

Analysis of 6G Value From the Dual Perspective of Static and Dynamic

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Abstract. As countries around the world accelerate their efforts to seize competitive advantages in future industries, 6G has become the focus of technological innovation. This article analyzes the value of 6G from both static and dynamic perspectives. Firstly, it constructs a 6G value model from a static perspective, analyzing the value of 6G at the national, industrial, corporate, and individual levels from macro, meso, and micro perspectives. Then, this article innovatively proposes a 6G value evolution model from a dynamic perspective, analyzing the evolution of 6G value from three stages: technology research and development, technology application, and technology maturity. The research results of this article provide decision-making references for formulating scientific development strategies in 6G technology advancement, infrastructure construction, industrial layout, and application scenario promotion. Also, this article provides innovative ideas for studying the value of new technologies.

Keywords: 6G, Value analysis, Static perspective, Dynamic perspective

1. Introduction

Currently, 6G has become the focus of technological innovation in the global mobile communication industry. 6G is a new generation mobile communication system that deeply integrates communication technology, information technology, big data technology, AI technology, and control technology [1]. As a key infrastructure for the future economy and society, 6G will change people's ways of production, life, thinking, and social development, promoting human civilization and social progress. The innovation of 6G technology is influenced not only by the existing technological foundation and innovation capabilities, but also by value goals. Correct value orientation can promote the high-quality development of 6G. Therefore, the development of 6G needs to fully consider the background of the times, based on the two-way interaction between technology and economic society, and examine the diversified value of 6G.

The theory of technological value holds that technology carries value and has relative value independence. Technology follows objective laws and technological activities also have specific value orientations, which have a dynamic restructuring effect on social and cultural value orientations. At the same time, technology is a product of social culture, and it dynamically reflects social interests and values.

The study of technology value involves multiple disciplines such as economics, management, and philosophy [2-5]. Scholars conducted research from different backgrounds and perspectives, these studies mainly included the following categories.

Firstly, it reviewed related literatures about economic evaluation of technology value. Kang et al. evaluated the technology value by evaluating project costs [6]. Lim et al. developed a conceptual model based on a technology transfer system that includes both technological and economic value to calculate the economic value of technology [7]. Yoon et al. used market methods to evaluate the value of technology using previous technology transaction data and identify factors that affect the estimated value [8].

Secondly, it reviewed related literatures about technology value from the perspective of value creation. Tantalo and Priem pointed out that value creation entities are more diversified, including suppliers, customers, other resource owners, and core enterprises based on platforms, thus the value appreciation can occur at any stage [9]. Weng believed that value creation includes value objects, value content, value submission, and value recovery [10]. From a process perspective, Yuan divided value creation into value proposition, value network, value maintenance, and value realization [11]. Wu et al. believed that both the industrial economy era and the digital economy era follow the evolutionary logic of "value creation value realization", but there are significant differences in the significant elements of value creation such as consumer role, value appreciation, value chain form, and subject diversity [12].

Thirdly, researches on the value of information technology mainly focused on the investment output of information technology, considering its impact on the country, industry, and enterprises levels. Researches at the enterprise level has received the most attention from managers and researchers, and the research results are also the most abundant. These researches mainly focused on the relationship between information technology investment and enterprise performance. Lin and Shao studied the relationship between IT investment and enterprise production efficiency [13]. Industry level researches generally compare the productivity of different industries and analyze the impact of industry characteristics on the contribution of information technology investment and output. Lee et al. studied the impact of information technology investment on productivity in China's electronics industry [14]. The indicators of information technology investment output at the national level include productivity, economic growth rate, and consumer surplus. Zhang et al. empirically tested the impact of information technology capital on economic growth and production efficiency in China from 1997 to 2010 [15].

In summary, the existing researches on the technology value is relatively scattered and mostly focuses on exploring economic value, lacking systematic consideration. At the same time, current researches are all static analysis of value, but in reality, the technology value is not static. Any new technology will go through a lifecycle from research and development to application, and then to maturity. Each development stage has its typical characteristics and development focus, and the technology value will also dynamically change accordingly.

