The Influencing Factors and Improvement Paths of the Manufacturing Industry Innovation System of Products for the Elderly

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Taking 22 manufacturing industries of the products for the elderly as the research objects, the process of reachability matrix and grounded theory is used to extract the influencing factors of manufacturing industry innovation system of products for the elderly. They are the completeness of the innovation subject, the ability of the innovation subject, the perfection of the infrastructure, the institutional incentives, the interaction efficiency of the innovation subject, and the degree of lock-in inertia, which are regarded as the condition variables for manufacturing industry innovation system. and the method of fuzzy sets qualitative comparative analysis is used to explore different configuration of conditional variables. The result identifies two configurations, namely, "subject-environment" dual-drive type and "subject-environment-interaction" comprehensive coupling type, which lead to high performance. The result also unfolds two configurations, "resource-oriented" and "technology-locked type," which lead to failure of the innovation system. Multiple paths indicate that diversified innovation-driven combinations can help improve the performance of the manufacturing industry innovation system of the products for the elderly, and the ability of the innovation subject and the interaction efficiency of the innovation subject are the core driving factors.

1. Introduction

With the aging of the world population and the development of the silver economy, the manufacturing industry of products for the elderly has development prospects and is considered to be the most promising sunrise industry in the development of an aging society [1]. Some developed countries entered an aging society in the 18th century, and the development level of the manufacturing industry of products for the elderly was relatively high under the background of the silver economy [2, 3]. Therefore, most of the existing literature studies the manufacturing industry of products for the elderly in developed countries such as Japan, the United States, and Europe [4–7]. However, there is little literature to explore why the manufacturing industry of products for the elderly in some developing countries has not developed well, and how the manufacturing industry of products for the elderly in these countries can achieve innovation and catch-up. As a developing country, China is a very meaningful case, because it has become one of the fastest aging countries in the world.

By the end of 2021, the proportion of the population aged 65 and above in China reached 13.5%, which is the highest in the world [8]. With the advent of aging, the potential of the silver-haired economy has gradually attracted more attention, and the manufacturing industry of products for the elderly is expected to become a new growth point for economic development [9]. However, in reality, the development of the manufacturing industry of products for the elderly is lagging behind the aging process in China, local innovative activities in the manufacturing industry of products for the elderly are weak, and the contradiction...
between supply and demand is prominent [10]. The level and scale of the manufacturing industry of products for the elderly do not match the status of the "world factory," "world market," and "first aging country." Compared with developed countries in terms of technology, quality and variety, China’s domestically-produced products for the elderly are far behind, and about 80% of the products depend on imports [11]. More importantly, the manufacturing industry of products for the elderly has low concentration, low technical threshold, obstacles to entry and exit, and lack of economies of scale [12]. Therefore, it is urgent to provide theoretical basis and strategic choices for the promotion of the manufacturing industry of products for the elderly.

At present, few scholars have conducted research on the manufacturing industry of products for the elderly. According to the theory of industrial innovation system, the hindrance of the development of the manufacturing industry of products for the elderly not only depends on individual enterprises, but also should pay attention to whether the entire industrial system is malfunctioning [13]. However, the previous literature has attributed the influencing factors of the development of the manufacturing industry of products for the elderly from the microlevel of the enterprise [14]. This view neglects to link the essential requirements of innovation system construction and perfection from macro and meso perspectives with technological innovation from microperspectives, and building an innovation system of the manufacturing industry of products for the elderly is the key path to improve its capabilities. The research on the influencing factors of the manufacturing industry of products for the elderly is still in the stage of theoretical exploration [15]. Although the existing literature involves some factors that affect the manufacturing industry of products for the elderly [16], there is no framework of influencing factors constructed based on theory, and most of the research considering the influence of a single element, the interaction and combination effects of influencing factors are ignored. It must be acknowledged that as a complex system, the manufacturing industry of products for the elderly is the result of multiple factors from different levels and different subjects.

