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Ethical Framework for Health Data Privacy Protection in Smart Elderly Care: A Grounded Theory Approach

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Abstract: As the trend of population aging is accelerating, health data privacy protection in smart elderly care has gained more significance to resolve ethical issues and contribute to the sustainable development of digital elderly care. This paper will review the literature, policies, regulations and technical standards and use grounded theory using open, axial and selective coding to determine major ethical aspects and develop a theoretical framework. The results indicate that the framework can be divided into four dimensions: compliance governance and risk control, individual rights and dignity protection, structural fairness and procedural justice, and collaborative governance with trusted innovation. The institutional base is compliance governance, the fundamental value is rights protection, balanced governance is facilitated by structural fairness, and continuous improvement is facilitated by collaborative innovation. Combined, these dimensions constitute an ethical system of governance that incorporates institutional regulation, rights protection, equitable governance, and technological innovation. This paper offers a theoretical approach to privacy protection of health data in smart elderly care. Nevertheless, additional empirical studies should be conducted to evaluate the applicability of the framework in various practical contexts.

Keywords: Smart Elderly Care; Data Governance; Privacy Protection; Ethical Framework; Grounded Theory.

1. Introduction

With population aging becoming increasingly pronounced, smart elderly care has emerged as an effective means of addressing the diverse needs of older adults. In China, the Data Security Law and the Personal Information Protection Law have established the basic legal framework for personal data processing. Past research has examined the concept of smart elderly care in various aspects, such as conceptual development, technological implementation, and service innovation [1,2]. Ethical and privacy issues, especially the lack of digital literacy and cognitive capacities among older adults have also received increased attention [3], along with health data collection, informed consent, privacy violations, and algorithm bias [46]. In reaction to this, researchers have suggested solutions like institutional governance, privacy preserving technologies, and user-centered data governance to strike a better balance between data utilization and protection of privacy [7-10].

Nevertheless, the majority of current studies focus on general governance strategies or technical solutions, whereas an overall ethical framework that is specifically tailored to smart elderly care is yet to be developed [11-12].The nature of smart elderly care exposes the aged to unique privacy risks. The complexity of governance is heightened by sensitive health information, the participation of various stakeholders, and the popularity of intelligent technologies. Lack of digital literacy can decrease the capacity of individuals to give informed consent or control their own data, and ongoing monitoring of health and tracking of behavior, although enhancing the delivery of services, can increase the anxiety about privacy and personal dignity. It is on this backdrop that this research uses grounded theory to examine pertinent literature, policy reports and technical standards with the help of NVivo-assisted coding to come up with an ethical framework of protecting health data privacy in smart elderly care. The framework aims at offering a theoretical foundation and practical recommendations on ethical data governance in this area.

2. Research Design

2.1. Research Method

Grounded Theory is a qualitative approach that was developed by Glaser and Strauss, which develops theoretical explanations based on empirical data in a systematic coding process. It fits well in analyzing the intricate interrelationship between technology, institutional arrangements, and ethical issues.

The protection of data privacy in smart elderly care involves matters concerning the rights of the aged, data security and ethical governance. Although there is an increasing body of research on this topic, there is still a lack of an integrated theoretical framework that would relate technological practice to ethics. In this regard, the paper uses Grounded Theory to review both domestic and international literature on smart elderly care, data governance, and privacy protection. An ethical system of protecting health data privacy in smart elderly care is created through open, axial, and selective coding.

2.2. Sample Selection and Data Collection

The sources of information used in this study were scholarly articles, legal and policy documents, and technical standards obtained between January and March 2025.

The China National Knowledge Infrastructure (CNKI) and the Web of Science (WoS) Core Collection were primarily used to source academic literature. The search was done using a combination of keywords such as smart elderly care, data privacy, data ethics, elderly information protection, and health data. Following a preliminary search, the titles, abstracts, and full texts were examined to find studies that were directly related to protecting data privacy in smart elderly care.

Meanwhile, this study also looked some more using official websites and other sources, like the Chinese Government site,

the National Standards system, EUR-Lex, APEC, and NIST, to add to the policy, rule, and tech standard stuff this study had. This study gathered up all the relevant laws, rules, policy papers, and tech specs.

