

RESEARCH ARTICLE

Research on the Application of Blockchain-Based Time Banking System in Intelligent Elderly Care Services

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Abstract: With the aging trend of the global population, smart pension has become a new way to solve the pension problem. As an innovative mutual assistance pension model, time banking promotes community mutual assistance by recording and exchanging service time. However, the traditional time bankings face the problems of lack of trust and low transparency. Blockchain technology, with its decentralized, immutable nature, provides new possibilities to solve these problems. This study introduces the concept of time banking and wisdom endowment and its importance, and then review the existing about time banking, wisdom endowment and block chain technology research, elaborated the detail how block chain technology is applied to time banking and wisdom pension services, including its possible advantages (such as security, traceability, etc.) and challenges (such as technical complexity, policies and regulations, etc.). This paper puts forward views and suggestions on the application of blockchain technology in time banking and smart elderly care services, including policy formulation, technology development, business model and other aspects, which also provides a new perspective and practical guidance for the development of time banking and smart elderly care services.

Keywords: Time Banking; Smart Pension; Blockchain Technology

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1 Overview of time banking and blockchain technology

1.1 Time banking

Time banking is a non-profit social mutual assistance system designed to encourage people to accumulate time points by volunteering, which can subsequently be used in exchange for services provided by others. This model originated in the United States, was founded by Dr. Edgar

Kahn in 1980, and was gradually popularized worldwide.

Time banking operates on a voluntary basis, and participants are usually community members who provide services according to their abilities and interests, such as accompanying the elderly, child care, housekeeping services, etc. For each service completed, volunteers receive time points that can be exchanged for the services they need in the future. For example, a person who helps a neighbor fix

his bicycle today and gets a two-hour time point. In the future, he may need someone else to help take care of the child, so he can use the two-hour time point in exchange for the corresponding service.

The core value of the time banking is to promote mutual assistance and cooperation within the community, strengthen the neighborhood relations, and also provide access to services for those people with limited resources. In addition, the time banking also advocates equality and respect. Everyone, regardless of age, gender, occupation, or social status, can participate in it and help others with their time and skills.

Despite the positive social benefits of time banking, its implementation also faces some challenges, such as ensuring the quality of service, managing the complexity of time accounts, and expanding participation. To overcome these challenges, some places are trying to integrate modern information technology, especially blockchain technology, into the time banking system to improve efficiency, transparency and trust.

1.2 Blockchain technology

Blockchain technology is a distributed database technology that allows multiple participants to share and store data without a central control point. The technology, originally designed for Bitcoin — as a digital currency, has now expanded into a number of areas beyond finance, including supply chain management, health care, the Internet of things and public services.

Blockchain works by using a decentralized network, in which each node holds a single copy of the entire database. When a new block of data is added to the chain, this information is verified by all the nodes in the network and updated to the respective copies. Since all transactions are encrypted and linked together to form a continuous chain, the data cannot be changed or deleted once it is recorded, which ensures the integrity and security of the data.

Key features of blockchain technology include decentralization, transparency, immutability, and anonymity. Decentralization means that there is no single point of

control, and the operation of the network does not depend on any central organization; transparency means that all transactions on the network are open and accessible to anyone; immutability ensures that data cannot be changed once recorded; and anonymity allows users to trade while maintaining privacy.

Blockchain is widely used and can be used to create and manage digital identities, track the source of goods, automate contract execution (smart contracts), provide financial services, and more. For example, in supply chain management, blockchain can ensure that every step of a product from production to the end consumer is accurately recorded and verified; in the financial sector, it can help create faster, more transparent and secure trading systems.

2 The combination of blockchain technology with time banking and smart pension

2.1 The advantages and challenges of blockchain technology applied in the "time banking" smart pension

2.1.1 Advantage

Security improvement. Blockchain technology provides a strong security guarantee for the elderly's personal information and assets through its encryption algorithm and decentralized characteristics. In the scenario of smart pension, sensitive information such as health data and financial information of the elderly can be safely stored and transmitted, avoiding the risk of data leakage or tampering.^[1]

Traceability enhancement. The traceability of blockchain technology provides a transparent and credible information recording system for elderly care services. On the smart pension platform, both health monitoring data and service transaction records can be accurately recorded and can be traced back and verified at any time, which is crucial to improving service quality, preventing fraud and meeting regulatory requirements.

Decentralized collaboration. The decentralized nature of blockchain helps to break the information island and realize information sharing and collaboration among different elderly care service providers. Through a decentralized

network, various service providers can join the blockchain as nodes to jointly build an open and trusting service ecosystem.