In view of the above research gaps, this paper investigates the current situation of the manufacturing industry of products for the elderly from a systematic perspective, which is helpful to expand the application scope of industrial innovation system theory and innovation management theory, and enrich and deepen the related theories of the manufacturing industry of products for the elderly. Through grounded theory and fsQCA, it identifies multiple concurrent combination factors and causal complex mechanisms that affect the manufacturing industry innovation system of products for the elderly, and clarifies the path between different configurations composed of multiple antecedents and the innovation system of the manufacturing industry of products for the elderly. From the perspective of system coordination and configuration, explain the problem of "how to break through the barriers to the innovation system of the manufacturing industry of products for the elderly," and propose an integrated framework for understanding the influencing factors of the innovation system of the manufacturing industry of products for the elderly, and makes up for the lack of completeness of the discussion on the influencing factors of the manufacturing industry of products for the elderly in the existing literature, and constructs and perfects the realization path and guiding policy of the system innovation of the manufacturing industry of products for the elderly.

The rest of the paper is organized as follows. After this introduction, Section 2 reviews a comprehensive literature, Section 3 describes the research methodology, whereas Section 4 shows statistics results. Finally, Section 5 presents the discussion of findings, a conclusion, theoretical and practical implications, future research, and limitations.

2. Literature Review

2.1. The Manufacturing Industry of Products for the Elderly. There are few related theoretical achievements in the manufacturing industry of products for the elderly. Most scholars believe that the manufacturing industry of products for the elderly is a manufacturing industry that provides products such as clothing for the older people, daily auxiliary products, nursing care products, rehabilitation training and health promotion aids, and improvement of aging environment, which is an important part of the aging industry [17]. Some scholars have analyzed the current situation of the manufacturing industry of products for the elderly, and described the scale and development status of China’s aging market [9, 18]. Some scholars have analyzed the reasons for the weakness of the supply side of the manufacturing industry of products for the elderly in China [12]. Chen and Chan [19] took the elderly mobile phone company as an example, and discussed how to break the dilemma of the manufacturing industry of products for the elderly from the perspective of entry barriers. Bock et al. [20] paid attention to the difference in innovation management between products for the elderly and traditional technology manufacturing products that emphasize technology over humanities. Regarding the research on the influencing factors of the manufacturing industry of products for the elderly, Lee and Coughlin [21] believed that the design concepts and technical methods of various old-age products affected the development of the manufacturing industry of products for the elderly from the perspective of product design. Some scholars have paid attention to the knowledge frontier patent identification, international competition situation and patent gap at home and abroad from the perspective of elderly welfare technology [16, 22].

To sum up, the existing literature focuses on this field from the perspectives of technical analysis, aging science, aging industry or people’s livelihood science and technology [23–26]. In terms of industry types, the above research paid more attention to the aged care services, and the attention to the manufacturing industry of products for the elderly needs to be strengthened urgently. Relevant researches on the manufacturing industry of products for the elderly are mostly based on the description of the phenomenon and reasons from the perspective of products and technology,
but there is still a lack of further research on the key factors and relationship mechanisms of the innovation of the manufacturing industry of products for the elderly.

2.2. Industrial Innovation System. The theory of industrial innovation system was first put forward by Malerba [27] and Breschi and Malerba [28], which is mainly a self-organized complex ecosystem composed of innovation subject, innovation environment and innovation elements. Some scholars believed that the key to the operation of industrial innovation system is to build a cooperative innovation network to ensure knowledge transfer and information flow [29, 30]. In recent years, the exploration of industrial innovation system has become a research hotspot in recent years. Yang et al. [31] explored the competitive situation of integrated circuit industry development from the framework of industrial innovation system. Zhou et al. [32] analyzed the evolution of industrial innovation system of aerospace manufacturing industry. Scholars mainly explore the influencing factors of industrial innovation system from the aspects of innovation subject, market, technological innovation ability, institutional environment, infrastructure and interactive relationship [33–35].

In summary, the theory of industrial innovation system has been widely used in various fields by scholars once it is proposed. However, the research objects of industrial innovation systems are generally high-tech industries or traditional manufacturing industries. Scholars have not yet explored the innovation system of the manufacturing industry of products for the elderly, and have not deeply revealed the complexity and particularity of the innovation system of manufacturing industry of products for the elderly. However, the industrial innovation system characterized by multifactor collaboration can be used as an important carrier to effectively enhance the innovation capability of the industry. Therefore, it is necessary to identify the coupling, operation mode and synergy mechanism of the internal elements of the innovation system of the manufacturing industry of products for the elderly from a systematic perspective, and proposed a perfect path to effectively fill the gaps in existing research and implement precise strategies to improve the efficiency of the manufacturing industry of products for the elderly.