Table 1. Classification of Research Materials

Category	Number of Documents
Domestic research literature	48
International research literature	42
Domestic legal provisions/institutional documents	9
International legal provisions/institutional documents	9

3. Category Extraction and Model Construction

This study follows the procedural Grounded Theory approach proposed by Strauss and Corbin. The collected textual materials were analyzed through open coding, axial coding, and selective coding. During the coding process, particular attention was paid to contents related to "older adults," "older users," "smart elderly care," and their application scenarios, in order to extract the core categories of data privacy protection in smart elderly care and construct an ethical framework for data privacy protection oriented toward older populations. The coding process was conducted with the assistance of NVivo software.

3.1. Open Coding

Open coding is the fundamental stage of Grounded Theory analysis. It involves sentence-by-sentence analysis, conceptualization, and categorization of original materials to identify initial concepts and categories.

3.1.1. Data Import and Sentence-by-Sentence Coding

A total of 108 documents were imported into NVivo software. The texts were carefully reviewed and coded sentence by sentence, and statements with theoretical significance were extracted and conceptualized. At this stage, 322 initial concepts were generated. Examples of open coding are presented in Table 2.

Table 2. Examples of Open Coding

Original Data Excerpts	Initial Concepts
Secondary use of data requires re-obtaining consent or ethical justification if impractical.	Ethical review of secondary data use
Data Tractability: Backward-to-Root Reference, Backward Reference, Forward References	Data traceability
Information accountability means the use of information should be transparent.	Transparency and accountability of information use
Establish and improve data security management regulations and refine data classification standards.	Data classification and hierarchical management
Data subjects should have the right to request deletion of personal data.	Protection of data deletion rights
Personal data use should comply with legal requirements and obtain authorization.	Lawful and authorized data use
The data collected should be visible and verifiable by the older adult.	Data visualization for older users
Older users should control what data are collected and shared.	User autonomous control
Explicit authorization must be obtained before collecting biometric information of older adults.	Explicit authorization for biometric information
Encourage older adults and their families to participate in supervision.	Participation of older adults and families in supervision
Emphasize ethical norms in data use to obtain and maintain trust among older users.	Ethical compliance and trust building

3.1.2. Concept Comparison and Category Refinement

Table 3. Examples of Initial Concepts and Initial Categories

Initial Concept Coding	Initial Category
Purpose specification, data minimization, lawful processing basis	Compliance
Legitimacy of data collection, lawful data processing	Legality
Secondary data use review, industry privacy standards	Regulatory compliance
Social responsibility, consistency of rights and responsibilities, security responsibility system	Responsibility
Privacy responsibility definition, clarification of responsible entities	Accountability
Data security obligations, information disclosure obligations	Obligation fulfillment
Identity security, data sovereignty, secure sharing	Security
Risk assessment, privacy threat identification	Early warning
Emergency response mechanisms, security protection measures	Risk mitigation
Balance between data utilization and privacy protection	Balance
Explicit authorization, consent management, anonymous options	Authorization
Right to know, informational self-determination, user understanding	Awareness
Autonomous decision-making, data control capability	Autonomy
Access rights, deletion rights, correction rights	Freedom
Data ownership, infringement remedy channels	Respect
Sensitive information protection, personality protection	Dignity
Personalized protection, user-friendly design	Inclusiveness
Algorithm bias prevention, equal access to services	Equality
Bystander privacy, interest coordination mechanisms	Fairness
Public participation, complaint protection	Equal rights
Algorithmic fairness, avoidance of data bias	Justice
Social participation, family supervision	Democracy
Transparent processing, public verifiability	Transparency
Readable privacy policies, information disclosure	Explicitness
Data lifecycle tracking, security auditing	Traceability
Ethical compliance, user trust	Trust
Business ethics, integrity, de-identification	Commitment
Multi-stakeholder participation, demand response	Collaboration
Public feedback, privacy education	Mutual assistance
Joint supervision, cross-sector governance	Joint prevention
Institutional innovation, ethical guidance for technological development	Innovation

Based on the similarities, associations, and logical relationships among concepts, the initial concepts were continuously compared, merged, and classified to form higher-level categories. For example, concepts such as "data compliance review" and "national information security compliance management" were integrated into the category of "compliance," while concepts such as "clear legal basis" and "lawful data processing" were classified into the category of "legality."