This paper first analyzes the value of 6G from a static perspective, and then creatively proposes a 6G value evolution model from a dynamic perspective, extending the static model from a three-dimensional perspective of time. It is hoped that the evolution trend of 6G value can be more comprehensively and objectively examined, providing reference for the strategic

layout of 6G throughout its entire lifecycle, and also providing new ideas for research on the technology value.

2. 6G value from a static perspective

The Marxist theory of "Technology and Society" (STS) holds that technology and society promote and influence each other. Technological innovation is a powerful lever for promoting the development of human civilization, continuously promoting industrial revolution, and promoting comprehensive changes in the economic structure and social relations of human society, thereby creating value and realizing value. As a technology innovation activity that carries value, 6G technology should be committed to solving social challenges, pain points, and needs, and creating diverse value for human society.

This study first constructs a 6G value model from a static perspective around the 6G value creation direction and the value creation subject, as shown in **Figure 1**. In terms of value creation orientation, 6G value covers five dimensions: strategic, economic, social, ecological, and cultural, reflecting its important role in ensuring the implementation of national strategies, promoting economic development, promoting social progress, achieving green and sustainable development, and enriching cultural experiences. In terms of value creation entities, the value creation entities of 6G technology include stakeholders such as the state, industry, enterprises, and individuals, who collaborate and influence each other, playing an important role in the 6G value system.



Fig.1. 6G Value System

2.1 The Five Dimensions of 6G Value

Exploring the value of new technologies should consider their value orientation. Technological innovation is purposeful and directional, carrying the value needs of human social progress. Only under the correct value orientation can new technologies better achieve innovation and development, better meet the needs of human production, life, and social development, and better benefit the people and the world. From a static perspective, the value of 6G is reflected in five dimensions: strategic value, economic value, social value, ecological value, and cultural value.

The strategic value of 6G includes assisting national cybersecurity construction, enhancing industrial competitive advantages, and promoting independent innovation of enterprises. The realization of the strategic value of 6G requires expanding the connotation and extension of 6G network security, and enhancing the innovation ability of 6G technology. The economic value of 6G includes promoting the optimization and upgrading of economic structure, empowering industrial digital transformation, helping enterprises reduce costs and increase efficiency, and enhancing personal self-worth and competitiveness. The realization of the economic value of 6G requires the deep integration of 6G technology with various industries, assisting in the improvement of new digital infrastructure, and promoting the digital upgrading of industries. The social value of 6G mainly includes promoting the precise development of social governance, assisting in the provision of inclusive social services in industries such as online healthcare, promoting corporate social responsibility, and enhancing the scope and efficiency of connection and collaboration between people and things. On the one hand, the realization of 6G's social value requires 6G to enhance its global coverage, making the achievements of economic and social development more equal and directly beneficial to all people. On the other hand, the realization of 6G's social value requires the deep integration of 6G with related technologies such as digital twins, biometrics, quantum computing, and new intelligent agents, promoting the modernization, comprehensiveness, and refinement of social governance systems and governance capabilities. The ecological value of 6G mainly includes promoting green, low-carbon and sustainable development, promoting green and low-carbon transformation of industries, assisting enterprises in energy conservation and emission reduction, and promoting sustainable lifestyles. The realization of 6G ecological value requires the design and technological innovation of 6G network architecture, adhering to the concept of green and low-carbon development, empowering other industries to undergo digital transformation in a green and low-carbon way, promoting the formation of green and low-carbon production and lifestyle, and promoting harmonious coexistence between humans and nature. The cultural value of 6G mainly includes promoting more diversified cultural supply, assisting in the innovative development of cultural related industries, promoting corporate culture construction, and promoting the development and promotion of new cultural consumption methods. The realization of 6G cultural value requires 6G and related technologies to expand the scope of information dissemination and innovate information dissemination methods.

