

# Interest Coordination Mechanism between Supply and Demand Sides for Smart Home Services for the Elderly: A Systematic Analysis based on PPP theory

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**Abstract:** The underlying cause for the imbalance between supply and demand of smart home services for the elderly in China lies in the improper coordination of interests between the supply and demand sides, i.e. the differentiation between the elderly' expectation for smart home services at a low price and the enterprises' supply of smart home services at a high price. In response to this challenge, government subsidy is not suitable for China's national conditions of aging before getting rich with a large population. Thus, constructing an interest coordination mechanism between supply and demand sides could be a feasible solution. We conduct a systematic analysis on three commonly used PPP modes in China and found that service outsourcing, franchising and equity cooperation may reasonably coordinate the interests between the supply and demand sides, which can not only bring benefits to the enterprises, but also promote the high-quality and low-price supply of smart home services for the elderly. To be specific, the advantage of service outsourcing mode is to form institutionalized interest compensation channel between supply and demand sides, and the advantage of franchising mode and equity cooperation mode is to produce sufficient interest compensation resources. Local governments should choose appropriate PPP mode to coordinate the interest differentiation between supply and demand sides in smart home services for the elderly according to the specific circumstances.

**Keywords:** smart home services for the elderly; interest coordination mechanism; PPP

## 1. Introduction

After the World War II, increasing aged population brings persistent pressure on the economic, social, medical and living arrangements of all countries, and home service is becoming the main mode of caring the elderly around the world [1]. However, the relative shortage of young nurses has posed great challenges for home service and long-term care [2]. In recent years, the "fourth scientific and technological revolution", represented by information technology, Internet of Things and cloud computing, has greatly promoted the development of home service and long-term care for the elderly. Many technologies have been used to support the process of aging in place, one of the most mature technical mode is smart home for the elderly [3]. Smart home for the elderly is committed to providing various services to meet the demands of the elderly such as safety, independence, health and assistance at a low cost. Thus, smart home service can play a significant role in caring for the elderly [4]. In 2015, China's prime minister Li Keqiang put forward the "internet plus" action plan in the government work report. Immediately after this, the National Development and Reform Commission (NDRC) aside with other departments issued a notice proposing to promote the "internet plus" action in the field of home service for the elderly. In 2017, the Ministry of Industry and Information Technology (MIIT), the Ministry of Civil Affairs (MCA) and other departments officially issued the *Action Plan for the Development of Smart Health and Elderly-care Industry (2017-2020)*. After that time, local governments in many cities of China launched pilot projects for smart home services for the elderly. In practice, the problems faced by smart home services for the elderly are gradually revealed, and the most prominent one is serious imbalance between supply and demand. On the one hand, enterprises have great market enthusiasm for smart home services industry under policy opportunities. On the other hand, great potential

demand for smart home services by the elderly were delayed to be converted into actual demand [5].

The academic circles have realized the key problem of imbalance between supply and demand in smart home services for the elderly, and carried out a series of studies. Jiang found that the imbalance between supply and demand of smart home services due to the inadequate response of service providers to the elderly' demand and the industry chain of smart home service should be restructured based on demand [6]. Wang said that the root of the problem lies in the imbalance between the supply-demand structure of smart home services for the elderly. So, it is necessary to open up the channel of resources flow, optimize the allocation of resources and improve the supply-demand matching [7]. Other scholars attributed the reasons of this problem to high supply price and low supply quality of smart home services for the elderly in China, which make it difficult to stimulate the demand of the elderly. Thus, it is necessary to reduce the service price and increase the added value of services through personnel training and institutional innovation [8]. With the deepening of research, scholars gradually realize that the imbalance between supply and demand of smart home services for the elderly mainly comes from the conflict of interests between supply and demand sides. As the demand side, the elderly expect the supply of smart elderly services to follow the public welfare principle, hence the supply price should be low or even free. However, the enterprises as the supply side hope to earn profits through providing services. Thus, the interest differentiation between the supply and demand sides results in the imbalance between supply and demand [9].

