



A Comparative Evaluation of Ethical Considerations in Data Mining Across Healthcare, Education, and Government Sectors: Promoting Responsible and Equitable Practices

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Abstract

In many industries, data mining is used to glean insights from big datasets. Due to the nature of the data, the stakeholders, the societal effects, and ethical challenges differ. Despite the wealth of literature on data mining ethics in government, healthcare, and education, comparing data in these sectors is scarce. This study fills this vacuum by investigating ethical standards in these industries and providing strategies for ensuring responsible, ethical practices. Of the 60 papers gathered from sources like ScienceDirect, Google Scholar, Springer Link, and Web of Science, which survived the inclusion and exclusion selection criteria, 30 were chosen purposefully. The study adopted a systematic literature review approach and found that ethical concepts were endorsed across these sectors but presented differently. This study necessitates thorough norms and laws considering industry-specific requirements to promote ethical data mining methods.

Keywords: Data mining; Ethical considerations; Healthcare sector; Education sector; Government sector

Introduction

The importance of customer behaviour data is increasing as digital technologies in the retail sector develop. The ability to conclude consumer data can assist various businesses in making key decisions and upholding profitable business operations. The data mining process aims to identify patterns in the data that can be utilised. In this case, one step in the data mining process, pattern mining technologies are employed (Fournier-Viger, Wensheng, Youxi, Mourad, Wei, Tin & Hai, 2022). In recent years, various sectors have used data mining extensively, which involves sifting through large databases for insightful patterns and insights for better decision-making processes and outcomes. However, given the increasing reliance on data mining techniques, significant ethical considerations must be addressed to ensure moral and just practices. Ethics involve standards of conduct that define right from wrong (Velasquez, Thomas-Shanks, & Meyer, 2010). Computer and data usage ethics is a dynamic and difficult topic comprising reality, ideas, guidelines, and values relevant to constantly evolving computer technology (Masum, 2019). One must first recognise that innovation is not value-free but rather loaded with values to properly apply this idea to technology (Kraemer, Van-Overveld & Peterson, 2019). To understand the value-laden nature of technology, one must recognise the necessity of including an explicit ethical evaluation technique in every technology decision-making process (Bistline, Budolfson &

Francis, 2021). Inaccurate information utilised in ways that violate privacy and real property has led to moral difficulties with data and technology use (Friedman & Hendry, 2019).

Additionally, vast amounts of medical data are analysed using data mining techniques in the healthcare sector to improve public health efforts, treatment protocols, and diagnosis. Despite the enormous potential of these advancements, there are moral concerns about privacy, informed consent, and potential biases. The most crucial ethical considerations are protecting patient privacy and ensuring that data collection and analysis are done with informed consent (Chiruvella & Guddati, 2021; Al Tajir, 2018). Like other industries, data mining in education has grown in popularity to improve educational opportunities, customise instruction, and spot students in danger. According to Liñán and Pérez (2015), to avoid statements that could result in discriminatory treatment when working with gender, social status, race, home country, religious beliefs, ideology, or disability, ethics must be taken into account at all stages, from data collection to the interpretation of results and decision making. Now that ethics is taught in elementary schools; computer ethics is no longer just for those who want to work in computer design or programming sectors but in all fields of life (Taherdoost, Namayandeh & Jalaliyoon, 2020). Government decision-making, resource distribution, and law enforcement all benefit

from data mining; however, monitoring, data storage, and potential personal data exploitation raise ethical concerns. Unauthorised access to systems and data is increasing daily in the government sector, performed through numerous creative methods. The biggest threat to IT principles is hackers, who routinely transgress them by attempting to compromise people's personal information and damage their business and financial accounts (Forester & Morrison, 2019). This study aims to compare the ethical standards obtainable in data mining processes across the healthcare, education, and government sectors and to provide strategies for ensuring responsible ethical practices. Two research questions were asked to achieve the aim of the study.

RQ1: What are the comparative ethical standards in the health, education, and government sector?

RQ2: What strategies are needed for ensuring responsible and fair practices in various sectors?