After multiple rounds of comparative analysis, 322 initial concepts were ultimately refined into 32 initial categories. Examples of the category formation process are shown in Table 3.

3.2. Axial Coding

Axial coding aims to reveal the intrinsic relationships among categories generated through open coding. Through clustering analysis of the 32 initial categories, eight subcategories and four main categories were further identified. Their logical relationships were then integrated and analyzed. The results of axial coding are presented in Table 4.

Table 4. Results of Axial Coding

Main Categories	Subcategories	Initial Categories	Interpretation
Compliance governance and risk controllability	Compliance construction and responsibility clarification	Compliance, Legality, Regulatory compliance, Responsibility, Accountability, Obligation fulfillment	Considering the limited digital capabilities of older adults, smart elderly care should shift from formal compliance toward substantive governance featuring clear responsibilities and age-friendly protection.
	Data security and risk balance	Security, Risk mitigation, Early warning, Balance	While ensuring health security and maximizing data utilization value, risk warning mechanisms and privacy protection technologies are adopted to balance safety monitoring and privacy protection.
Protection of subject rights and dignity	Autonomous decision-making and data sovereignty	Autonomy, Authorization, Awareness, Freedom	Age-friendly informed consent and authorization mechanisms are established to protect older adults' rights to know, control, and independently decide on personal data.
	Human dignity and differentiated equality	Respect, Dignity, Inclusiveness, Equality	Inclusive design prevents older adults from becoming passive data subjects and safeguards their dignity and privacy autonomy.
Structural fairness and procedural justice	Fair distribution and algorithmic justice	Fairness, Equal rights, Impartiality, Justice	Resource allocation optimization and algorithm auditing reduce inequities caused by the digital divide and algorithmic bias.
	Procedural justice and democratic participation	Justice, Democracy	Channels for older adults to participate in technology design and rule-making are established to achieve fairness in governance processes.
Collaborative governance and trusted innovation	Transparency and trust building	Transparency, Explicitness, Traceability, Trust	Data transparency, explainability, and traceability mechanisms enhance older users' trust in smart elderly care systems.
	Collaborative governance and sustainable innovation	Collaboration, Joint prevention, Mutual assistance, Innovation	A multi-stakeholder collaborative network involving governments, enterprises, communities, and families promotes coordinated development between privacy protection and technological innovation.

3.3. Picking Out the Most Important Parts and Building the Model

Picking out the most important parts is about finding the main idea and seeing how everything else fits with it. Looking closer at the four main areas, we found the main idea is the "Ethical Framework for Data Privacy Protection in Smart Elderly Care."

This framework is built based on what older adults are like physically, think-wise, and socially. It keeps data safe by making sure rules are followed and controlling risks, protects their independence and dignity by focusing on their individual rights, deals with problems like the digital divide and not enough say in how things are run by being fair to everyone and making sure the process is fair, and helps build trust and improve technology through working together.

These four areas don't just work alone; they support each other. Following the rules provides the foundation, protecting individual rights shows what the framework is really about, fairness and fairness in the process keep things balanced, and working together encourages constant improvement. Put together, they make an ethical framework centered around older adults for data privacy in smart elderly care, shifting from just preventing problems to focusing on the right values. The framework we made is shown in Figure 1.

3.4. Assessment of Theoretical Saturation

To verify whether the proposed framework had reached theoretical saturation, six reserved documents were coded as an additional validation sample. The analysis produced no new concepts, categories, or core categories, and the relationships among the existing categories remained stable. These results indicate that the ethical framework for data privacy protection in smart elderly care has achieved an acceptable level of theoretical saturation.