Many scholars tried to give the solution to deal with the interest differentiation between supply and demands in smart home services. Hua et al. suggest that the supply strategy should be determined according to the group differences of the elderly. Low-price smart home services should be provided to low-income elderly, and high-price smart home services should be provided to high-income elderly [10]. Zhou et al. suggest that Low-priced, medium priced and high-priced smart home services should be provided by the government, social organizations and the enterprises respectively, and government subsidy is the foundation of this policy [11]. Although the above-mentioned approaches provide choices for interest coordination between the supply and demand sides, their feasibility doesn't seem very high. government subsidy is not suitable for China's national conditions of aging before getting rich with a large population. At present, the Chinese government can hardly provide sustained subsidies for the the elderly to get smart home services. Not only in China, the interest differentiation between the supply and demand sides of smart home services for the elderly is widespread in various countries [12], and conventional solution is to build an interest coordination mechanism between the supply and demand sides, which can promote supply-demand matching on the basis of win-win of multiple stakeholders [13]. Therefore, it is necessary to explore the interest coordination mechanism suitable for smart home services for the elderly in China.

In this study, we take a Chinese city Qingdao as a typical case, and conduct field research and online survey to investigate the interest differentiation between supply and demand sides of smart home services for the elderly. Then, the theory of "public-private partnership" (PPP) and its feasibility to analyze this research issue were discussed. Lastly, PPP theory were used to analyze the scientific path to construct the interest coordination mechanism between supply and demand sides in smart home services for the elderly in China.

## **2. Interest differentiation between supply and demand sides of smart home services for the elderly in china**

Through field research and online survey, we found that there is interest differentiation between supply and demand sides of smart home services for the elderly in Qingdao city, China, which represent in the service mismatch and price mismatch between supply and demand sides (Table 1). The data of demand side is from field research on the elderly people. The supply side data in this study is from Qingdao smart elderly care service platform- <https://www.qingdaoyanglao.com/>. This is because China's smart home service for elderly care is a policy-driven product rather than

technology-driven or demand-driven one, most smart home services in China are provided through government platforms rather than commercial platforms.

In the regard of service mismatch, this happened in most safety services such as surveillance cameras and pressure sensors, most health services such as health monitoring and health consultation, and some auxiliary services such as convenient housing design and intelligent wheelchairs. Service mismatch between supply and demand sides makes the elderly' demand on safety, health and auxiliary care cannot be met. In the regard of price mismatch, the supply price of smart home services for the elderly such as laundry, cleaning, escort and substitute items is higher than the elderly' acceptable price to a large extent. For example, the average supply price of laundry, cleaning and escort service is 23.3, 28.6 and 24.5 RMB per hour, which exceeds the elderly' acceptable price by 10.3, 14.2 and 17.3 RMB per hour respectively. The reason for the price mismatch of smart home service lies in the fact that, most elderly people think that the price of smart home service provided by the government platform should be lower than that of the commercial services purchased through the market. However, the price of most services from the government platform are close to the prices of 58.com, Ganji.com and other commercial service platforms.

Table 1 A comparison of elderly' acceptable price and enterprises' supply price in smart home services for the elderly in Qingdao city

Service type	specific service	Demand ratio	Elderly' acceptable price	Enterprises' supply price	Elderly' average acceptable price	Enterprises' average supply price
Safety services	surveillance camera	21%	200-1000	-	568	-
	Pressure sensor	38%	200-1500	-	264	-
	smart bracelet	77%	100-500	199	218	199
	Refrigerator sensor	42%	100-300	-	172	-
	Door control system	22%	50-300	-	183	-
	Fire/gas leakage alarm	40%	50-500	-	241	-
Health services	Health monitoring	38%	100-300	-	125	-
	Health consultation	45%	100-500	-	166	-
	Health assistance	16%	50-200	-	77	-
	Solace of loneliness	2%	200-500	-	350	-
	Emotion regulation	0%	-	-	-	-
Auxiliary services	Convenient housing design	14%	800-2000	-	1330	-
	Intelligent wheelchair	19%	300-5000	-	2280	-
	Anti-fall device	0%	-	-	-	-
	Smart bed	0%	-	-	-	-
	Smart robot	12%	300-3000	-	1732	-
Nursing services	Cooking service	57%	5-22/hour	8/time	10.3/ hour	8/time
	Laundry service	43%	8-25/ hour	15-35/ hour	14.2/ hour	23.3/ hour
	Cleaning service	22%	15-30/ hour	20-30/ hour	22.6/ hour	28.6/ hour
	Escort service	7%	10-25/ hour	10-15/ hour	17.3/ hour	24.5/ hour
	Meal assistance	0%	-	12.5/time	-	12.5/time
	Bathing assistance	0%	-	100-150/time	-	120/time
	Substitute service	6%	10-30/ hour	30/ hour	12.3/ hour	30/ hour
	Auxiliary nursing	0%	-	15-30/ hour	-	30/ hour