Review of Related Literature

Various relevant literature was examined to comprehend the data mining ethics involved in these three sectors. The ethical considerations of the sectors discussed in this part are listed below.

Ethical Challenges in Data Mining

Healthcare Sector: In health-related big data, the public must be reassured that security measures are mandated and enforced. Policies can and should address adopting appropriate technologies, evaluating and monitoring security systems, and accountability and transparency mechanisms (Vayena, Dzenowagis, Brownstein & Sheikh (2018). According to them, some ethical challenges of data mining in the healthcare sector include, among others, intruding into patient privacy and confidentiality, unformed consent, unfairness to children, pregnant women, and the elderly, biases in data quality and reliability, biases and discrimination against patients, and unethical use of research findings of patient's data. Comparing all these unethical practices in the healthcare sectors, one will say there is little or no value for ethics in healthcare.

Education Sector: According to Kingston, 2020, to change the current social order, citizens and civil society must alter how they use computers and data, follow business ethics, give up individualism and inertia, and get involved in public and democratic issues. He identified a few ethical issues that the educational sector faces. They include inadequate protection of student data from unauthorised access or

misuse is one of them. Others include improper handling of student privacy and data security, improper handling of students' records and databases, unformed consent and data ownership of students, educational inequity and accessibility, and improper handling of student records and databases. Again, all these are some unethical concerns obtainable in the educational sector. This misconduct is making some standards of education go down the drain.

Government Sector: Open data access, particularly in the government, should have the capacity to change how governments, citizens, and the business sector interact, as claimed by Magalhaes & Roseira (2020). According to them, some of the difficulties in this field include improper treatment of citizen data privacy and security, permeability to data access, problems with transparency and accountability in data handling, problems with citizen confidence and involvement, and unfair resource distribution. Moreso, aligning these misconducts to what is presently happening in the government sector, one will say that ethical standards are not valued.

Ethical Considerations in Data Mining

Healthcare Sector: Howe Lii and Elenberg, 2020 opined that the key ethical concerns raised by Big Data research include respecting patient's autonomy via the provision of adequate consent, ensuring equity, and respecting participants' privacy. Supporting this claim, Shirazi, Baziyad, and Karimi (2020) emphasised the need for stakeholders to remain current with the most recent applications and approaches in this field in their review of data mining in healthcare. They mention that a work that examines applications and data mining in healthcare may provide useful details for future research. Moreso, Maikel, Leonardo, Michele, Bruna, Pedro, Nicholas, and Leonel (2021) emphasised the value of moral behaviour in evaluating the ethical concerns raised by data mining in the medical industry. In their opinion, the authors talk about how data mining ethics could advance medical knowledge and aid in diagnoses in the healthcare sector.

Education Sector: Ifenthaler and Yau (2019) looked at student privacy and security, data ownership, and permission as they relate to the ethical aspects of educational data mining. To promote ethical and responsible practices in educational data mining, it emphasises the significance of safeguarding student privacy, outlining clear ownership criteria for academic data, and gaining informed consent. It guarantees openness and responsibility in educational data mining,

minimising biases and treating students fairly. They explored surveillance, privacy, and openness issues in their investigation of the ethics of data mining in the public sector. They believe paying more attention to ethics when handling students' data should be paramount.

Government Sector: Samoilenko, Parycek, and Glassey (2020) studied the ethical problems with data mining in government decision-making processes by looking at some topics. The authors discuss the justice, accountability, and transparency of government data mining methods. They emphasise the value of ethical norms, responsible data use, and stakeholder involvement to encourage honest and fair data mining approaches in the public sector. In accord, Bielikova, Ceché, and Hanusoya, 2019 discuss the ethical implications of government data mining in their study and offer recommendations for balancing the need for national security with people's right to privacy, fostering openness, and guarding against potential power abuses.