3. Methodology

3.1. Method Selection. Grounded theory method is based on literature reading and experience, through face-to-face interviews, repeatedly comparing and refining the concepts in cases, and then conceptualizing and integrating related relationship categories, systematically coding and theoretical sampling to construct new theories [36]. What matters when using this method is not the number of interviewees but the depth the interview and the amount of information [37]. The interview continues until the data is saturated, and after the data is completed, it can be analyzed through a series of coding procedures. At present, considering that the research on the influencing factors of the manufacturing industry of products for the elderly has not been effectively explained by existing theories, grounded theory method is used to explore new theoretical elements and new conceptual relationships.

This paper mainly adopts the method of qualitative comparative analysis of fuzzy sets to analyze the factors. Qualitative comparative analysis of fuzzy sets is based on set theory and Boolean algebra techniques, combining some of the advantages of qualitative and quantitative research methods [38]. This is an asymmetric configuration-focused research paradigm [37]. Configuration thinking adopts an overall and systematic analysis approach, that is, the case-level configuration rather than a single independent variable is used to analyze the results [39]. Qualitative comparative analysis of fuzzy sets (fsQCA) is a research method to clarify the causal allocation of multifaceted conditional computation (i.e., the combination of independent variables that lead to specific results) [39]. Applying fsQCA helps to identify other combinations of causal conditions that lead to the same result. It has significant advantages in analyzing asymmetric problems and multiple concurrent causality problems, because it analyzes how different factors relate the configuration of necessity and sufficient conditions with potential results [40].

This method of combining qualitative and quantitative analysis techniques is very different from the traditional quantitative analysis what is variance-based approaches using null hypothesis significance testing. The choice of this method and model is mainly based on three aspects. First, fsQCA explores multiple solutions rather than the single best solution explored by the exploratory regression analysis [41]. Rather than measuring each variable’s unique sharing of the overall data, fsQCA identifies complex solutions and combinations of independent variables. Therefore, it is different from the mainstream statistical method that tries to develop a single causal model that fits the best with the data, but pays attention to the diversity and complexity of causal relationship, and determines the number and characteristics of different causal models among multiple comparable cases [42]. The fsQCA method expands the analysis framework of causality. This study is devoted to exploring the influencing factors of innovation performance of the manufacturing industry of products for the elderly and clarifying the complex mechanism of each factor, while the research of fsQCA aims to interpret the causes of complex social phenomena and explore their formation paths, which is suitable for this study. Second, the relationship between variables is complex and nonlinear, but their sudden changes can lead to different results. Variance-based approaches assume that the relationship between variables is linear, but this problem can be overcome by adopting the method of qualitative comparative analysis of fuzzy sets, which can treat complex phenomena as clusters of relevant conditions [38]. Third, mainstream statistics takes an atomic perspective, focusing on analyzing the unique “net effects” of a single variable [43]. However, when independent variables are correlated, the unique effects of individual variables may be masked by correlated variables. At the same time, mainstream statistical methods use the method of moderating variable analysis to try to answer the configuration effect, but
it is difficult to explain more than 3 interaction variables [38]. The manufacturing industry innovation performance of products for the elderly is an interdependent and highly complex whole. Using fsQCA method can be used to more closely approximate the phenomenon of industrial innovation, and deeply explore the relationship between each group and the manufacturing industry innovation performance of products for the elderly. Fourthly, the mainstream statistical analysis does not pay attention to the equivalence of results, while fsQCA can achieve the same result by multiple paths, which breaks through the solution of the only best path in equilibrium in traditional analysis methods [39]. One of the key issues in this study is what paths exist to promote the high performance of the manufacturing industry of products for the elderly, so adopting fsQCA method is helpful to explore multiple equivalent paths to promote the manufacturing industry of products for the elderly. Lastly, fsQCA has more advantages than regression analysis in the analysis of small and medium-sized samples, and is more sensitive in the analysis of causal complexity [44]. The sample size of this study meets the requirements of fsQCA for sample size. FsQCA is also insensitive to outliers, and the representativeness of samples will not affect all solutions, which makes it more robust than variance-based approaches.

