

Exploration of the Upgrading Path of China's Gas Meter Industry in the Digital Economy Era

Qinghua Liu^{1,*}, Jie Huang²

¹ Department of Marketing, School of Business Administration, Chongqing Technology and Business University, Chongqing, 400067, China

² Department of Business Administration, School of Business Administration, Chongqing Technology and Business University, Chongqing, 400067, China

* Corresponding author: Qinghua Liu (Email: 36675806@qq.com)

Abstract: Gas supply is a fundamental public good that affects millions of households. The online hot search event in April 2024 regarding the "fast running" of gas meters in multiple cities such as Chongqing and Chengdu indicates that there is still a long way to go in improving the quality and upgrading of the gas service industry and gas meter manufacturing industry. Based on the background of the digital economy era, this paper analyzes the role of gas meter manufacturers in the multilateral market of the smart gas management platform and the role of the gas meter industry value chain, explores the basic path and countermeasures for the upgrading of the gas meter industry, with a view to providing valuable reference for the digital transformation of the traditional gas meter industry in the industrial Internet era.

Keywords: Upgrading Path, Gas Meter Industry, Digital Economy Era.

1. Introduction

In April 2024, posts on Chongqing's online political platform and People's Daily message board reflecting the "fast running" of gas meters went viral. Citizens in multiple cities such as Chongqing and Chengdu reported that after replacing their smart gas meters, there was no significant change in usage, but suspected that gas costs had significantly increased, leading to continuous complaints. After investigations by government departments in Chongqing and Chengdu, it has been reported that there are problems such as "using estimation to copy", "illegal estimation", chaotic billing cycles, and inaccurate individual meters [1]. This event is a typical case of the contradiction between the growing needs of the people for a better life and the unbalanced and insufficient development in the new era. It reflects the importance of gas and people's livelihood, and also indicates that with the improvement of people's living standards, the acceleration of urbanization, and the increase in gas penetration rate, gas operating enterprises and users have put forward higher requirements for the safety, reliability, and intelligence of gas use.

However, Rome wasn't built in a day. In fact, under the trend of informatization, networking, and intelligence in the digital economy era, the upgrading of the gas industry has already begun, and gas smart management platforms led by gas suppliers have been launched in multiple cities [2]. The phenomenon of gas meters running fast this time indicates that the improvement and upgrading of both the gas service industry and the gas meter manufacturing industry are still worthy of attention.

2. Market Space for Smart Gas Meters

To achieve the "dual carbon" strategic goal, the position of natural gas in the energy structure will become more prominent. On March 13, 2024, the State Council issued the "Action Plan for Promoting Large scale Equipment Renewal and Consumer Goods Trade in", and on April 8, the Ministry

of Housing and Urban Rural Development issued the "Implementation Plan for Promoting the Renewal of Building and Municipal Infrastructure Equipment". Under the promotion of multiple policies such as urban infrastructure equipment renewal, "coal to gas", and "gas to rural areas", the market size of smart gas meters will continue to expand, and demand will continue to maintain a strong trend.

The development of measurement technology and the advancement of new generation communication technologies such as 5G and the Internet of Things have promoted the digital evolution of gas meters. At present, the types of smart gas meters in China are mainly divided into IC card smart gas meters, remote transmission gas meters, and other gas meters. At present, intelligent gas meters account for 50% of the existing market in China, while mechanical gas meters still account for half. The replacement market for existing gas meters is an uncertain source of demand. In 2023, the production of smart gas meters in China will reach 49.45 million units, and the demand will also reach 48.56 million units. The market demand for stock replacement is still strong, and the penetration rate of smart gas meters will continue to increase. The market size of smart gas meters in China will reach 10 billion yuan in 2024 and will grow to 11.923 billion yuan by 2028 [3]. The law of market supply and demand indicates that wherever there is demand, there are business opportunities. The vast market space requires the upgrading of gas services and gas manufacturing industries to meet people's demand for high-quality gas services.

3. The Role of Manufacturers in The Multilateral Gas Service Market

Gas is a basic life service for thousands of households. With the maturity of industrial Internet technology, gas smart platform has begun to be promoted and applied in many cities across the country. It can not only monitor gas usage in real time through embedded sensors and communication modules in the gas meter, but also achieve remote monitoring and real-time data uploading, improving the convenience and

intelligence level of gas management. At the same time, through the gas smart platform, all market participants are connected to improve the efficiency of gas management and service convenience.