Research Methodology

The selection of publications has been executed in two phases. First, the keywords used to search the papers were determined. After detailed consideration, the keywords selected were data mining, ethical considerations, healthcare, education, and government sectors. A combination of these keywords was applied in the search using Boolean operators AND and OR to get the best results. The following search string queries were used to obtain papers from various databases: Data Mining AND Ethical considerations, Education sector AND Ethical considerations, Healthcare sector AND Ethical considerations, Government sector AND Ethics, Data Mining AND Healthcare sector AND Education AND Government AND (Ethical considerations OR Practice), Data Mining AND Healthcare sector AND Education AND Government AND (Ethical considerations OR Standards), and Data

Mining AND Healthcare sector AND Education AND Government AND (Ethical considerations OR Concerns).

A systematic literature review was adopted for this study to select a reasonable number of papers on the internet related to data mining ethics in healthcare, education, and government sectors, and four different databases were used for the search process. The following databases were searched using the defined search string queries: Google Scholar, Springer Link, Science Direct, and Web of Science. After an initial search, a total of 450 papers were found.

The second phase included filtering insufficient and irrelevant papers. After the removal of duplicate papers, 200 papers remained. Afterwards, the following inclusion criteria have been defined: ScienceDirect, Google Scholar, Springer Link, Presentation of ethical standards applied in data mining, Specific use of ethical standards in data mining, Overview of sectors that implement ethical standards in data mining, Inclusion of specific roles of data mining ethics in healthcare, educational and government sectors, Articles that had full text, and Article available in English.

All the papers were filtered by screening the titles, abstracts, and keywords. The papers that met the inclusion criteria were then selected, and 147 were taken. The exclusion criteria to determine which papers would enter the final selection are Publications not applicable to this research, Publications not related to the research questions, and Multiple publications covering the same topic. After excluding some papers with the above exclusion criteria and rechecking the inclusion criteria, 60 papers entered the final selection. These 60 papers were separated into healthcare, education, and government sectors. A total of 30 papers (13, 12, and 5 taken from health, education, and government sectors, respectively) were purposefully selected for full analysis, classification, and category. This study used a statistical method that was both descriptive and inferential.

Results/Discussion

Table 1: Summary of Ethical Frameworks in Data Mining of the three sectors

S/N	Sector	Number of Articles Studied	Titles of Selected Articles Studied	Author(s)/Year	Summarised Ethical Focus of Articles
1	Healthcare	13	<ul style="list-style-type: none"> Ethical Challenges of Big Data in Healthcare: A Systematic Review Ethical Considerations in Data Mining for Healthcare Data Mining in Healthcare: Examples, Techniques and Benefits An Application-Based Review of Recent Advances of Data Mining in Healthcare Diagnosis of neuropathies in diabetic patients by applying machine learning. 	<p>Howe Lii, & Elenberg (2020)</p> <p>Grando & Cecatti (2019)</p> <p>Slava (2023)</p> <p>Shirazi, Baziyad & Karimi (2020)</p> <p>Vallegas & Aqueveque (2021)</p>	<ul style="list-style-type: none"> Respecting patient privacy and confidentiality Informed Consent Fairness to the children, pregnant women, and elderly Data quality and reliability. Equal treatment of patients Ethical use of research findings
2	Education	12	<ul style="list-style-type: none"> Ethical Considerations in Educational Data Mining: Privacy, Data Ownership, and Consent Data Privacy, Ethics and Protection: Guidance Note on Big Data for Achievement of the 2030 Agenda Comparison of learning analytics and educational data mining: A topic modelling approach Are Ethics Training Programs Improving? A Meta-Analytic Review of Past and Present Ethics Instruction in the Sciences. Educational Data Mining and Learning Analytics: differences, similarities, and time evolution 	<p>Ifenthaler & Yau (2019)</p> <p>United Nations Development Group (2017)</p> <p>Lemay, Clare & Tenzin (2021)</p> <p>Watts, Medeiros, Mulhearn, Steele, Connelly & Mumford (2017).</p> <p>Liñán, & Pérez (2015)</p>	<ul style="list-style-type: none"> Proper handling of student privacy and data security Adequate handling of students' records and database Informed consent and data ownership of student data Educational equity and accessibility Safeguarding student data from unauthorised access or misuse
3	Government	5	<ul style="list-style-type: none"> Ethical Considerations in Data Mining for Government Decision-Making Ethics of Data Mining in the Government Sector 	<p>Samoilenko, Parycek & Glassey (2020)</p> <p>Bielikova, Cech & Hanusova (2019)</p>	<ul style="list-style-type: none"> Proper handling of citizen data privacy and security Proper data access and consent Good transparency and accountability in data handling