2.1.2 Challenge

1. Technical landing difficulty

Although blockchain technology has great potential in theory, it is not easy to actually apply it to the field of smart pension.^[2] Technology development needs to consider the use habits and technology acceptance of elderly users, and also needs to solve the compatibility problem with other elderly care services^[3].

2. Technical complexity

Blockchain technology itself is relatively complex, and for the elderly who are not familiar with the technology, there may be high learning costs and operation difficulties. Therefore, simplifying the user interface and operation process and improving the ease of use of the system is an important task to promote blockchain in the application of smart pension.

3. Policies and regulations

At present, the laws and regulations on blockchain technology are not perfect, which limits its wide application in the field of smart pension to a certain extent. With the continuous development of blockchain technology, corresponding policies and regulatory frameworks need to be introduced to ensure the compliance and security of the technology, while protecting the rights and interests of users.

4. Excitation mechanism

In the field of smart elderly care, the incentive mechanism based on blockchain is still in the exploration stage. How to establish an effective incentive system through blockchain technology and encourage more individuals and organizations to participate in the service provision and innovation of smart pension services is an important topic facing us at present.

To sum up, blockchain technology has a broad application prospect in the field of smart pension, but at the same time, it also needs to overcome the challenges of

technology implementation, user acceptance, policies and regulations, and incentive mechanism, so as to give full play to its potential and provide safer, more convenient and humanized pension services for the elderly.

2.2 Technical implementation solutions: smart contract, distributed ledger, etc

Smart contracts and distributed ledgers are two core concepts in blockchain technology, which are the basis for decentralized applications. In the wisdom of the "time banking" in the application of pension, these two concepts play a crucial role.

2.2.1 Smart contracts

In the "time banking" smart pension model, smart contract plays the role of automatic execution of service exchange rules^[4]. For example, when a young and healthy elderly person provides services for the elderly, the smart contract can automatically record the service time and deposit it into the elderly person's personal account in the time banking. When the young and healthy old man needs elderly care services in the future, the smart contract can automatically deduct the corresponding time from his account and allocate it to the volunteers providing the service. This approach ensures the transparency and impartiality of the service exchange and reduces the possibility of human intervention and error.

2.2.2 Distributed ledger

In the "time banking" smart pension model, the distributed ledger is used to record the history of all services exchanged. As the ledger is updated synchronously on multiple nodes, it ensures the consistency and immutability of the data. The service time of each participant was recorded in a block and connected to the previous block by cryptographic methods, forming an uninterrupted chain. This makes every transaction in the time banking traceable and verifiable, greatly enhancing the credibility and security of the system^[5].

Through these applications, blockchain technology not only improves the operation efficiency of the "time banking" smart pension model, but also enhances the trust among

participants, providing more reliable and convenient pension services for the elderly.

3 Blockchain policy support and embedded "time banking" application example

Due to its unique decentralization, data immutability and traceability, blockchain technology has shown great potential and application value in the field of "time banking" smart pension^[11]. With the support of blockchain technology, this new old-age service model can effectively integrate social pension resources, improve management efficiency and reduce costs.

In China, the government has begun to explore the application of blockchain technology to the "time banking" pension model, and to provide policy support and institutional guarantee for its development. For example, the National Development and Reform Commission, the Ministry of Civil Affairs and the National Health Commission jointly issued the Implementation Plan of the Special Action for Urban and Enterprises for the Elderly, which clearly proposed to establish a time banking system and do a good job in volunteer cultivation, which has become a necessary option in the list of support policies of local governments. In addition, the Ministry of Industry and Information Technology and the central net letter office issued "about accelerating the block chain technology application and the development of industry guidance" also emphasized by 2025, block chain industry comprehensive strength to reach the world advanced level, and in the product traceability, data circulation, supply chain management and other fields to foster a batch of well-known products, form scenario demonstration application^[6].

Specific to the application of "time banking", there have been many successful cases. For example, the new pension model created by Ant Blockchain and Nanjing "time banking" is a typical example. The project uses blockchain technology as a new model to create trust, and solves the problems of data authenticity, reliability and cross-regional transfer in the operation of time bankings. The immutable, permanent and lifelong data on the blockchain ensure that

the "time wealth" stored by volunteers can be accurately redeemed in the future. In addition, through the smart contract and other technologies, the automatic cumulative withdrawal calculation of different proportions of the value is realized, ensuring the transparency and fairness of the service.

Qingdao city opened the country's first electronic social security card as the carrier of the electronic time banking. The platform uses mobile Internet, big data, blockchain and other innovative technologies to provide a "time exchange platform" for volunteer services, which includes the service time in the time banking with the electronic social security card as the carrier, and is deeply applied to the Ping An volunteer service management system^[8].