2.2 Four levels of 6G value

The realization of the value of new technologies requires the creation of value entities. Value creators play an important role and responsibility in the development of new technologies, being both the main participants and beneficiaries of technological innovation. They continuously utilize new technologies to realize their multi-dimensional value. 6G value creation entities include countries, industries, enterprises, and individuals. The innovation of 6G and its related technologies is expected to generate a large number of innovative applications to meet the needs of countries, industries, enterprises, and individuals, and create value in various forms.

The country is the setter of 6G policies and regulations, and the guide of 6G development. At the same time, it will better meet the needs of sustainable economic and social development in the future through 6G. 6G is crucial for the new round of technological innovation and

industrial transformation, and will become a key driving force for promoting high-quality and sustainable development of the national economy and society, promoting the common realization of five dimensions of value at the national level. The industry is a fertile ground for 6G technology research and development, network deployment, and commercial expansion. At the same time, it will fully utilize 6G and related technologies to complete the transformation and upgrading of the industrial structure. 6G technology can widely empower industries, optimize and reshape key links and core chains through infrastructure transformation and upgrading, and empower industries to forge competitive advantages. Enterprises are practitioners of 6G technology and innovative applications. 6G will effectively enhance the independent innovation ability of enterprises, help them reduce costs and increase efficiency, help them fulfill social responsibilities, empower them to save energy and reduce emissions, promote corporate culture construction, and help enterprises achieve high-quality development. Individuals are the direct beneficiaries of 6G. 6G network technology will ensure that everyone has the right to access the network anytime and anywhere by building a full space three-dimensional coverage network, providing richer and more inclusive information services, and creating a new situation for personal digital life.

3. The Evolution of 6G Value from a Dynamic Perspective

The development of new technologies usually goes through three main stages: technology research and development, technology application, and technology maturity. During the technology research and development stage, scientific research and technological innovation form the foundation. Enterprises achieve "technological patentization", and then it is recognized by standardization organizations or industries. This process leads to "patent standardization" and contributes to the national innovation. The technology application stage is typically characterized by the commercialization of technology. In this phase, patents and standards generated during the R&D stage are translated into products and services. They undergo continuous upgrades and optimizations, driving an expansion in production scale and the gradual establishment of industrial development.

As a significant technological revolution, the development of 6G will also follow the same pattern. At different stages of development, the value of 6G will continue to evolve. The static value of 6G will progressively thicken and broaden, demonstrating a process of dynamic evolution, as shown in **Figure 2**. The R&D stage is led by the nation and industry, with technology research and development enterprises playing a supporting role. The focus is on the research layout of strategic values such as technology standards and independent innovation. The technology application stage is a phase of rapid ascent in five-dimensional value. The nation continuously unlocks economic and social value, while at the industrial and enterprise levels, ecological value gradually comes into play. Simultaneously, there is an empowerment of individual value. In the stage of technological maturity, the five-dimensional value realizes comprehensively. Driven by national, industrial, and enterprise values, 6G technology will unleash greater value at the individual level. It provides societal value for individual users by offering connectivity, coordination, and universally accessible information. Additionally, it promotes the realization of cultural value.