Note: (1) the type of services is based on literature review and previous field research; (2) the demand side data is from social survey, and the supply side data is from Qingdao smart elderly care service platform <https://www.qingdaoyanglao.com/>; (3) the price unit is RMB.

In fact, Qingdao government has realized that the price of smart home services for the elderly on the government platform should lower than that from the market, and has provided certain subsidies on a small scale. For example, the Civil Affairs Bureau (CAB) of Qingdao built dozens of community canteen for the elderly in the city, and provided financial subsidies to ensure the low-price supply of catering service for the elderly [14]. However, it is still not possible for the government to provide universal subsidies for all kinds of smart home services due to the government finance limitation. In order to improve supply-demand matching, it is urgent to establish an interest coordination mechanism between supply and demand sides for smart home services for the elderly. The aim of this interest coordination mechanism should not only guarantee the enterprises to obtain profits as the supply side, but also adapt to the elderly' expectation of low-price services as the demand side.

### **3. Analytical tool: public-private partnership theory**

#### **3.1 Brief introduction on public-private partnership (PPP) theory**

Public-Private Partnership (PPP) refers to the cooperative ventures between the public and private sectors. Private sectors participate in the provision of public goods and services, which brings benefits to the private sectors while realizing the functions of the public sectors [15]. The formation and development of PPP in the modern sense are mainly attributed to the market-oriented reform of public service supply in the New Public Management Movement. Since 1970s, countries all over the world tried to implement PPP in public service projects in many fields. In the 1980s, Chinese government began to use PPP model to attract foreign investment in infrastructure construction. In 1995, the Chinese government issued a number of policies such as *Several Opinions on Promoting and Guiding Private Capital*, in order to promote the development of PPP in China. Driven by national policies, China's PPP practice has made outstanding achievements in improving the efficiency of public project resource allocation as well as promoting the public and private interests [16].

In the operation process of PPP, various cooperative relationships are established between public and private sectors to provide public goods or services. To be specific, private sectors undertake the task of design, construction, operation and maintenance of public services, and obtains profit through user-fee or government fee. The public sectors establish cooperative relationship with private sectors so as to improve the supply efficiency and quality of public goods or services by introducing market competition mechanism and incentive and restraint mechanism [17]. Ideally, public and private sectors coordinate with each other, make common decisions, share risks, benefit equally, and eventually achieve multi-win. The government will achieve the goal of improving the level of public service, and private sectors will make reasonable profit and increase their market share [18].

#### **3.2 Feasibility of PPP theory for analyzing this research issue**

In PPP, private sectors participate in the provision of public goods and services, which can not only bring benefits to the private sectors, but also improve the level of public service for the public sectors. Therefore, PPP is highly appropriate to coordinate the interest differentiation between supply and demand sides of smart home services for the elderly. On the one hand, PPP can promote the industry development of smart home services and absorb private sectors into this quasi-public service field. The introduction of market competition and its incentive mechanism can help the enterprises to obtain reasonable profits. On the other hand, the public sectors will regulate the price and quality of the services provided by private sectors based on sign contracts (service outsourcing, franchising, equity cooperation, etc.) with them, which can also meet the elderly' demand.

