION AND ANALYSIS

The studies reviewed were categorized into five primary themes:

- **Ethical Frameworks and Education in Data Science**
- **AI and Ethical Decision-Making**
- **Ethics in Big Data and Analytics**
- **Ethics in the Application Domain**
- **Methodological Innovations in Ethical AI**

4.1.1. ETHICAL FRAMEWORKS AND EDUCATION IN DATA SCIENCE

Overview and Critical Comparison:

This theme emphasizes the integration of ethics into data science education and the development of ethical guidelines. Studies such as (Egger et al., 2022) and (Baumer et al., 2022) advocate for embedding ethics within the data science curriculum, arguing that ethical considerations should be foundational rather than supplementary. (Colando & Hardin, 2023) highlight the importance of incorporating philosophical perspectives to enrich ethical understanding.

While there is a consensus on the importance of ethical education, the methodologies proposed vary. Some studies promote practical, case-based learning (Baumer et al., 2022), whereas others emphasize theoretical frameworks (Colando & Hardin, 2023). This divergence indicates a gap in determining the most effective educational strategies.

Interaction with Other Themes:

- **Methodological Innovations:** The TAPS Responsibility Matrix (Urovi et al., 2023) and the toolkit of dilemmas (Domínguez Hernández & Galanos, 2022) provide practical tools that can be integrated into educational programs.
- **AI and Ethical Decision-Making:** Educating data scientists on AI's role in ethical decision-making (Noothigattu et al., 2018) enhances their ability to develop ethically aligned AI systems.

Implications:

For policymakers, the findings suggest a need to standardize ethical education in data science programs, potentially mandating the inclusion of ethics courses in accreditation criteria. For data scientists, continuous professional development in ethics becomes essential to stay abreast of emerging challenges.

4.1.2. AI AND ETHICAL DECISION-MAKING

Overview and Critical Comparison:

This theme explores how AI can be utilized for ethical decision-making. (Noothigattu et al., 2018) propose a voting-based system for ethical decisions, while (Rodgers et al., 2023) discuss AI algorithms in HR management. (Zhou et al., 2023) critically assess whether large language models can perform moral reasoning.

A key debate centers on AI's capacity to genuinely embody ethical principles. While AI can process vast amounts of data to inform decisions, its lack of consciousness raises questions about its ability to navigate complex moral landscapes without human oversight (Nassar & Kamal, 2021)

Interaction with Other Themes:

- **Ethical Frameworks:** Incorporating ethical guidelines into AI development ensures that AI systems align with human values.
- **Methodological Innovations:** Responsible design patterns (Harbi et al., 2023) can be applied to AI systems to enhance ethical decision-making capabilities.

Implications:

For policymakers, regulating AI's role in ethical decision-making is crucial to prevent misuse. For data scientists, there is a responsibility to ensure AI systems are transparent and include mechanisms for human oversight.

4.1.3. ETHICS IN BIG DATA AND ANALYTICS

Overview and Critical Comparison:

This theme addresses ethical concerns in managing big data, focusing on privacy, security, and stakeholder roles. (Sarker, 2021) and (Nair, 2020) highlight the challenges of ensuring data privacy amid large-scale data collection. (Ho & Beyan, 2020) discuss biases throughout the data science lifecycle.

Despite recognizing the importance of ethical data management, there is inconsistency in applying ethical guidelines across sectors. This inconsistency leads to varying data protection standards and potential ethical lapses.

Interaction with Other Themes:

- **Ethics in Application Domains:** Ethical considerations in big data directly impact application areas like healthcare and communication analysis.
- **Methodological Innovations:** Algorithmic auditing practices (Fischer et al., 2022) can be used to detect biases in big data analytics.

Implications:

For policymakers, establishing universal data protection regulations can mitigate ethical inconsistencies. Data scientists must prioritize data anonymization and consent to protect user privacy.

4.1.4. ETHICS IN THE APPLICATION DOMAIN

Overview and Critical Comparison:

This theme examines the application of ethical considerations in specific domains. (Lysaght et al., 2019) focus on healthcare, emphasizing the need for domain-specific ethical frameworks. (El-Nasr & Kleinman, 2020) discuss ethical considerations in game development.

Creating universal ethical frameworks that are flexible enough to adapt to various domains remains a challenge. There's a tension between the need for domain-specific guidelines and the desire for overarching ethical principles.