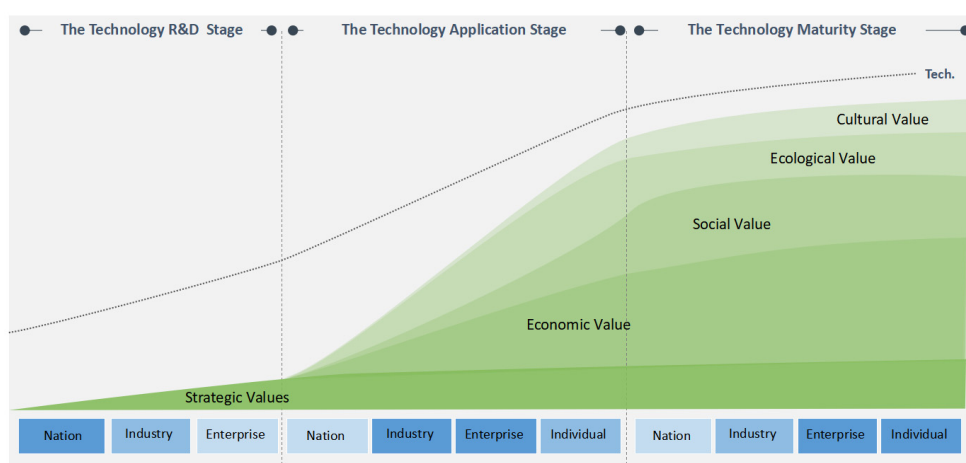


Fig.1. 6G Technology Stage and Values Alignment

3.1 Technology research and development stage: Driven by multi-dimensional strategic values

In the technology research and development stage, the path to value realization for 6G technology is primarily led by representatives from the nation, industry, and enterprises. The strategic value of 6G technology is positioned through national strategic research, the formation of industry technical standards, and enterprises' independent innovation.

Currently, we are in the 6G research and development stage. Countries actively lay out 6G technology research and standard-setting efforts. The aim is to seize a technological leadership advantage and realize national strategic values. China has explicitly outlined forward-looking layouts and increased research and development support. The United States is funding next-generation wireless mobile communication foundational research. The European Union, in collaboration with 5GIA, has launched a flagship 6G project to ensure a leading position. South Korea has introduced the "K-NETWORK 2030" strategy, and Japan has published the "Beyond 5G Promotion Strategy", clearly defining 6G development goals and standardization promotion strategies.

Countries' 6G industry alliances are actively promoting 6G technology innovation and standard research to enhance their domestic competitiveness in the 6G sector. China has established the IMT-2030 (6G) Group, bringing together industry, academia, research, and application forces. The United States has formed the Next G Alliance, aiming to propel North America into a leadership position in 6G and future mobile technologies. 6G-IA, an organization in the European Union, contributes to Europe's leadership in 5G, SNS/6G research. South Korea and Japan are strategically positioning themselves in 6G technology research and development, fostering innovation and collaboration.

Enterprises actively participate in 6G technology research and strengthen their position as the primary innovators. This is a significant manifestation of their strategic value. Enterprises that take the lead in researching and developing 6G and related technologies during this period will have the opportunity to dominate the technological market. Typical enterprises currently

involved in 6G research include telecommunications operators, communication equipment manufacturers, terminal manufacturers, and companies in vertical industries such as automotive. Taking China Mobile as an example, it has strategically positioned key 6G technologies in the areas of "wireless communication," "wireless networking," and "network architecture." This includes new network architectures, endogenous AI, integrated communication perception, heterogeneous integrated networking, digital twin networks, endogenous security, integrated air-land-sea networks, and other technological directions. The company has already generated a series of research outcomes, maintaining a leading position in the field of 6G technology.

3.2 Technology Application Stage: Rapidly Ascending Multi-dimensional Value Trend

In the technology application stage, 6G technology remains a competitive stronghold in the global high-tech industry, maintaining its strategic value. As 6G technology gradually transitions from the laboratory to the market, there will be continuous breakthroughs in 6G and its associated technologies. Fusion applications will expand further, the industrial foundation will be further solidified. Network coverage will extend from key urban areas to towns and rural areas. The user base will start to expand. Its economic value, social value, ecological value, and cultural value are beginning to manifest, indicating a rapidly rising trend in multi-dimensional value.