3.1. Logical Model of Gas Smart Platform

The basic function of a smart gas platform is to remotely collect and transmit residential gas usage data, aggregate it to a data center for centralized processing, and thus achieve functions such as cost calculation, gas flow safety monitoring, equipment management, and fee management [4]. Although the smart gas platforms in different regions are not exactly the same, they have roughly the same logical architecture, as shown in Table 1.

Table 1. Logical Model of Smart Gas Platform

Platform Level	Functional Elements
Application Layer	User Management/Billing Management/Fee Management/Device Management/Security Monitoring/Data View
Network Layer	Wireless Communication Network/ Wireless Private Network/Internet
Perception Layer	PositionSensor/Flow Sensor/Pressure Sensor Temperature Sensor/Humidity Sensor

In this logical model, the perception layer is the foundation. The perception layer collects user traffic, device status, environmental status, communication connection status and other data in a timely manner through sensors, and synchronizes them with the platform application control layer through the network layer in collaboration with the sensor network. The application layer conducts statistical analysis on the massive data gathered, and views and manages user, device, cost, security, and other data as needed.

The basic element that constitutes the perception layer is the terminal. Terminal manufacturers integrate various IoT sensors such as flow sensors, position sensors, temperature sensors, and humidity sensors into smart gas meters through product development. The data collected by these sensors is aggregated on the platform to form big data, which forms the foundation for the operation and management of gas companies.

3.2. The Main Body and Role of The Gas Service Market

Table 2. Multilateral Participants in Smart Gas Platforms

Platform Level	Main Body	Scene value
Application Layer	End User	Detecting gas usage, leak warning, and online payment
	Government Regulatory Agencies	Master the gas supply situation and monitor gas safety risks
	Gas Company	User management, billing and fee management, device management, security monitoring data view
Network Layer	Communication Operator	Provide data transmission channels
Perception Layer	Gas Meter Manufacturer	Equipment usage status monitoring and after-sales service response

The logical model in Table 1 reflects the implementation

process of intelligent services in the gas market. In this process, the platform connects multiple participants in the gas market to closely collaborate and form a value network for achieving intelligent management and optimizing user service experience. As shown in Table 2.

Among the multilateral participants in the smart gas platform, government regulators and end users are consumers. Gas companies, holding government issued gas operating licenses, are responsible for the distribution and supply of gas, ensuring stable and safe gas services for society. Therefore, they are the operators of the platform.

As one of the multilateral entities connected to the smart gas management platform, gas meter manufacturers play an irreplaceable role. Firstly, they are manufacturers of intelligent gas meters. Through technological research and development, they continuously improve the measurement accuracy of gas meters, enhance the reading methods of gas meters, and promote their development towards informatization, digitization, and automation. Secondly, they are also an important driving force for the application of smart gas platforms. The main domestic gas meter manufacturers include Vanguard Krom, Jinka Intelligent, Vanguard Electronics, Weixing, etc. They not only produce high-quality smart gas meters, but also provide smart gas platform solutions.

4. Analysis of the Value Chain of Gas Meter Industry

Industrial upgrading is a complex process that includes both internal technological upgrades, product improvements, and management model improvements, as well as optimizing supply chain management on the industry chain, strengthening cooperation with suppliers and customers, and achieving market and service upgrades. Therefore, conducting an overall analysis of the gas industry chain is more conducive to clarifying the upgrading path of the gas meter industry. Analyzing the complete process of gas meters from production to use end-to-end can clearly present the main entities and their roles in various links of the industrial value chain, as shown in Figure 1.

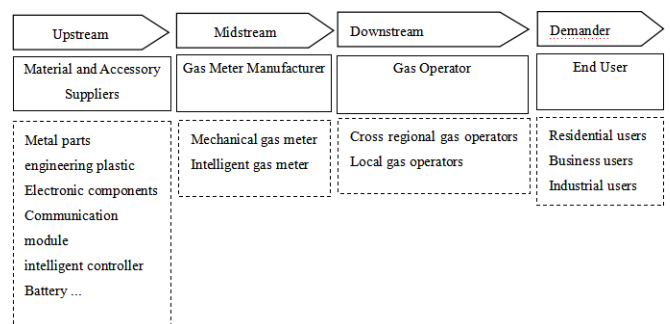


Figure 1. Gas Meter Industry Chain

According to Figure 2, the gas meter industry chain can be divided into two parts: the service and production stages. The production process is the design and manufacturing process of gas meters, while the service process is the usage and service process of gas meters.