This paper comprehensively adopts grounded theory and fsQCA. First, based on 22 industry cases, this paper uses grounded theoretical methods for open, spindle, and selective coding, refines the influencing factors of innovation system performance in the manufacturing industry of products for the elderly, and constructs the driving mechanism of perfect innovation system. Then, the fuzzy set qualitative comparative analysis method is adopted to construct the truth table, and then the high performance and the impact path of innovation failure of the innovation system of the manufacturing industry of products for the elderly are obtained.

3.2. Data Collection. According to the collection and collation of development reports, research reports and other data of relatively mature industries in the manufacturing industry of products for the elderly, selecting 22 manufacturing industry of products for the elderly as samples (as shown in Table 1). From March 2020 to April 2021, the relevant personnel in the sample industries were interviewed one by one. The interviewees included members of industry associations, senior executives or technicians of leading enterprises in various industries, and heads of elderly care institutions (the number of interviewees in each industry is 10–20). The interview data were used to collect basic information such as industry policies and standards, innovation ability and typical enterprises. Then, following the principle of typicality and theoretical sampling, this paper made a double-case confirmatory analysis on two case industries of rehabilitation aids manufacturing industry and rehabilitation robot manufacturing industry. At the same time, it is supplemented by second-hand data such as industry association websites, media reports, media interviews with major members of the association, relevant academic articles, industry information and policy documents to ensure that the data can objectively reflect the real situation.

This study was coded by three coders, and the reliability of the coders was tested to assure a scientific and reliable conclusion of the research. Referring to the qualitative data analysis of Donald et al. [37], three coders randomly selected parts of the data from the whole as the pretest samples, encoded them respectively according to the coding description and requirements, and calculated the mutual agreement result and the reliability formula based on the content analysis method raised by Holsti [45]. After the calculation, the average mutual agreement of the content analysis is \( K = 0.787 + 0.765 + 0.792/3 = 0.781 \), the reliability of the analyst R = 3 × 0.781/1 + 2 × 0.781 = 0.931. The reliability of the result is higher than the general requirement of 0.8, indicating a high consistency of the coding members.

This study also set up a questionnaire to investigate the influencing factors. In order to ensure the reliability and validity of the questionnaire, the mature scales at home and abroad were first used and modified with the help of 3 experts; then, 22 companies were selected for research and the questionnaires were distributed. This study was measured by Likert’s 5-point scale, with 1 indicating “completely inconsistent” and 5 indicating “completely consistent.” A total of 301 questionnaires were received, excluding 25 invalid questionnaires with incomplete filling and missing key variable answers, and the remaining 276 valid questionnaires, with an effective recovery rate of 91.7%. The size of the enterprise, the time of establishment of the enterprise, and the industry in which the enterprise is located are used as control variables. 52 project technical directors, R&D engineers, and executive secretaries of 22 enterprises were randomly selected for interviews, and the questionnaires were revised according to the results of trial filling and interviews. According to the requirements of fsQCA, we assembled a 3-person data collection and coding team to collect multiple data sources for cross-validation and specific coding. On this basis, combined with the assignment criteria of each factor, the key factors of each sample are assigned.

3.3. Data Analysis. In this study, MindManager2020 software was used to sort out the data. The coding process mainly includes open coding, axial coding and selective coding. Open coding is a line-by-line coding to generate concepts from interview records and files [36]. Axial coding is adopted to classify the concepts obtained in the open coding [37]. Because the direct extraction of categories by hand is easily affected by subjective factors, at this stage, we use 0-1 scoring method to summarize and analyze the initial categories and extract the subcategories, and then use explanatory structure model method to further study the subcategories and finally extract the main categories. In the open coding stage, 34 initial categories were obtained, and these initial categories were sequentially coded as f1-f34. Adopting 0-1 scoring method, 13 industry experts are invited to evaluate the importance of these initial categories,
and the initial categories were scored according to the two grades of “important” and “general,” with scores of 1 and 0, respectively. The calculation formula of the importance coefficient of the initial category is

$$y_i = \frac{(1 \times n_{1i} + 0 \times n_{2i})}{N}$$  \hspace{1cm} (1)

$y_i$ represents the importance coefficient of the “$i$-th” initial category ($i = 1, \ldots, 34$). $n_{1i}$ and $n_{2i}$ respectively indicate the number of people who choose “important” and “average” when evaluating the “$i$” initial category. $n$ represents the total number of people participating in the evaluation, and $n = 13$.