Interaction with Other Themes:

- **Ethical Frameworks:** Domain-specific applications highlight the necessity for adaptable ethical frameworks.
- **AI and Ethical Decision-Making:** The use of AI in sensitive domains like healthcare intensifies the need for ethical decision-making protocols.

Implications:

For policymakers, there's a need to develop sector-specific regulations that address unique ethical challenges. Data scientists must engage with domain experts to ensure ethical compliance in specialized fields.

4.1.5. METHODOLOGICAL INNOVATIONS IN ETHICAL AI

Overview and Critical Comparison:

This theme explores new methodologies for integrating ethics into AI development. (Harbi et al., 2023) introduce responsible design patterns, while (Vakkuri et al., 2019) evaluate the RESOLVEDD strategy. A gap exists between theoretical methodologies and their practical implementation. While innovative methods are proposed, their adoption in real-world settings is limited due to complexities and resource constraints.

Interaction with Other Themes:

- **Ethical Frameworks and Education:** Educational initiatives can promote the adoption of new methodologies.
- **Ethics in Big Data and Analytics:** Methodologies that address biases can improve ethical practices in big data analytics.

Implications:

For **policymakers**, supporting research and development in ethical methodologies can bridge the gap between theory and practice. **Data scientists** should adopt these methodologies to enhance the ethical integrity of AI systems.

4.2. INTERACTIONS BETWEEN THEMES

The themes are interconnected, creating a multifaceted ethical landscape in data science. Figure 2 illustrates the relationships among the key themes.