			<ul style="list-style-type: none"> Value-sensitive design: shaping technology with moral imagination A primer for understanding and applying data mining Pattern mining: current challenges and opportunities 	<p>Friedman, & Hendry (2019)</p> <p>Thauraisinggham (2000)</p> <p>Fournier-Viger, Wensheng, Youxi, Mourad, Wei, Tin, & Hai (2022)</p>	<ul style="list-style-type: none"> Citizen's trust and participation Fair allocation of resources
	Total	30			

Below are the similarities and differences from the evaluation and analysis of Table 1 above

Similarities:

After considering the summary of the ethical considerations of each sector, the following are drawn as the similarities they share:

- 1. Protection of privacy:** Data mining involves accessing and analysing private information, such as medical, academic, or governmental records. The security and privacy of this data are frequently a concern, affecting the three sectors. Chiruvella and; Guddati, 2021; Forester & Morrison, 2019; Liñán and Pérez, 2015 support this claim. They all agreed that the privacy of personal information should be paramount when dealing with people's data; therefore, strictly protecting privacy should be a key norm in any sector.
- 2. Obtaining informed consent:** Informed consent is a moral precept all these industries share. Gaining permission from people is essential to respecting their autonomy and ensuring openness because data mining frequently necessitates accessing and using personal data. The primary ethical issues raised by Big Data research, according to Howe Lii & Elenberg, 2020 and Samoilenko, Parycek, & Glassey, 2020, are honouring patients' autonomy through the giving of proper consent. According to them, every organisation must respect the privacy of its customers; hence, using their data only with their permission is strongly advised.
- 3. Data Quality and Bias:** These industries worry about data quality and possible biases. It is critical to recognise and address data biases like gender or racial prejudices to avoid biased results. The three sectors address this ethic. In their review of data mining, Shirazi, Baziyad, and Karimi (2020)

emphasised the need for stakeholders to stay current with the most recent applications and methodologies in their various domains to receive quality information supporting this assertion.

- 4. Equal and fair treatment:** The three sectors were very concerned about the requirement for equal and fair treatment when performing their jobs. Children, the elderly, physically disabled, pregnant mothers, and others should be treated fairly in every industry. Bielikova, Ceche, and Hanusoya, 2019) examined surveillance and transparency issues on the ethics of data mining in the public sector. Samoilenko, Parycek, and Glassey, 2020 also highlight the importance of ethical standards, responsible data use, and stakeholder involvement to support honest and impartial data mining techniques. Both works agree to the ethics of rendering fair and equal treatment during the discharge of duties.
- 5. Ethical application of research findings:** The three sectors concurred that utilising client research data ethically is important. No patient, student, or citizen should have their data exploited without the owner's permission. Ifenthaler and Yau (2019) highlight that to promote ethical and responsible practices in educational data mining, the significance of safeguarding student privacy, outlining clear ownership criteria for academic data, and gaining informed consent should be considered as a priority.

Differences:

Apart from the similarities, ethical differences are shared among these sectors, which are unique to each industry.