After calculation, the initial categories whose importance coefficient is less than 0.5 are deleted, the remaining initial categories are clustered again, and the initial categories with the same properties and similar meanings are merged, and finally 20 sub-categories are obtained. The 20 sub-categories are named S1–S20 in turn, (corresponding to: manufacturing enterprises, knowledge production institutions, innovation demands, industry service institutions, organizational innovation capabilities, market expansion capabilities, organizational innovation willingness, industrial parks, exhibition platforms, scientific and technology innovation platforms, policy support, standard system construction, humanistic orientation, government policy planning quality, industrial agglomeration, organizational cooperation, external resource acquisition, cross-border learning, path dependence and interorganizational openness), the opinions of five experts in the manufacturing industry of products for the elderly were consulted, and the relationship among subcategories were assigned. The specific assignment principle is as follows: if $S_i$ has direct influence on $S_j$, then assign a value of 1. If $S_i$ has no direct influence on $S_j$, the value is 0 ($i, j = 1, \ldots, 20$). For the factors that have direct influence on each other, the one with great influence is assigned a value of 1, and the one with little influence is assigned a value of 0. When $S_i$ and $S_j$ have direct influence on each other, and the degree is equal, each is assigned a value of 1. If there is no direct influence on each other, each is assigned a value of 0. The $20 \times 20$ adjacency matrix $A$ is calculated, and the reachable matrix is obtained by the following operations between the matrix $A$ and the identity matrix $I$. The specific calculation process is as follows:

| Number | Sample industry | Typical enterprise |
|--------|----------------|------------------|
| 1      | Wearable smart device manufacturing | Huawei Terminal Co., Ltd. |
| 2      | Manufacturing of built-in clothing health management equipment | Shenyang Xinsong Robot Automation Co., Ltd. |
| 3      | Manufacturing of electrocardiogram and blood pressure monitoring equipment | Zhejiang Huiyang Technology Co., Ltd. |
| 4      | Manufacturing of blood glucose and oxygen inspection and testing equipment | Jiangsu Yuyue Medical Equipment Co., Ltd. |
| 5      | Home or community portable multifunctional health monitoring equipment manufacturing industry | Shenyang Neusoft Xikang Medical System Co., Ltd. |
| 6      | Primary diagnosis and treatment follow-up equipment manufacturing industry | Jiangsu Kangshang Biomedical Technology Co., Ltd. |
| 7      | Community self-service health examination equipment manufacturing industry | Wuhan Xinxinmai Health Technology Co., Ltd. |
| 8      | Emergency and alarm monitoring equipment manufacturing industry | Zhejiang Jiakai Wisdom Pension Service Co., Ltd. |
| 9      | Intelligent elderly care equipment manufacturing industry | Shanghai Maidong Medical Equipment Co., Ltd. |
| 10     | Elderly health food and pharmaceutical industry | Shenzhen Tangrenfu Health Industry Co., Ltd. |
| 11     | Mobile phone manufacturing for the elderly | Shanghai Cappuccino Electronic Technology Co., Ltd. |
| 12     | Smart Home and Home Appliances Manufacturing Industry for the Elderly | Shenzhen Yunchen IOT Technology Co., Ltd. |
| 13     | Family health information management system and production of related products | Guangxi Qifeng Technology Co., Ltd. |
| 14     | Information management system of old-age care institutions and production of related products | Hangzhou Aixun Technology Co., Ltd. |
| 15     | Community smart health management system and related product production | Shanghai Youkang Technology Company |
| 16     | Health assessment equipment manufacturing | Qingdao Hailan Rehabilitation Equipment Co., Ltd. |
| 17     | Intelligent training equipment manufacturing industry | Henan Xiangyu Medical Equipment Co., Ltd. |
| 18     | Rehabilitation aids manufacturing industry | Shanghai Kanglun Medical Equipment Co., Ltd. |
| 19     | Smart physiotherapy equipment manufacturing industry | Changzhou Jiaci Rehabilitation Medical Equipment Co., Ltd. |
| 20     | Rehabilitation robot manufacturing | Shanghai Fourier Intelligent Technology Co., Ltd. |
| 21     | Nursing robot manufacturing | Anhui Hagong Haijie Intelligent Technology Co., Ltd. |
| 22     | Accompanying the robotics manufacturing industry | Hunan Chaoneng Robot Technology Co., Ltd. |
\[ A_1 = A + I, \]
\[ A_2 = (A + I)^2, \]
\[ A_3 = (A + I)^3. \]