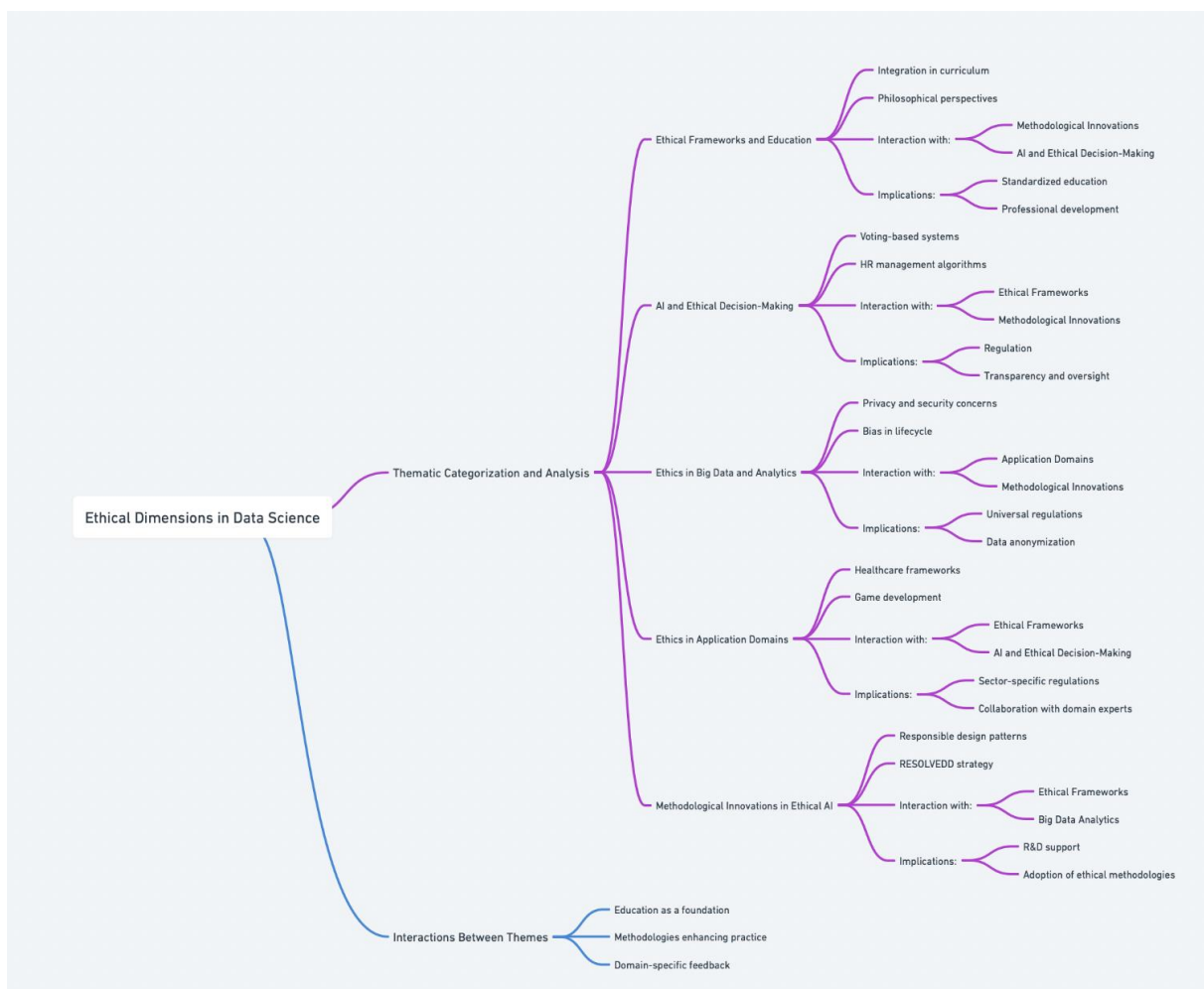


Figure 2 - Ethical Dimensions in Data Science Mind Map

Key Interactions:

- **Education as a Foundation:** Ethical education underpins the development of ethical frameworks and methodologies, influencing practices in AI decision-making and big data analytics.
- **Methodologies Enhance Practice:** Innovations in ethical AI methodologies provide tools that can be applied across domains, reinforcing ethical standards in practical applications.
- **Domain-Specific Feedback:** Insights from application domains inform the development of more robust and adaptable ethical frameworks and methodologies.

4.3. BROADER IMPLICATIONS

For Policymakers:

- **Standardization of Ethical Guidelines:** There's a need for standardized ethical guidelines that are adaptable to various domains and technologies.
- **Regulation of AI Ethics:** Policymakers must address the ethical implications of AI decision-making, ensuring transparency and accountability.
- **Support for Ethical Education:** Investment in educational initiatives can produce a workforce capable of navigating complex ethical challenges.

For Data Scientists:

- **Adoption of Ethical Frameworks:** Data scientists should integrate ethical frameworks and methodologies into their workflows.
- **Continuous Ethical Training:** Ongoing education is essential to keep pace with emerging ethical challenges and technological advancements.
- **Interdisciplinary Collaboration:** Working with experts from ethics, law, and domain-specific fields can enhance ethical decision-making.

4.4. LIMITATIONS AND FUTURE RESEARCH

While the study provides a comprehensive analysis, certain limitations exist:

- **Lack of Empirical Validation:** The proposed frameworks and methodologies require empirical testing in real-world scenarios.
- **Rapid Technological Evolution:** Emerging technologies like generative AI present new ethical challenges not fully addressed in current literature.

Future Research Directions:

- **Empirical Studies:** Conducting case studies to test the effectiveness of ethical frameworks in practice.
- **Emerging Technologies:** Exploring the ethical implications of new technologies and updating frameworks accordingly.

- **Global Perspectives:** Incorporating diverse cultural and ethical perspectives to develop universally applicable ethical guidelines.

4.5. CONCLUSION

The ethical challenges in data science are complex and multifaceted, requiring a holistic approach that combines education, practical methodologies, and policy interventions. By critically analyzing the literature and synthesizing key themes, this study highlights the necessity for collaborative efforts among policymakers, educators, and practitioners to foster an ethical data science ecosystem.

5. CONCLUSIONS AND FUTURE RESEARCH

5.1. CONCLUSION

This research underscores the critical importance of embedding ethical considerations into data science practices. By addressing key themes such as data privacy, accountability, transparency, and bias, the study provides actionable insights for practitioners, educators, and policymakers. Through a combination of Nominal Group Technique (NGT) discussions and a scoping literature review, this work not only identifies significant challenges but also offers a structured roadmap for addressing these issues effectively.

Key Contributions:

Framework for Ethical Data Practices:

A core outcome of this research is the development of a comprehensive checklist to guide ethical practices in data science. This checklist categorizes critical areas for attention:

1. **Data Privacy and Protection:** Emphasizing informed consent, anonymizing sensitive data, and adhering to privacy laws as fundamental principles of ethical data science.
2. **Ethical Responsibility and Training:** Highlighting the need for continuous education and real-world training to foster a culture of responsibility among data scientists.
3. **Accountability and Compliance:** Introducing roles such as a "Data Ethnician" to oversee compliance with ethical guidelines and ensure transparent decision-making.
4. **Trustworthiness and Transparency:** Addressing the need for explainable models and fostering public trust through open communication and fair practices.
5. **Bias and Fairness:** Mitigating biases through auditing, interdisciplinary collaboration, and fairness metrics to ensure equitable outcomes.
6. **Business and Use-Case Dilemmas:** Navigating conflicts between business objectives and ethical principles while assessing long-term societal impacts.