1. **Usage of data:** According to Nda, Tasmin, and Aziati (2020), big data in higher education institutions is meant to improve the creation of innovative teaching-learning orientation for the performance of educational institutions as a wise contribution to making curriculum design for teachers and students in particular and sustained competitive advantage of the education sector as a whole. Magalhaes and Roseira, 2020, who argued in favour of data usage, said that how open government data is used to generate profit depends on the operations of each organisation. As a result of this claim, in conjunction with the findings of this study, we will say that each industry's use of data is uniquely significant to each organisation.
 2. **Stakeholder involvement:** Data mining may engage a variety of stakeholders. Pharmaceutical companies, researchers, healthcare workers, patients, and other parties might all be interested in the healthcare sector. Education stakeholders might include teachers, parents, professors, researchers, and educational institutions. Government stakeholders may include citizens, decision-makers, administrative agencies, and advocacy groups. Every industry must take into account the objectives and viewpoints of essential stakeholders. A more thorough and goal-oriented formulation of ethics would stimulate public participation during the formulation and implementation phases while involving all required stakeholders to a greater extent (Wilker, Rusche & Ryma-Fitschen, 2019). As a result, each organisation's various stakeholders should manage data appropriately per the organisation's policy.
 3. **Ethical Concerns:** While privacy and consent are universal, each industry has specific ethical concerns. For instance, it is crucial in the healthcare sector to safeguard patient autonomy, confidentiality, and damage minimisation. Protecting minors' rights, eradicating educational inequities, and maintaining stakeholder confidence are important ethical considerations in education. In making ethical decisions in the public sector, transparency, fairness, and the public interest frequently play a significant role. In support of this, Vayena, Dzenowagis, Brownstein, and Sheikh (2018) assert that policies can and should address implementing suitable technology, assessing and monitoring security systems, and implementing accountability and transparency methods, as used in many organisations. Therefore, each organisation has a unique ethical concern that they need to adhere to.
- These similarities and differences draw attention to the demand for sector-specific ethical norms and practices that address the particular challenges and goals of data mining in healthcare, education, and government. Hence, societal norms, statutory changes, and ethical frameworks must be regularly assessed and modified to respond to evolving technology

Table 2: Comparing Ethical Policy by Sectors

Sectors	Summarised Ethical Policy of 10 Articles						
	Privacy Protection	Informed Consent	Data Quality	Equal and Fair Treatment	Citizen Trust	Fair Allocation of Resource	Transparency in Data Usage
Healthcare	3	1	2	2	1	1	0
Education	2	2	2	1	2	1	0
Government	2	1	1	1	3	0	2
Total	7	4	5	4	6	2	2
% Total	70%	40%	50%	40%	60%	20%	20%

As shown in Table 2's statistical analysis above, the total percentage of the ethical policies for the three sectors are analysed as follows: privacy protection ethics has the highest percentage (70%) compared to other ethical policies. Followed by citizen trust (60%) and data quality (50%). Other ethical policies analysed have percentages that are less than 50%. From what we

have seen so far, we can say that for the three sectors, privacy protection is paramount, followed by citizen trust and data quality in most organisations. This finding agrees with the claim of Chiruvella and Guddati, 2021 and AI Tajir, 2018, which state that the most crucial ethical considerations are protecting patient privacy and ensuring that data collection and

analysis are done with informed consent. In conclusion, we can state that all three sectors support ethical

policies but at different levels, which is consistent with the study's goal.