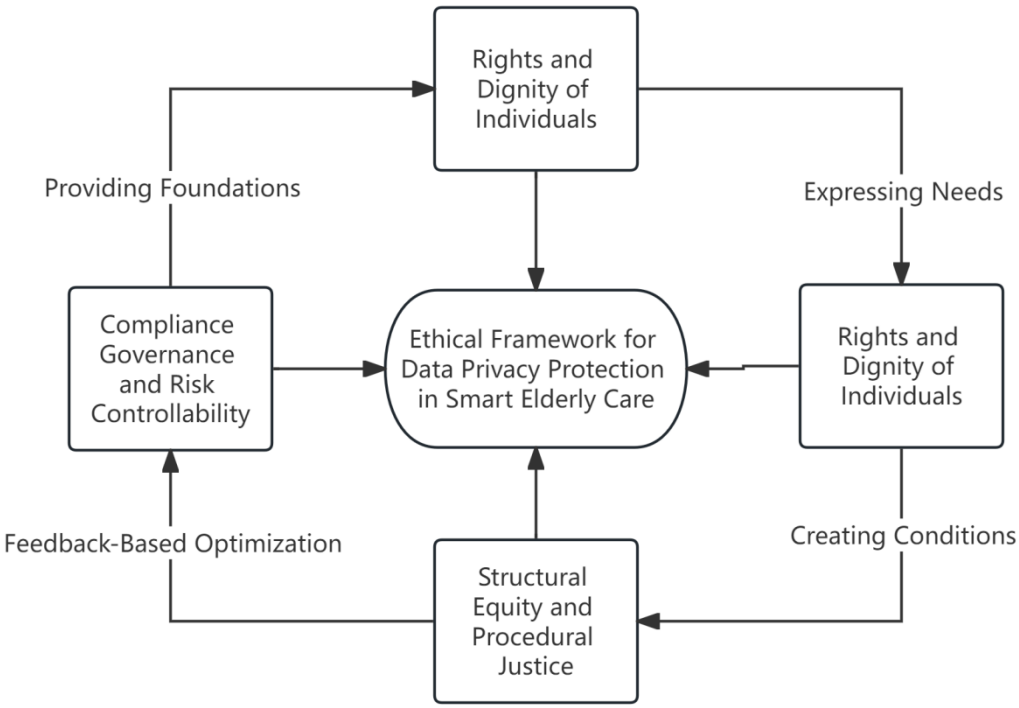

Fig 1. Ethical Framework for Data Privacy Protection in Smart Elderly Care

4. Interpretation of the Ethical Framework

The ethical framework for health data privacy protection in smart elderly care follows an older adult-centered principle and includes four dimensions: compliance governance, protection of subject rights, structural fairness, and collaborative innovation. Compliance governance serves as the institutional basis, protection of subject rights reflects the core ethical value, structural fairness helps balance resource allocation and regulatory differences, and collaborative innovation supports sustainable governance development. These dimensions are interconnected and jointly establish an ethical framework for data privacy protection in smart elderly care.

4.1. Compliance Governance and Risk Controllability

4.1.1. Compliance Construction and Responsibility Clarification

Older people using smart care services often don't know their way around technology very well. This means they might just agree to things without really understanding the privacy rules or what the data will be used for. So, the rules for managing this stuff should be more than just following the letters of the law. They need to actually protect people in ways that make sense for smart elderly care.

According to the laws about protecting personal info and keeping data safe, things like health info, what people do, and data about their private life should be sorted into levels based on how sensitive they are. Then, different rules should apply for how this data is used, stored, and who can see it [13]. Also, everyone involved—like the companies collecting the data, the ones providing the services, and others—should have clear responsibilities from the start until the end It's also really important to check for risks, control who can access the data, and make sure people are accountable for what they do with it [14,15].

A case in Chongqing about fraud with health insurance card activation showed that the checks for verifying who someone is and making sure they're allowed to do things aren't strong enough when getting older people's personal info. This case also shows that having clear rules for who is responsible and being able to track what happens to the data is really important for managing data better in smart elderly care [16].

4.1.2. Balancing Data Security and Utilization

Taking care of seniors with smart tech needs to strike a balance between keeping their privacy safe and using the data effectively. If the rules are too strict, it might stop good new services from being made. But if too much data is shared, it can be a risk to the seniors' rights. So, the rules for managing data should be tweaked based on what the data is like and the risks involved.