Innovative Educational Approaches:

The study highlights the importance of integrating ethics into data science curricula. By focusing on practical training modules—such as bias detection, privacy-preserving techniques, and ethical decision-making—educational institutions can prepare future data scientists for real-world challenges.

Practical Tools and Guidelines:

The research offers actionable solutions for implementing the checklist categories in

professional contexts, providing a roadmap for organizations to adopt ethical data practices that align with societal values.

Interdisciplinary Collaboration:

Recognizing that ethical challenges require diverse perspectives, the findings emphasize collaboration among data scientists, ethicists, legal experts, and policymakers to create well-rounded solutions.

Significance for the Field:

- For **education**, the study offers a clear framework for embedding ethical training into data science curricula, emphasizing real-world applicability.
- For **policy and governance**, it outlines actionable steps to standardize ethical practices across industries.
- For **practitioners**, the findings deliver practical tools and guidelines to navigate ethical dilemmas in diverse contexts.

While the research significantly advances the understanding of ethical challenges in data science, it also highlights the persistent gap between theoretical ideals and practical implementation. Closing this gap requires continuous adaptation to evolving societal and technological landscapes.

5.2. LIMITATIONS AND CHALLENGES

This study acknowledges several limitations that contextualize its findings and provide direction for future exploration:

1. Participant Selection Bias:

- While the participant pool was diverse in expertise, it primarily reflected perspectives from specific academic and professional backgrounds. This limits the generalizability of findings across different cultural, regulatory, and industrial contexts.
- Future research should include a broader range of participants from underrepresented regions and industries to capture more inclusive perspectives.

2. Contextual Variability:

- Ethical norms and regulatory frameworks differ widely across regions. For example, while GDPR informs privacy practices in Europe, less regulated environments face unique challenges.
- Comparative studies exploring these regional differences can identify universal principles and localized solutions.

3. Scalability and Long-Term Impacts:

- The sustainability of solutions, such as bias mitigation strategies and privacy-preserving techniques, remains unexplored. Longitudinal studies are necessary to assess their long-term effectiveness.

4. Challenges in Measuring Ethics:

- Concepts like fairness, accountability, and transparency are inherently complex and difficult to measure. Developing multidimensional assessment tools is critical to advancing the field.

5. Integration of Qualitative and Quantitative Approaches:

- Bridging the divide between the qualitative aspects of ethics and the quantitative focus of data science requires innovative frameworks and methodologies.

5.3. RECOMMENDATIONS FOR FUTURE RESEARCH

To build on these findings and address the limitations, future research should prioritize the following:

1. Refinement and Implementation of the Checklist:

- Develop detailed guidelines for each category in the checklist, ensuring they are applicable across various data science domains.
- Test the checklist in pilot programs within professional and educational settings, gathering feedback to refine its utility.

2. Domain-Specific Applications:

- Tailor ethical frameworks to address domain-specific challenges, such as healthcare privacy, algorithmic fairness in recruitment, or transparency in financial models.

3. Innovate Educational Strategies:

- Expand ethics education with interactive modules, real-world case studies, and interdisciplinary approaches that integrate technical skills with ethical reasoning.
- Measure the effectiveness of these programs in preparing students to navigate ethical dilemmas.

4. Longitudinal Studies on Ethical Practices:

- Investigate how privacy measures, accountability structures, and bias mitigation strategies influence long-term societal trust and professional outcomes.

5. Enhance Interdisciplinary Collaboration:

- Foster partnerships among technical experts, ethicists, sociologists, and legal professionals to address complex ethical dilemmas from multiple perspectives.

6. Address Emerging Technologies:

- Explore the ethical implications of new technologies, such as generative AI, predictive analytics, and autonomous systems, ensuring frameworks evolve to meet these challenges.

7. Promote User Awareness and Transparency:

- Educate users and stakeholders about data practices, their rights, and the ethical implications of data use.
- Build trust through transparent communication and explainable models.

8. Strengthen Accountability Measures:

- Implement systems to assign clear accountability for ethical decisions, such as appointing data ethics officers or “Data Ethnicians.”
- Regularly audit data practices to ensure compliance with ethical and legal standards.

9. Encourage Continuous Feedback:

- Establish mechanisms for monitoring and refining ethical practices based on stakeholder feedback.
- Update guidelines to reflect emerging challenges and technological advancements.