In fact, China has tried to apply public-private partnership to elderly care industry. In 2015,

China's prime minister Li Keqiang pointed out that, the cooperation mode between the government and private sectors should be promoted in areas such as medical care, elderly care and transportation. In the same year, Hunan province set up the first provincial-level government-guided investment fund for health and elderly care industry in China. PPP programs for elderly care services were also successfully launched in many places such as Zibo city of Shandong Province and Kaifeng city of Henan Province. After 2017, PPP programs for integrate care and elderly care were expanded across the whole country, which has provided a reliable experience reference for the interest coordination between supply and demand sides of smart home services for the elderly [19]. Elderly care PPP program has also become an important research issue In Chinese academia [20]. It has to be pointed out that, in the existing studies PPP is treated as a financing tool to absorb private sector funds into the field of elderly care and home service [21]. However, PPP has more meanings, it is also a mechanism for promoting and coordinating the interests of the public and private sectors. Thus, the research on the interest coordination between multiple stakeholders from public and private sectors in elderly care and home service PPP programs need to be carried out [22]. In the next part, the interest coordination mechanism between supply and demand sides for smart home services for the elderly are discussed systematically based on the PPP theory.

#### **4. Analysis results: interest coordination mechanism between supply and demand sides for smart home services for the elderly**

In China, there are three most commonly used PPP modes namely service outsourcing, franchise, and equity cooperation. Although there are many differences between the three PPP modes, their operating logic is the same. The public sectors transfer public assets, franchise rights and other resources to the private sectors, which use the resources to obtain reasonable profits from business operations. In return, the private sectors should bear the supply of public goods and services, and return part of their profits to the government [23]. In this process, the private sectors can obtain reasonable profits on the one hand, and the public sectors can also supply the low-cost and high-quality public services to meet the needs of the public on the other hand. This is a way to achieve win-win of both public and private sectors [24].

The logic of interest coordination between supply and demand side in PPP program is as follows. Public assets or public power owned by the public are transferred to the private sectors for market-oriented operation and value creation. Then, the value created from business operation are allocated reasonably between the private and public sectors, which could promote the interests of both the private sectors as the supply side and also the public sectors as the demand side. In this part, the three commonly used PPP practice modes (service outsourcing, franchise, equity cooperation) are used to analyze the scientific path to realize the interest coordination between supply and demand sides in smart home services for the elderly in China.

##### **4.1 Service outsourcing**

Service outsourcing, one of the most commonly used modes in PPP programs in China, refers to the operation mode in which the public sectors delegate the authority of operation, maintenance and service providing of existing public assets to private sectors. As the public assets owned by the government has high economic value and can bring profits to the enterprises, the government could transfer this kind of resources to smart home service enterprises as the basis for the benefit compensation for the elderly. To be specific, the public sector (the government) signs service outsourcing contract with private sectors such as medical institutions and smart home care service providers, which allow them to access its medical, safety and other smart services to the official smart home service platform built by the government, helping the private sectors to gain market share and reasonable profits. In return, the private sectors need to return partial profits to the government, which can be used for subsidizing the elderly to buy the basic smart home services on the platform. In this way, the interests of both the supply and demand sides of smart home services for the elderly can be successfully coordinated (Figure 1).

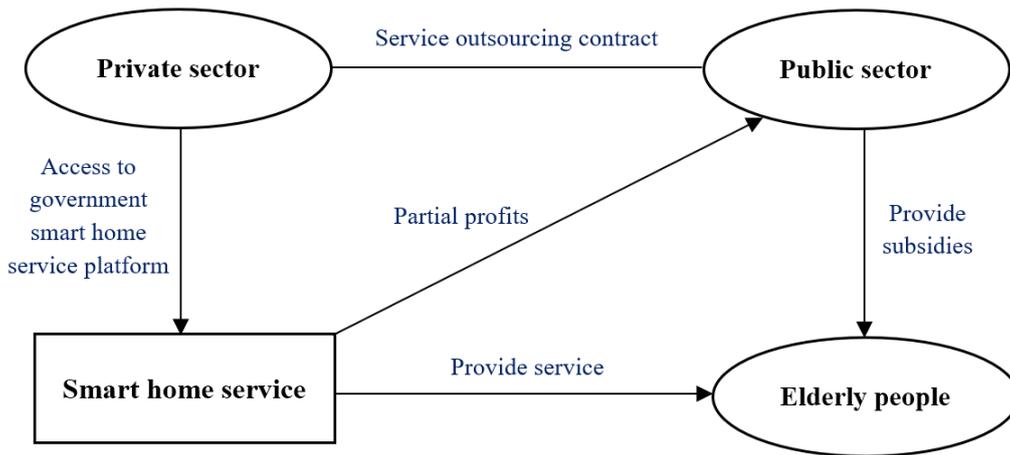


Figure 1 PPP service outsourcing mode for interest coordination between supply and demand sides in smart home services for the elderly