In the service sector, gas companies are in a dominant position, while gas meter manufacturers are in a secondary position. Due to the fact that gas supply is a public good related to the production of numerous enterprises and the basic living needs and safety of life and property of thousands of households, under the national license system, the gas

supply of a city is often controlled by a few enterprises, forming a natural market monopoly position for gas companies. The dominant player in this stage is the gas operator. Due to having the right to operate gas, conducting terminal procurement, providing gas account opening, gas supply services, and charging to end users, it has a strong voice in the industry chain. Monopolistic position plays a positive role in ensuring the universal supply of gas public goods and services, but monopolistic nature also has a greater impact on market efficiency. For example, the "Annual Report on Anti Monopoly Law Enforcement in China (2023)" released by the State Administration for Market Regulation shows that in 2023, there were a total of four cases involving monopoly agreements and abuse of market dominance in the urban gas field, with fines ranging from over one million to tens of millions of yuan. In a monopolistic market, the main manifestations of insufficient market efficiency are inefficient resource allocation, decreased innovation capability, and reduced consumer welfare. In addition, the transformation of traditional watches requires investment costs, and the driving force for gas companies to promote the intelligence of the gas industry is not sufficient.

In the production process of gas meters, gas meter manufacturers hold a dominant position. Gas meter manufacturers conduct technical research and development, product design and production, purchase raw materials and spare parts for production and integration, and package and brand building to form final products that can directly meet customer needs. At this stage of the industrial value chain, gas meter manufacturers are collaborators and core value implementers in the industry chain. However, the gas meter supply market is a highly competitive market. There are over 1000 gas meter production enterprises nationwide, mainly located in Zhejiang, Chongqing, Sichuan and other places. Among them, listed companies such as Jinka Intelligent, Weixing Intelligent, and Jicheng Electronics are industry leaders with strong technological strength, advanced production processes, and great brand influence. However, over 60% of the industry is comprised of small and medium-sized enterprises in the third tier. With the intensification of market competition and the widespread application of advanced technologies such as the Internet of Things, big data, cloud computing, and artificial intelligence, intelligent gas management has become a new development trend. In order to gain a leading market position, gas meter manufacturers are active practitioners of upgrading their products and services by adopting these new technologies.

It is precisely because of the duality of the position of gas meter manufacturers in the industrial value chain that greater challenges are posed to enterprises in the process of upgrading the gas meter manufacturing industry: they need to lead and coordinate the terminal technology upgrade process to improve product competitiveness; We also need to play the role of a good supplier and cooperate with the gas company to serve end users well.

5. Upgrading Path of Gas Meter Industry

According to the SCP (Structure Conduct Performance) model established by Harvard University's authoritative experts in industrial economics, Bain, Scherrer, and others, market structure determines the behavior of firms in the market, and firm behavior in turn determines the performance

of various aspects of market operation. Exploring the industrial upgrading path of the gas meter manufacturing industry within this framework requires consideration of the dual position of gas meter manufacturers in the industry value chain, as well as the business model of the enterprise itself. At the same time, according to the basic assumption of "capital chasing profit" in economics, enterprises within an industry can improve their marginal efficiency and profitability by upgrading their technology, innovating their market, and improving their management models. For the gas meter industry, only when the gas meter manufacturers achieve an overall increase in added value through technological, market, and management upgrades can they promote industrial upgrading.

5.1. Technological Innovation: Developing Intelligent Products

Gas meters are an important means and tool for consumers and gas companies to measure, and the accuracy of their working data will have a significant impact on the interests of both parties [5]. Especially for civilian gas meters, which have a large and wide range of quantities and require mandatory calibration for each unit, how to improve detection efficiency while ensuring measurement and testing accuracy has become a focus of attention in the gas meter industry [6]. With the continuous improvement of people's living standards, there is an increasing demand for the accuracy and efficiency of gas meters. This means that gas meters with high sensitivity, reliability, and intelligence have a competitive advantage in the market.

The development of metering technology for gas meters has mainly gone through the following stages: traditional mechanical gas meters, membrane gas meters, IC card membrane gas meters, remote intelligent gas meters, and ultrasonic gas meters [7]. The core technology tree mainly evolves around three aspects: measurement technology, communication technology, and control technology. With the development of electronic information technology and network technology, the intelligence, remote management, and service of gas meters will become the main direction of gas meter development. With the help of communication technology and Internet of Things technology, gas meters will continue to advance on the road of intelligence. The new intelligent gas meter will realize more accurate and efficient gas measurement and management. The main technical line is mainly along two aspects: one is the adoption of new technologies, the application of ultrasonic, laser and infrared gas sensing technologies in flow data collection and monitoring, and the other is the integration of Internet communication technologies. At present, NB-IoT based intelligent meters have become the mainstream of the market, and the products combining gas meters with quantum technology have begun to be commercially available.