5.3.1. INCORPORATING THE CHECKLIST INTO BROADER APPLICATIONS

The **Data Privacy and Protection** category emphasizes safeguarding user data while ensuring compliance with privacy laws. Similarly, **Bias and Fairness** focus on eliminating systemic biases in algorithms to ensure equitable outcomes for all stakeholders.

The **Ethical Responsibility and Training** category highlights the importance of education in fostering a culture of responsibility, while **Trustworthiness and Transparency** aim to build public trust through explainable and transparent data practices.

The **Accountability and Compliance** component ensures that clear roles and responsibilities are established for ethical oversight, and **Business and Use-Case Dilemmas** focus on aligning business objectives with ethical principles for long-term societal benefits.

By embedding this checklist into curricula, organizational policies, and professional practices, the data science community can move toward a more ethical, inclusive, and human-centered discipline.

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APPENDIX A



This is to certify that

Project No.: **DDMKT2024-11-267143**

Project Title: **Empowering Ethical Insights among Data Scientists**

Principal Researcher: **Mariana Costa**

according to the regulations of the Ethics Committee of NOVA IMS and MagIC Research Center this project was considered to meet the requirements of the NOVA IMS Internal Review Board, being considered **APPROVED** on 11/26/2024.

It is the Principal Researcher's responsibility to ensure that all researchers and stakeholders associated with this project are aware of the conditions of approval and which documents have been approved.

The Principal Researcher is required to notify the Ethics Committee, via amendment or progress report, of

- Any significant change to the project and the reason for that change;
- Any unforeseen events or unexpected developments that merit notification;
- The inability of the Principal Researcher to continue in that role or any other change in research personnel involved in the project.

Lisbon, 11/26/2024

NOVA IMS Ethics Committee
ethicscommittee@novaims.unl.pt

APPENDIX B

Nominal Group Technique Guide

Objective: To identify and prioritize the primary ethical challenges that data scientists face and brainstorm methods to enhance their ethical awareness and decision-making capabilities.

Question: "What are the primary challenges data scientists encounter in navigating ethical dilemmas, and how can we effectively enhance their ethical awareness and decision-making capabilities?"

Duration: 1 hour

1. Agenda:
2. Introduction (5 minutes)
3. Silent Generation of Ideas (10 minutes)
4. Round-Robin Sharing (15 minutes)
5. Discussion and Clarification (15 minutes)
6. Voting and Ranking (10 minutes)
7. Conclusion and Next Steps (5 minutes)

1. Introduction (5 minutes)

- **Time:** 0:00 - 0:05
- **Script:**

"Good afternoon, everyone. Thank you all for taking the time to participate in this Nominal Group Technique session. The purpose of this session is to identify and prioritize the primary ethical challenges that data scientists face, and to brainstorm methods to enhance their ethical awareness and decision-making capabilities. The question we will be answering today is: "What are the primary challenges data scientists encounter in navigating ethical dilemmas, and how can we effectively enhance their ethical awareness and decision-making capabilities?"

Our discussion today will be added to the findings from a systematic literature review that I conducted. We will follow a structured process to ensure that everyone has an opportunity to contribute their ideas and insights.

We will start with a silent generation of ideas, followed by a round-robin sharing session where each of you will present your ideas. After that, we will have a group discussion to clarify and elaborate on these ideas. Finally, we will vote on the most important challenges and solutions. Are there any questions before we begin?

Some Key Findings from the Systematic Literature Review (SLR)

Major Ethical Challenges:

Bias in Algorithms:

- **Issue:** Algorithms can perpetuate and even amplify biases present in the data they are trained on. This can lead to unfair and discriminatory outcomes.
- **Examples:** Several studies highlighted instances where biased algorithms negatively impacted decisions in areas like hiring, loan approvals, and law enforcement.
- **References:** "A review on ethical concerns in big data management" by Nair (2020) discusses the implications of bias and the importance of fairness in data processing.

Privacy Concerns:

- **Issue:** The use of big data often involves handling sensitive personal information, raising significant privacy concerns.
- **Examples:** Data breaches and unauthorized use of personal data have led to public distrust and ethical dilemmas.
- **References:** "AI-assisted decision-making in healthcare: the application of an ethics framework for big data in health and research" by Lysaght et al. (2019) examines the ethical landscape of privacy in healthcare data.

Data Management Issues:

- **Issue:** Proper data management is crucial for maintaining data integrity and ensuring ethical use.
- **Examples:** Ethical concerns arise from data collection methods, data storage practices, and data sharing policies.
- **References:** "Data science and ethical issues: between knowledge gain and ethical responsibility" by Egger, Neuburger, and Mattuzzi (2022) emphasizes the need for ethical data practices throughout the data lifecycle.