Firstly, the upgrade of 6G and its associated technologies will drive the improvement of national standardization levels and innovation capabilities. It will initiate exploration into the industrialization of application scenarios, injecting vitality into technological innovation for enterprises and unleashing the strategic value of 6G at the national, industrial, and enterprise levels. Secondly, the construction of 6G networks will drive investments in new infrastructure, stimulate the development of the upstream and downstream of the industrial chain, promote the optimization and upgrade of the economic structure, give rise to entirely new industrial forms and business models, and bring forth economic value. Thirdly, continuous innovation in 6G applications involves exploring new services and models such as fully immersive education, precise remote healthcare, and improving user experiences in public services. This contributes to the realization of societal value in the 6G era. Fourthly, in various aspects such as network architecture, transmission technology, and new types of devices, it is constructing a green 6G. It empowers other industries to achieve energy efficiency and emission reduction, fostering a green and low-carbon environment and contributing to ecological value. Fifthly, with the increase in 6G speed and the expansion of display media, there will be a continuous enrichment of usage scenarios for digital content. This will lead to the emergence of new formats such as immersive gaming, digital performances, and other innovative forms, gradually revealing cultural value.

3.3 Technology Maturity Stage: Comprehensive Value Fully Realized

Entering the technological maturity stage, the development of 6G in all aspects will gradually reach its peak. 6G will realize the vision of "digital twin and ubiquitous intelligence" driving accelerated innovation and prosperity in application scenarios. The application of 6G networks will further permeate society, contributing to high-quality economic and social development. At this stage, the efficiency of technological innovation begins to converge, the level of 6G network construction approaches its peak, user scale and penetration rate reach high levels, 6G

deeply integrates with vertical industries, various business applications flourish, and the industrial ecosystem tends toward maturity.

In this stage, as a critical infrastructure for economic and social development, 6G, with its outstanding network performance, will be able to provide diversified, personalized, and customized products and services for enterprises and individual users. It will maximize market demand in both vertical industries and personal consumption, gradually unleashing its maximum value across the five dimensions. Firstly, 6G will continue to exert its strategic value on multiple fronts, continuously contributing to national security, enhancing national competitiveness, empowering the optimization and upgrade of industrial structures, and providing ongoing support for enterprises to conduct technological innovations. Secondly, with the widespread application of 6G networks and the rapid development of various businesses, 6G will comprehensively empower individual entrepreneurship, corporate development, and industrial upgrading. This will propel the development of the digital economy to new heights, unleashing its maximum economic value. Thirdly, 6G will truly achieve seamless global coverage through the integration of air, space, and ground. The ubiquitous connectivity provided by the network will bridge the digital divide, promoting the balanced and sophisticated provision of social services. It will contribute to the scientific and precise governance of society and drive the construction of an inclusive and intelligent human society. Fourthly, 6G, through features such as holographic technology, multi-dimensional perception, and intelligent interaction, will facilitate the innovation of cultural forms and the creation of cultural content. It will promote cultural dissemination and propagation through diverse, intelligent, and immersive information communication methods. Fifthly, 6G will achieve the goal of overall energy efficiency improvement from the network layer to the terminal application layer, becoming a low-energy, green, and environmentally friendly network. It will empower other industries in their transition towards intelligent transformation in a green and low-carbon manner. This will promote the development of a green and low-carbon production and lifestyle, fostering harmony between humans and nature and fully unleashing its ecological value.

4. Conclusion

6G technology not only has the ability to achieve innovation and complementarity in the field of communication, but also has the value of leading the digital era as a technology innovation activity that carries value. It is committed to solving social challenges, pain points, and needs, and creating diversified value for human society.

This study analyzes the value of 6G from both a static and dynamic perspective. A static perspective revolves around the 6G value creation direction and the value creation subject, and constructs a 6G value model. Meanwhile, this study innovatively proposes the need to analyze the evolution and development of 6G value at different stages from a dynamic perspective. At present, 6G technology is still in the early stages of technological research and development. Dynamic value research can help 6G technology better understand its potential value and impact at different stages of future development, thus providing decision-making references for formulating scientific development strategies in technology promotion, infrastructure

construction, industrial layout, and application scenario promotion. The value model in this study can also be used to analyze other new technologies.

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