Around the world, the APEC Privacy Framework points out that we need to coordinate privacy protection with how information moves around [17], and the NIST Privacy Framework suggests using a risk-based approach to cut down on privacy risks [18]. In real life, tech that helps protect privacy, like making data less personal or anonymous, can make data use safer. For really personal and sensitive info, we need to pay more attention to making sure seniors really understand and agree to how their data is used, check if it's ethical, and check how secure it is [19]. Also, sorting data into categories and figuring out risks can help manage it differently in different situations, which helps find a good balance between protecting privacy and getting value from the data [20,21].

4.2. Protection of Subject Rights and Dignity

4.2.1. Data Autonomy and Empowered Decision-Making

The main problem with keeping older people's data rights safe is that there's a disconnect between giving them tech tools and letting them make real choices for themselves. With smart care for the elderly, the info gap between older folks and digital stuff often makes it hard for them to really understand

what they're agreeing to [22]. Confusing permission steps and how tech uses data might stop older people from fully getting what info is being gathered, how it's used, and who sees it, taking away their say in who has their personal data. A big example in 2023 showed that bad actors used older folks' limited tech knowledge to get personal info by signing up for phones and making online accounts for illegal stuff. This shows how tough it really is to protect older folks' control over their data [23]. So, managing data in smart elderly care should move from just asking for permission to really empowering older people. Permission based on what situation it's used for can help match data collection and use with specific care needs while making it easier to understand using ways that older people will get. Also, using simple visual interfaces for permission, checking who looked at the data, and letting people pull out of things can give older people more control over their data and let them be part of related decisions [25,26]. Plus, tracking data from start to finish should be put in place to watch how it moves and figure out who's responsible when something goes wrong, making data control a real thing that older people understand and can use [27].

4.2.2. Dignity Protection and Inclusive Equality

How smart tech for older people affects their dignity is linked to the possible invasion of their privacy and autonomy from constant data tracking. As their health, what they do, and other personal info is collected over time, older folks might slowly end up as passive bystanders in data processing, making it harder for them to control their daily lives [28]. Also, current privacy protection methods often just focus on formal notices, not caring about differences in how well older people can think or use tech, which makes real informed consent tough to get. Older studies found that many older people don't really read privacy policies when using smart apps, leading to potential privacy problems because they just casually agreed.

So, when it comes to keeping older people's info private in smart care, we really need to focus on respecting their independence and figuring out how different each person is [29]. When it comes to the tech itself, we should only collect the info we really need, cutting out stuff that's not necessary and not watching people too much [30]. On a bigger level, we should come up with ways for others to handle data for folks who aren't as sharp mentally, but we have to make sure that's done the right way and isn't abuse [31]. Also, we need to design tech that's easy for older people to use – simpler controls and information that's easy to understand – so people with different skills can help run things with their data [32]. By combining making the tech work for them with rules to protect them, smart care for the elderly can give good care and also show respect for people.

4.3. Structural Equity and Procedural Fairness

4.3.1. Equitable Access and Algorithmic Accountability

Making sure smart care tech is fair for older folks means they should be able to use digital stuff and that the computer choices are made properly. Things like money, where they live, and how good they are with tech can keep some older people from getting the same benefits as others, making the digital world even more split between people. To fix this, when deciding how to share data, we need to think about different needs and give everyone a chance to join in, plus help out those who need it most.

Meanwhile, the computer stuff used in smart care for older people might give unfair results because the info it learned from isn't perfect or the design isn't right. This could mess up how resources are shared and the choices made. People should be responsible for these computer choices all through the process of getting data, making the models, and using them. We need to check regularly where the data comes from, how the computer stuff works, and what the results are. This helps make things clearer and reduces unfairness. Getting older people, their family caregivers, and experts on ethics involved in how things are run can also help make the computer stuff easier to understand and make sure it's fair.