After calculating according to the above method, we can get
\[ A_1 \neq A_2 \neq A_{r - 1} = Ar = Ar + 1. \] (3)

Among them, \( Ar = (A + I)r, r \leq 10–1. \)
Take the reachable matrix \( M = (A + I)r. \)
Obviously, \( M = (A + I) r = (A + I)r + 1. \)

Therefore, the reachability matrix \( M \) among the subcategories of the manufacturing industry of products for the elderly can be calculated (as shown in Table 2). Firstly, the definitions of reachable set and antecedent set are introduced: the reachable set of element \( S_i \) is a set of elements corresponding to all columns with elements 1 in the \( S_i \) row of the reachable matrix, which is often represented by \( R(S_i) \). The antecedent set of elements \( S_j \) is a set of elements corresponding to all rows with elements 1 in the \( S_j \) column of the reachability matrix, which is commonly represented by \( A(S_j) \). According to this, the hierarchical division is carried out, and the specific division rule is that if \( S_i \) is the highest-level node, condition \( R(S_i) \cap A(S_i) = R(S_i) \) must be met. After finding the highest-level node, delete the rows and columns corresponding to the subcategory in the reachability matrix, and continue to find the second level node. And so on, until it is divided to the lowest level node. Finally, the four subcategories of policy support, industrial agglomeration, cross-border learning and path dependence are located at the highest level node, while the five subcategories of manufacturing enterprises, knowledge production institutions, innovation demanders, industry service institutions and exhibition platforms are located at the lowest level node, the rest are located at the middle level node. The specific results are shown in Table 2.

To sum up, by adopting the method of interpreting structural model, 20 subcategories were finally merged into 6 main categories, and the concrete results were shown in Figure 1. After selective coding, the six subcategories are further divided into three higher-order categories, and a new theoretical framework was constructed. Among them, the completeness of innovation subject and the ability intensity of innovation subject are the main factors affecting the innovation of the manufacturing industry of products for the elderly. The degree of infrastructure perfection and institutional incentives constitute environmental factors. The interaction efficiency of innovation subjects and the degree of lock-in inertia show the degree of interaction among innovation subjects in the manufacturing industry of products for the elderly, which were named as interaction factors. The S-E-I influencing factor model was constructed through reachability matrix and grounded theory (as shown in Figure 1).

Then, this paper uses SPSS26.0 and AMOS26 to test the reliability and validity of the measurement model. The KMO test value was 0.848, and the statistical significance probability of the Batlett sphere test was \( P < 0.001 \), indicating that it fully met the feasibility standard of principal component analysis. The standard loading, Cronbach’s \( \alpha \), composite reliability (CR) and average variance extracted (AVE) of each factor are shown in Table 2. It can be seen that the scale’s Cronbach’s \( \alpha \) and composite reliability (CR) are greater than 0.7, and the average variance extracted (AVE) is greater than 0.5, which indicates that the scale has good internal consistency and convergent validity (as shown in Table 3).

After calculating the data of each dimension in the scale and the data of the scale as a whole, based on the correlation analysis results of this data, as shown in Table 4, all correlation coefficients are marked with * (\( * \) means \( P < 0.05 \)), and the correlation coefficients are all greater than 0, which means that each dimension is significantly positively correlated.