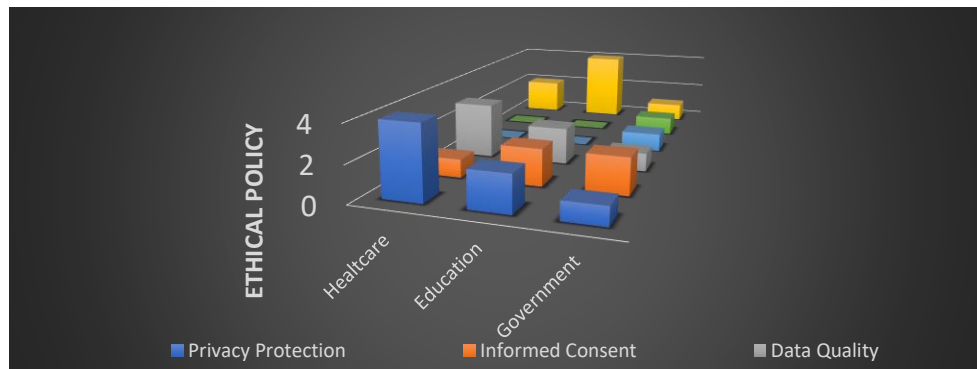


Figure 1: Comparing Ethical Policy by Sectors

Table 2's statistical analysis is displayed above in Figure 1. On a scale of 1 to 4, the chart allows us to compare the ethical policy ratings for each industry. The healthcare sector receives the highest ranking of 4 for 'privacy protection' and the lowest scale of 0 for 'fair allocation of resources' and 'citizen trust'. The education sector receives the highest ranking of 4 for 'equal and fair treatment' and 0 for the lowest for 'fair allocation of resources' and 'citizen trust'. The government sector receives the highest ranking of 2 for 'informed consent' and the lowest ranking of 1 for other ethical policies. Maikel, Leonardo, Michele, Bruna, Pedro, Nicholas, and Leonel, 2021 make the case that concerns with privacy, informed permission, and the handling of sensitive information are crucial to balance data mining's potential advantages and ethical issues, to safeguard people's rights and interests. Again, we can say that all three sectors support all ethical guidelines to a varying degree consistent with the study's goal.

Strategies for Ensuring Responsible and Fair Practices

By implementing best practices and suggestions, organisations can encourage ethical data mining techniques, prioritising privacy protection, ethical considerations, and beneficial societal effects. Responsible data mining entails abiding by moral standards, protecting personal information, and fostering accountability and openness. Here are some suggested strategies for implementing ethical standards in data mining:

1. **Development and enforcement of rules and regulations:** Samoilenko, Parycek, and Glassey, 2020 emphasise the value of ethical norms, responsible data use, and stakeholder involvement to promote ethical and fair data mining approaches in

the public sector. Grando & Cecatti's 2019 argument is that strong data protection rules, procedures for informed consent, and ways to decrease biases are required to ensure acceptable and ethical data mining practices in sectors align with this. Policymakers are responsible for creating and enforcing the rules and regulations that govern data mining practices. They can develop legislative policies and administrative procedures that support data mining's commitment to responsibility, openness, and informed consent.

2. **Constant update on ethical standards:** Researchers are essential in examining ethical issues, creating approaches, and expanding our understanding of ethical data mining. They can look at the ethical implications of data mining, such as algorithmic bias, privacy issues, and fairness worries. Shirazi, Baziyad, and Karimi, 2020 all emphasised how important it is for stakeholders to be updated with the most recent developments and strategies in their respective fields. This discovery is crucial for updating stakeholders on current developments involving ethical norms in their industries.
3. **Robust data protection mechanism:** Personal data should be de-identified, where appropriate, using techniques like aggregation, pseudonymisation, or masking, for example, to minimise any potential risks to privacy and take into account the likelihood of any potential harms associated with data use and non-use, according to the UNDG's (2017) of 2030 agenda for big data. Encrypt sensitive and confidential data must be encrypted before transferring it to or after receiving it from any network-connected server. Unless there is a valid, legal, and fair basis, no de-identified data should be intentionally or knowingly re-identified.

4. **Transparency and explainability:** Transparency can be fostered by providing clear and accessible information about data mining practices, including data sources, algorithms, and methods. To preserve public confidence and protect democratic ideals, it is also crucial to ensure transparency in government data mining activities, accountability in decision-making processes, and prevention of data exploitation (Forester & Morrison, 2019).
 5. **Constant training and retraining on data ethics:** Participation in workshops, conferences, and seminars on data ethics, responsible data mining, and related topics is important. This statement is corroborated by Watts, Medeiros, Mulhearn, Steele, Connelly, and Mumford's (2017) study, which highlights the importance of regularly carrying out thorough, systematic evaluation efforts to track the evolution of ethics education program outcomes.
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Conclusion

According to this study, many sectors follow ethical standards when it comes to data mining, but a comparison of the similarities and differences between the health, education, and government sectors reveals that moral principles, such as upholding individuals' rights to privacy and autonomy, promoting transparency in the processes used to collect and analyse data, and many others, have emerged. This research also highlights strategies for ensuring responsible and fair practices in various sectors, such as developing and enforcing rules and regulations, constant updates on ethical standards, robust data protection mechanisms, fostering transparency and explainability, and constant training and retraining on data ethics. The subject of further study should understand the unique ethical ramifications of data mining on vulnerable populations, such as patients with delicate medical problems, students from disadvantaged homes, and people under government monitoring. Investigating how data mining techniques may disproportionately affect these people can aid in identifying and resolving any potential injustices.

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