## 4.2 Franchising

Franchising is another commonly used modes in PPP programs in China, which refers to the operation mode in which the public sectors delegate franchise rights for certain public projects and services to private sectors in the contract period, which empower the private sectors to build and operate public projects for profit. After the expiration of the contract, the assets and their ownership will be transferred to the public sectors. The franchise rights can give enterprises exclusive market access, which can bring potential benefits to the enterprises. Therefore, the government could transfer this kind of resources to smart home service enterprises as the basis for the benefit compensation for the elderly. To be specific, the public sector (the government) signs franchising contract with one comprehensive smart home service provider, which allow it to gain franchising right to operate the official smart home service platform built by the government and access all kinds of smart elderly care services to the platform. In return, the comprehensive smart home service provider has to provide a certain number of welfare services. For example, the franchise unit shall supply a specified amount of low-price primary elderly care services such as nursing and basic healthcare services. Of course, it can also provide high-price elderly care services for profits such as safety, assistance, advanced health services and so on. The government should supervise and manage the behavior of the franchise unit, and provide additional subsidies for the elderly to get sufficient basic smart home services. Thus, the interests of both the supply and demand sides of smart home services for the elderly can be well realized (Figure 2). Compared with service outsourcing mode, the franchising mode has a higher degree of marketization.

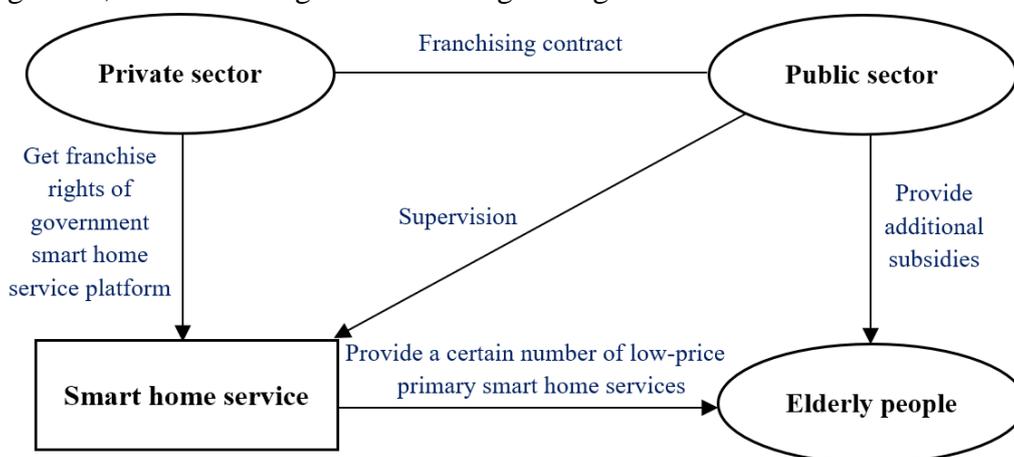


Figure 2 PPP franchising mode for interest coordination between supply and demand sides in smart home services for the elderly

### 4.3 Equity cooperation

Equity cooperation, also called partially privatization, is the last commonly used PPP mode of in China. The mainly form of equity cooperation is equity transfer. As equity ownership of commercial enterprises by public sectors can bring equity income, thus public sectors could use the equity income as the basis for the benefit compensation for the elderly. To be specific, the public sector (the government) signs equity cooperation contract with private sectors such as medical institutions and smart homecare service providers, and integrate the existing smart home service platforms owned by the government and the private sectors into one integrated platform. Both the public and private sectors own part of the equity of the new platform. The private sectors have the rights and responsibilities to provide all-round smart home services for the elderly such as safety, health and assistance for the elderly. At the same time, the government can also get partial profit as one of the shareholders. In this way, the service providers can obtain profits on the basis of business operation, and the government can also use the return on equity to provide subsidies for the elderly to buy the basic smart home services (Figure 3). Compared with the former two modes, equity cooperation mode has a higher degree of marketization.