For gas meter manufacturers, it is necessary to use smart gas meters combined with big data and cloud platform technology to help gas companies achieve more accurate gas metering and management, in order to avoid low-level price competition.

5.2. Business Model Innovation: Transitioning from Hardware Manufacturers to Solution Providers

From the perspective of gas meter manufacturers, as terminal products are mainly purchased by gas companies, the

gas meter sales market can be understood as a B2B market. At the same time, due to the monopolistic position of gas companies and numerous gas meter manufacturers, manufacturers are generally at a disadvantage in price negotiations during the gas meter sales process. During the game, gas companies can compress the profits of gas meters to a very small extent.

In this situation, gas meter manufacturers can often fully leverage their technological advantages in gas meter measurement, communication, intelligent control, and other aspects to increase their bargaining power. They can develop smart gas management platform software and adopt a "terminal+software platform" packaging model, striving to provide "one-stop" services for gas companies. Once successful, one can "bind" the gas company through platform software services, gaining great advantages and convenience in subsequent terminal sales.

Through the "terminal+software platform" approach, once gas meter manufacturers transform from hardware manufacturers to solution providers, it also means upgrading their business models. As is well known, the marginal cost of software products is very low. Platform developers can replicate and customize their platform software services among different gas companies at a lower cost. Moreover, the platform software has been adopted by a certain gas company, which means that gas meter manufacturers have natural technological advantages in their terminal equipment procurement bidding process, such as data transmission protocols, etc. Driving gas meter terminal sales through smart platforms has become the main way for related enterprises to compete in the market.

5.3. Market Innovation: Expanding into International Markets

Currently, climate change is receiving increasing global attention. In order to effectively curb greenhouse gas emissions, major countries around the world have entered the fast lane of addressing climate change and developing low-carbon economies by increasing investment in natural gas supply and reducing emissions from coal and oil. Therefore, the international market for smart gas meters has a vast market space. According to Fortune Business Insights data, the global gas meter market size has exceeded \$30 billion, and with the increasing demand for global gas flow measurement, the gas meter market size will continue to expand. By 2026, the market size of the smart gas meter industry in North America will reach 3.6 billion US dollars, Europe will reach 3.3 billion US dollars, and the Asia Pacific region will reach 3.7 billion US dollars, totaling over 10 billion US dollars, with an average annual growth rate of 7.08% [8].

The competitiveness of Chinese gas meter products in the international market is mainly reflected in their technological and cost advantages. With the popularization of smart home and IoT technology, the technological level of smart gas meters in China continues to improve, with advanced functions such as high-precision measurement, high security, and remote meter reading, which can meet the needs of modern households and enterprises for energy metering equipment. At the same time, the production cost of smart gas meters in China is relatively low, and it has a price competitive advantage in the international market, which can provide high-quality products at more attractive prices.

In order to enter the international market, Chinese companies need to further enhance their brand influence and

visibility. Compared with internationally renowned brands, Chinese brands have relatively low brand influence and awareness in the international market, which may affect consumers' acceptance and trust in Chinese gas meters. At the same time, some countries and regions may have specific safety standards and certification requirements, and Chinese gas meters need to make more efforts in these areas to meet the needs of the international market, including obtaining relevant international safety certifications and standard compliance certificates.

6. Suggestions for Upgrading the Gas Meter Industry

As a typical traditional industry, the transformation and upgrading of the gas meter industry face a series of constraints, especially under the gas business license system, where gas supply has a certain degree of monopoly. In order to promote the upgrading of the smart gas meter industry and achieve intelligent gas supply services, it is not only necessary to enhance the transformation motivation of gas meter manufacturers, but also to be empowered by a good external policy environment.

6.1. Strengthening the Role of Enterprise Technology Innovation Engine

Gas meter manufacturing enterprises focus on innovation in measurement and testing technology. With the development of industrial automation and IoT technology, the field of gas detection is also moving towards automation and intelligence. Under the limited conditions of their own technology and funds, enterprises can carry out integrated innovation, gather innovative elements from all parties, and cooperate with research institutions and universities through market-oriented mechanisms to develop core technologies and equipment such as non-destructive testing, spectral analysis, gas detection instruments and sensors, forming core technologies and products with independent intellectual property rights, making detection more accurate and efficient, and promoting the large-scale application of intelligent terminals [9].