As shown in Table 5, the fitting degree of the linear regression model is good, \( R^2 = 0.840 > 0.6 \), which means that the calculation results can reflect the completeness of the innovative subject, the ability of the innovative subject, the perfection of infrastructure, institutional incentives, the interaction efficiency of innovation subjects, and the degree of lock-in inertia impact on the innovation system performance of manufacturing industry of products suitable for the elderly very reliably. There was no multicollinearity among the six variables, and all the VIF were all less than 5. The regression equation is significant, \( F = 215.457, P < 0.001 \), which means that at least one of the six variables can significantly affect the dependent variable. The completeness of the innovation subject can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly (\( \beta = 0.238 > 0, P < 0.05 \)); the ability of the innovation subject can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly (\( \beta = 0.238 > 0, P < 0.05 \)); the ability of the innovation subject can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly (\( \beta = 0.238 > 0, P < 0.05 \)); the ability of the innovation subject can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly (\( \beta = 0.238 > 0, P < 0.05 \)); the ability of the innovation subject can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly (\( \beta = 0.238 > 0, P < 0.05 \)); 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The performance of manufacturing industry of products suitable for the elderly ($\beta = 0.204 > 0, P < 0.05$); the degree of infrastructure perfection can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly ($\beta = 0.139 > 0, P < 0.05$); institutional incentives can significantly and positively affect
positively affect the innovation system performance of manufacturing industry of products suitable for the elderly \((\beta = 0.102 > 0, P < 0.05)\); the degree of locking inertia can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly \((\beta = 0.310 > 0, P < 0.05)\); the interaction efficiency of innovation subjects can significantly and positively affect the innovation system performance of manufacturing industry of products suitable for the elderly \((\beta = 0.172 > 0, P < 0.05)\).

Finally, the following regression equation is obtained between the variables:

\[
\begin{align*}
\text{Industrial innovation performance} & = 0.604 + 0.238^*\text{completeness of innovation subject} + 0.204^*\text{ability of innovation subject} + 0.139^*\text{perfection of infrastructure subject} + 0.102^*\text{institutional incentive} + 0.310^*\text{degree of lock-in inertia} + 0.172^*\text{interaction efficiency of innovation subjects}.
\end{align*}
\]

According to the above four dimensions, the total score is the comprehensive degree value of industrial innovation performance (that is, the comprehensive value range is 0~20). The industrial innovation performance is a continuous value, and the Calibrate function of the fsQCA3.0 software needs to be used to convert the data into the corresponding set dependent value. The converted function formula is \(Y = f = \text{Calibrate}(X, n_1, n_2, n_3)\). Among them, \(n_1\), \(n_2\), and \(n_3\) are the three threshold values set during assignment. fsQCA3.0 software is used to calculate the truth table. Based on the research of Fiss [41], the upper quartile, median and lower quartile are used as anchor points for calibration. For example, the completely non-subordinate anchor point, cross point and completely subordinate anchor point of industrial innovation performance are shown in Table 6. Anchors and crossover point where innovation systems fail are just the opposite.

4. Fuzzy Set Qualitative Comparative Analysis

4.1. Determination and Assignment of Variables. The main factors that influence the innovation system of manufacturing industry of products for the elderly extracted by grounded process, namely, the completeness of innovation subject, the ability intensity of innovation subject, the perfection of infrastructure, the institutional incentive and the degree of lock-in inertia are regarded as conditional variables. The criteria for the assignment of condition variables are selected by the sub-categories combined with references. There is no uniform reference standard for these 22 kinds of manufacturing industries for the elderly. Therefore, according to the objective reality of the industries, this paper uses the interviewees to assign values to the conditional variables through the four-value method in fsQCA, in which “0” represents extremely low degree, “0.33” represents a low degree, “0.67” represents a relatively high degree, and “1” represents a high degree [42]. Industrial innovation performance is the result variable, and the independent scoring strategy is mainly used to evaluate the four dimensions of capital input efficiency, personnel input efficiency, knowledge output and economic output. The scores of each dimension range from 0 to 5, among which 5 represents the highest performance of this dimension.