In addition, data collection in smart elderly care may unintentionally involve information about family members or community residents as bystander data [38]. Therefore, a multi-stakeholder consultation mechanism is necessary to clarify data rights boundaries and balance data utilization with privacy protection.

4.3.2. Participatory Governance and Procedural Legitimacy

Smart elderly care should be fair and the choices made should be legit. But right now, older folks don't get much say in making the rules, checking the services, or protecting their rights. To make things legit, we need clear rules and ways for older adults to actually participate more.

When it comes to data, collecting, processing, and sharing it should be done following set rules so we can track it and know who's responsible. Elderly care places need to deal with personal info following the right rules and making explanations that make sense to older adults, matching how they think. This helps them give informed consent [32].

We can give more people a chance to join in by using both online places to give feedback and getting involved in person through groups and elder care places. This way, older adults who know a lot and a little about computers can share what they need and help make the governance better [33,34]. Also, we need clear oversight, ways to be responsible for mistakes, and easy-to-use ways to protect their rights to make sure we're watching closely and can fix problems within smart elder care systems.

4.4. Collaborative Governance and Trust-Oriented Innovation

4.4.1. Enhancing Transparency and Institutional Trust

Being open and honest is a big deal for getting older people to trust how data is handled in smart care. Because the tech stuff is complicated and companies want to make money, seniors might be worried about how smart services get and use their personal info. So, making it easier to understand, see where the data goes, and let them control it more is really important to help them understand and take part in how things are run.

Smart elderly care places need to clearly explain why they're collecting data, how they'll use it, and who they'll share it with, using words older adults can easily understand. They should also make it easy for seniors to check, fix, delete, or stop sharing their personal info to protect their rights and control their data [35]. At the same time, we need ways for seniors to complain, give feedback, and have things checked to help make sure their rights are really protected.

Being open should also be about everything that happens to the data. We need to look at what privacy risks there might be, check if the computer programs are fair, and keep watching all the time, right from when the system is being made until it's running. Having outside experts check things

and letting the public know can make people trust the system even more [36]. When older adults know how their data is collected, used, and looked after, they'll trust smart care services more.

4.4.2. Multi-Stakeholder Governance and Sustainable Development

Building smart elderly care out in the long run needs everyone working together. If it's just tech companies coming up with ideas, they might not really get what older folks need in daily life. So, seniors, their families, neighbors, nursing homes, tech firms, and the government should all chip in on figuring out needs, designing solutions, and rolling out the services.

We need to work together and stop thinking about just one way to regulate things. Instead, we should use a network approach that has laws, industry rules, and people involved. The law about data security and the one about protecting personal info give us the framework for managing data. But if industry groups, places that care for older adults, and tech companies jump in too, we can make it clearer who's responsible and how to handle risks. This helps stop data from being all over the place and fixes problems in how we manage it [37].

We should also get more people involved and watch what's happening by letting them see reports and letting people who are involved look things over. This way, older adults can help with making decisions. Because taking care of older people using smart tech involves many different fields, it's important for healthcare people, those who provide care, and IT experts to work together. They need to do this to make sure everyone follows the same rules, share information, and watch things together. This helps make sure we protect people's privacy while also using new technology in a good way [38].

5. Conclusion

Developing an ethical framework for health data privacy protection in smart elderly care is not only a response to the ethical challenges brought by population aging and technological advancement but also an important step toward sustainable development of smart elderly care.

Using a method called Grounded Theory, this study suggests a four-part plan. It includes making sure you follow the rules and controlling risks, protecting people's rights and dignity, making sure things are fair and the steps are right, and working together to trust new ideas. All these parts together give a way of governing that links managing risks with giving people more power and value.

The plan makes it clear what's right and wrong when handling data for elderly care with smart tech. It gives a reason (the theory) for making policies and improving how places work. It also encourages older people to change from just receiving data to being active participants in how data is managed.

This study also has its downsides. Since the framework was mostly put together by looking at articles and doing theoretical stuff, we need more real-world studies to see if it actually works in different situations with smart elderly care. Future studies could look into the ethics stuff related to new tech, like AI that can make stuff up, and make the data handling systems even better to get a good mix between new technology and caring for people.

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