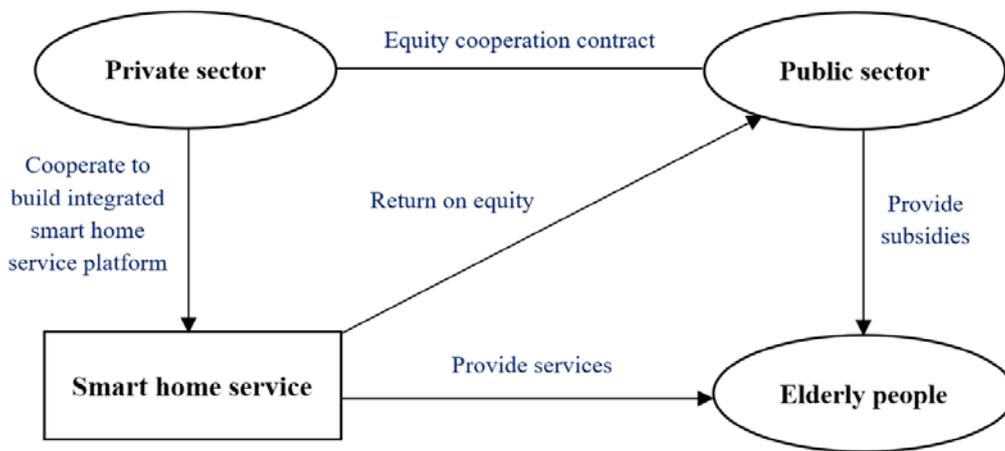


Figure 3 PPP equity cooperation mode for interest coordination between supply and demand sides in smart home services for the elderly

### 5. Discussion and conclusions

In China, the underlying cause for the imbalance between supply and demand of smart home services for the elderly in China lies in the improper coordination of interests between the supply and demand sides, i.e. the differentiation between the elderly' expectation for smart home services at a low price and the enterprises' supply of smart home services at a high price. In response to this challenge, government subsidy is not suitable for China's national conditions of aging before getting rich with a large population. Thus, constructing an interest coordination mechanism between supply and demand sides could be a feasible solution. Public-private partnership (PPP) refers to the cooperative ventures between the public and private sectors. Private sectors participate in the provision of public goods and services, which brings benefits to the private sectors while realizing the functions of the public sectors. Therefore, PPP is highly appropriate to coordinate the interest differentiation between supply and demand sides of smart home services for the elderly. The analysis result shows that, service outsourcing, franchising and equity cooperation could reasonably coordinate the interests between the supply sides, which can not only bring benefits to the enterprises, but also promote the high-quality and low-price supply of smart home services for the elderly.

The three PPP modes, service outsourcing, franchising and equity cooperation, have their own advantages and disadvantages in coordinating the interest differentiation between the supply and demand sides in smart home services for the elderly people respectively. To be specific, the degree

of marketization of the service outsourcing mode is low, and the government has a stronger degree of control over the operation of PPP program, which make it easier to form institutionalized interest compensation channel between supply and demand sides in smart home services for the elderly people. The degree of marketization of the franchising and equity cooperation modes are relatively high, and the autonomy of private sectors is stronger, which makes it easier to produce sufficient interest compensation resources. Institutionalized interest compensation channel and sufficient interest compensation resources are both important. Thus, local governments should choose appropriate PPP mode to coordinate the interest differentiation between supply and demand sides in smart home services for the elderly according to the specific circumstances. In the process of selecting PPP mode, the opinions of multi-stakeholders including the government, enterprises, service agencies, industry association and the elderly should be widely absorbed. Multi-stakeholders bargain and negotiate with each other in order to find a feasible way to coordinate the interest differentiation of multiple bodies and achieve a win-win situation [25]. Just as the development of smart home service is a step-by-step process, the interest coordination of its supply and demand sides may be also a long process. The essence and ultimate goal of interest coordination between supply and demand sides is not simply “bargaining” or “interest compromise”, but to achieve a win-win situation on the basis of value creation through cooperation by multiple stakeholders, which is also the principle and spirit of the development of smart home services for the elderly.

## **Abbreviations**

NDRC: National Development and Reform Commission

MIIT: Ministry of Industry and Information Technology

MCA: Ministry of Civil Affairs

PPP: public-private partnership

CAB: Civil Affairs Bureau

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