6.2. Innovate Business Models to Effectively Drive the Market

In response to the monopolistic characteristics of the gas public goods market, breaking the shackles of pure terminal price competition, leveraging the advantages of terminal technology, and exploring a model of terminal sales+platform software services. The specific implementation approach is to cooperate with gas companies that play a leading role in the industrial chain, optimize the intelligent service capabilities of the smart gas management platform, focus on safety, reliability, intelligent convenience, remote management, intelligent control, and information security, reduce manual intervention links, and help gas companies save costs and improve service levels. By accelerating the market side supply capacity of gas supply for public goods, achieving full coverage of newly built residential communities, accelerating the upgrading speed of traditional gas meters, and enhancing the market coverage of smart gas meters.

6.3. Give Full Play to The Empowering and Guiding Role of Industrial Support Policies

Adopting advanced technology and reliable quality intelligent gas meters and management systems to support the intelligent management of gas companies is conducive to the construction and development of the Internet of Things and smart cities, and is in line with the support direction of national policies. To promote the development of the intelligent gas industry, various departments of the country have introduced a series of policies, such as the "14th Five Year Plan for Digital Economy Development" released by the State Council in January 2022, which optimizes and upgrades digital infrastructure. Accelerate the construction of information network infrastructure, promote the coordinated development of cloud network and computing network integration, and orderly promote the intelligent upgrading of infrastructure. At the same time, we will strengthen financial policy support, increase investment and financing rates for projects such as the research and development of new gas detection technologies and the renovation of existing gas, and promote the intelligent upgrading of the gas meter industry.

6.4. Upgrading Enterprise Brand and Enhancing Market Influence

Market competition is to some extent manifested as competition between brands. Although the gas meter market is a B2B market worldwide, brands still represent product quality, corporate image, and reputation, directly affecting customers' purchasing decisions. For gas companies, the integration of gas metering and detection technology with the Internet of Things technology can improve the functionality and quality of gas meter products, endowing the brand with high-tech life and intelligent soul, which is the key foundation for brand upgrading. At the same time, make full use of new Internet media channels to realize the social communication of the brand among consumers, improve the brand's good image and popularity, so as to form a good reputation among the end user group, and then "pull" the purchase decision of the B-end gas company, which can often play the role of "four or two to one thousand catties".

Acknowledgment

We would like to express our gratitude to Mr. Liu Lu, former general manager of Chongqing Bairuite Intelligent Technology Co., Ltd., for his valuable opinions and suggestions on the development of the gas meter industry. This work was funded by the on campus project of Chongqing Technology and Business University (project number 1955068).

References

- [1] Yu Ping, Livelihood is no small matter. Chongqing Daily, April 20, 2024, Issue 02.
- [2] Wu Xiaoyu, Huaxin Gas Group: Adding "Confidence" to Shanxi's Carbon Reduction. China Energy News, October 25, 2021, 15th edition.
- [3] Huang Nianbing, Xiao Haifeng, Application Management Practice of Gas Safety Intelligent Management System Based on Internet of Things and Data Analysis. Urban Gas, vol. 591, pp. 5-8, May. 2024.
- [4] China Research Institute Puhua Industry Research Institute, Report on In Depth Market Research and Investment Forecast China's Intelligent Gas Meter Industry from 2024 to 2029. [Online]. Available: <https://www.chinairn.com/news/20240823/102244272.shtml>
- [5] Chen Weijun, Measurement, Tsting and Technical Requirements for Gas Meters. China Quality Supervision, no. 9, pp.108-109, 2023.
- [6] Niu Lina, Yang Guanglei, Yang Guanglei, Xiao Weiming, Xiao Weiming, Jiang Hangcheng, Electronic Gas Meter Digital Measurement and Testing. China Metrology, vol. 5, pp.128-132, May 2024.
- [7] Xu Zhihao, Zhang Haiyan, Liu Chenyang, Luo Zhaochuan, Development and Comparison of Advantages and Disadvantages of Common Gas Meters. Automation Instruments, vol.9, pp. 28-30, Sep. 2020.
- [8] Zhao Hongtu. Carbon Neutrality and the New Changes in International Energy Politics. Modern International Relations, vol.2, pp. 29-63, Feb. 2022.
- [9] Guo Xihu, Zhou Yi, The Necessity and Countermeasures of China's Industrial Upgrading. Economic Research Guide, vol.41, pp. 48, Jan. 2009.