These cases show that blockchain technology can not only optimize the operation mechanism of the traditional "time banking", but also provide an efficient application platform for volunteers and social organizations to implement mutual elderly care services, which helps to improve the efficiency of management and operation and save costs. The combination of the advantages of blockchain and "time banking" aims to break the operation bottleneck of traditional mutual elderly care, and provides theoretical and practical value for the optimization strategy of integrating blockchain into "time banking" community mutual elderly care services^[7].

4 Policy recommendations and implementation strategies

4.1 Formulate special policies

In order to maximize the potential of blockchain technology, the government should issue guidelines and policies specifically for the application of the technology in elderly care services. These policies and guidelines should elaborate on the role positioning, application scenarios, technical specifications and safety standards of blockchain technology in elderly care services.

Clarify the role positioning of blockchain technology in elderly care services. Blockchain technology can be used

as a tool for elderly care services, helping to achieve data sharing, security and transparency. It can be used to record and manage the health information, medical records, and financial information of the elderly, so as to improve the efficiency and quality of elderly care services. Blockchain technology can be used to create a secure, decentralized identity authentication system that allows seniors to easily access various online services without worrying about the security of personal information. In addition, blockchain technology can also be used to automate the payment and tracking of pensions, ensuring the transparency and correct distribution of funds.

Formulate technical specifications for blockchain technology in elderly care services. This includes defining data formats, communication protocols, security requirements, etc. Technical specifications should take into account the special needs and limitations of the elderly to ensure the ease of use and disability of the technology^[9]. Establish security standards for blockchain technology in elderly care services. This includes the selection of encryption algorithm, key management, node authentication, etc. Security standards shall ensure the security, integrity and nondeniability of the data and prevent unauthorized access and tampering.

4.2 Strengthening support for technology research and development

Scientific research institutions and enterprises are encouraged to increase investment in the application of blockchain technology in elderly care services, and to carry out research and development of key technologies, such as smart contracts, distributed ledger technology, etc., to improve the efficiency and security of the system. Provide financial support, tax incentives and other policies to encourage technological innovation. Research institutions and enterprises are an important force to promote the innovation and application of blockchain technology. In order to promote the application of blockchain technology in elderly care services, the government should encourage these institutions and enterprises to increase their investment

in the research and development of related technologies.

The government can encourage research institutions and enterprises to develop blockchain technology by providing financial support. This can include direct funding subsidies, scientific research project funding, loan guarantee and other forms. Through these measures, the government can reduce the cost and risk of research institutions and enterprise research and development, and stimulate their motivation for innovation.

Through preferential tax policies to encourage scientific research institutions and enterprises to carry out the research and development of blockchain technology. The government can give certain tax breaks to enterprises engaged in the research and development of blockchain technology, or give VAT deductions to the relevant equipment and software purchased by scientific research institutions and enterprises. These policies can reduce the cost of research and development of scientific research institutions and enterprises, and improve their profitability.

In addition to financial support and tax incentives, the government can also encourage research institutions and enterprises to develop blockchain technology in other ways. For example, the government can set up special awards to recognize institutions and enterprises that achieve outstanding achievements in blockchain technology development and application, and the government can also organize relevant technical exchanges and training activities to improve the ability of scientific research institutions and enterprises to conduct blockchain technology research and development.

4.3 Carry out pilot projects

The pilot project is an effective way to promote the application of new technologies. It can test and validate the effectiveness, feasibility and safety of the technology within a limited scope, providing experience and basis for large-scale applications. Pilot projects can help identify the problems and challenges in the application of blockchain technology in elderly care services. In the practical application process, there may be technical problems,

operation difficulties, safety problems and other problems. Through pilot projects, these problems can be found and solved in time, avoiding greater losses in large-scale application^[10].

It provides experience for the large-scale application of blockchain technology in elderly care services. Both successful experiences and failure lessons of pilot projects can provide a valuable reference for subsequent applications^[12]. Successful experiences can be directly replicated and promoted, and the lessons of failure can avoid repeating the past mistakes.

When selecting the pilot region or institution, the following factors should be considered: first, the region or institution has strong demand for elderly care services and innovation; second, the region or institution has a certain technical basis to support the application of blockchain technology; third, the region or institution has good willingness to cooperate and is willing to promote the pilot project with the government and other institutions.

Through the implementation of the pilot project, the application of blockchain technology in elderly care services can be effectively promoted, and the quality and efficiency of elderly care services can be improved. At the same time, the success of the pilot project can also enhance public confidence in blockchain technology, laying a solid foundation for its application in a wider range of fields.

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