Transparency and Accountability:

- **Issue:** Lack of transparency in how data is collected, processed, and used can lead to mistrust and ethical issues.
- **Examples:** Ethical challenges in AI systems often stem from opaque algorithms that stakeholders do not understand or cannot scrutinize.
- **References:** "Ethical dilemmas in AI-powered decision-making: a deep dive into big data-driven ethical considerations" by Nassar and Kamal (2021) discusses the importance of transparency and accountability in AI ethics.

Methods to Enhance Ethical Awareness and Decision-Making:

Educational Programs and Training:

- **Approach:** Integrating ethics into data science curricula and ongoing professional training.
- **Examples:** Courses that combine technical training with ethical discussions, case studies, and practical applications.
- **References:** "Integrating data science ethics into an undergraduate major: A case study" by Baumer, Garcia, and Kim (2022) demonstrates how ethics education can be embedded in data science programs.

Ethical Frameworks and Guidelines:

- **Approach:** Developing and adhering to ethical guidelines and frameworks to guide decision-making processes.
- **Examples:** Implementing frameworks that ensure ethical considerations are part of every stage of data handling and analysis.
- **References:** "A voting-based system for ethical decision making" by Noothigattu et al. (2018) proposes a system to aggregate societal preferences for ethical decision-making.

Gamification:

- **Approach:** Using gamification techniques to make learning about ethics more engaging and interactive.
- **Examples:** Games and simulations that present ethical dilemmas and encourage players to think critically about their decisions.
- **References:** Various papers in the review mention gamification as an innovative method to enhance ethical awareness and engagement.

Interdisciplinary Collaboration:

- **Approach:** Encouraging collaboration between data scientists and experts in ethics, law, and social sciences.
- **Examples:** Forming interdisciplinary teams to address ethical issues from multiple perspectives.
- **References:** "Data science as political action: Grounding data science in a politics of justice" by Green (2021) argues for an interdisciplinary approach to integrating ethics into data science.

Practical Tools and Methods:

- **Approach:** Developing practical tools and methodologies that can be easily integrated into everyday data science practices.
- **Examples:** Tools for bias detection, privacy protection, and transparent reporting.

- **References:** "TAPS Responsibility Matrix: A tool for responsible data science by design" by Urovi et al. (2023) introduces a comprehensive framework to address ethical considerations in data science projects.

2. Silent Generation of Ideas (10 minutes)

- **Time:** 0:05 - 0:15
- **Script:**

"We will now spend the next 10 minutes generating ideas silently. Please take this time to write down your thoughts on the primary ethical challenges that data scientists face, and any methods you think could enhance their ethical awareness and decision-making capabilities. There are no right or wrong answers, so please feel free to write down anything that comes to mind.

We will share these ideas with the group afterward. Your time starts now."

3. Round-Robin Sharing (18 minutes)

- **Time:** 0:15 - 0:30
- **Script:**

"Thank you for taking the time to generate your ideas. We will now go around the room and share one idea at a time in a round-robin format. Please share just one idea each time it's your turn. We will continue until all ideas have been shared. I will write them down so that everyone can see them.

Let's begin with [Participant 1]." - 3min each

[Proceed to each participant in turn.]

4. Discussion and Clarification (15 minutes)

- **Time:** 0:30 - 0:45
- **Script:**

"Now that we have all the ideas listed, let's take some time to discuss and clarify them. If you have any questions or need further explanation about any of the ideas, this is the time to ask. Please feel free to elaborate on your own ideas or ask others to provide more details about theirs."

5. Voting and Ranking (10 minutes)

- **Time:** 0:45 - 0:55
- **Script:**

"We will now vote on the ideas to determine which ones are the most important. Please rank the ideas based on their importance and feasibility and send me a private message on the zoom chat. Please take a few minutes to review the ideas and rank them accordingly.

Once you have completed your voting sheet, please hand it back to me."

6. Conclusion and Next Steps (5 minutes)

- **Time:** 0:55 - 1:00
- **Script:**

"Thank you for your thoughtful contributions and participation. Based on your votes, the top-priority ethical challenges and solutions have been identified. These will form the basis of the next steps in our project.

I will compile the results and share a summary with you all. If there are any further comments or questions, please feel free to share them now.
Once again, thank you for your time and valuable insights. Your participation is crucial to the success of this research."