### Table 5: The influencing factors scale of regression analysis.

| Nonnormalized coefficients | Standardized coefficient | T   | Sig value | Collinearity statistics | VIF |
|---------------------------|-------------------------|-----|-----------|-------------------------|-----|
| (Constant)                | 0.604 0.124             |     |           |                         |     |
| Completeness of innovation subject | 0.238 0.047            | 0.213 | 5.098   | 0.001  | 3.434  | 2.913 |
| Ability of innovation subject | 0.204 0.042            | 0.169 | 4.844   | 0.001  | 3.494  | 2.693 |
| Perfection of infrastructure | 0.139 0.040            | 0.133 | 3.476   | 0.001  | 3.374  | 2.768 |
| Institutional incentive    | 0.102 0.036             | 0.101 | 2.855   | 0.001  | 4.820  | 2.073 |
| Degree of lock-in inertia  | 0.310 0.039             | 0.318 | 7.937   | 0.001  | 0.373  | 2.680 |
| The interaction efficiency of innovation subjects | 0.172 0.045            | 0.151 | 3.848   | 0.001  | 3.870  | 2.582 |

\[
R^2 = 0.818,
F = 215.457,
P < 0.001
\]

4.2. Necessity Analysis. Before configuration analysis, it is necessary to analyze the necessity of a single condition variable. If the value of “consistency” in software is “1,” it means that the variable is a necessary condition, if it is “0,” it means that it is not a sufficient condition, and if the value is 0~1, the antecedent condition test of the sample is regarded as passing. Tables 7 and 8 show the results of the necessity test. It can be found that in the process of qualitative comparative analysis of fuzzy sets, no single variable with a consistency value greater than 0.9 means that there is no necessary condition to meet the consistency requirements. Therefore, this paper further conducts sufficient analysis to identify the condition configuration corresponding to high performance and innovation failure.

4.3. Configuration Analysis. The truth table needs to be filtered by frequency and consistency. Since the frequency describes the number of samples covered by the configuration in which it is located, to ensure that a minimum number of cases is obtained for evaluating the relationship, a column number needs to be set. A higher column number means more cases per configuration, but results in a decrease in the percentage of covered samples, or coverage. After screening the frequencies, the consistency threshold should be set. Referring to Pappas and Woodside [38], the proportional reduction in inconsistency is 0.75.
The “truth table algorithm” operation is carried out by fsQCA3.0 software, and the truth table is the basis for the result path and research discovery. As specified in the fsQCA method, the consistency of the prerequisite analysis can be assessed using the following formula:

\[
\text{Consistency}(Y \leq X) = \sum \left[ \min \left( \frac{X_i, Y} {Y_i} \right) \right].
\] (4)

In this study, when fsQCA3.0 is used to calculate the truth table, the consistency value cannot be lower than 0.75, the consistency threshold is set to 0.8, and the case threshold is set to 1 according to relevant research conventions. FsQCA calculates three solutions, namely complex solution, parsimonious solution and intermediate solution. Here, a solution refers to a combination of configurations supported by a large number of cases [46]. Complex solutions propose all possible combinatorial conditions based on traditional logical operations. However, since the number of determined configurations may be very large, the number of complex solutions may be large, which makes the interpretation of the solutions quite difficult [47]. Therefore, we generally further simplify the complex solutions into simplified solutions and intermediate solutions. Since the intermediate solution is generally considered to be the most explanatory solution compared to the complex solution and the simple solution, this paper uses the intermediate solution for explanation. In addition, the antecedent conditions coexisting in the simple and intermediate solutions are the core conditions, while the only ones appearing in the intermediate solutions are the marginal conditions [38]. Table 9 presents parsimonious solution for high-performance innovation system. Table 10 presents the intermediate solutions for high-performance innovation systems. Table 11 presents parsimonious solution for innovation system failure. Each condition configuration has high consistency and a certain degree of coverage, indicating that they are all sufficient conditions to produce result variables (high or low performance innovative systems).

### Table 6: Threshold of degree of industrial innovation performance in fsQCA approach.

| Technology path transforming degree | Full nonmembership | Threshold | Crossover point | Full membership |
|----------------------------------|--------------------|-----------|----------------|----------------|
| Technology path transforming degree | 11.25              | 14        | 16.75          |                |

### Table 7: Necessity analysis of high-performance innovation system.

| Consistency | Coverage |
|-------------|----------|
| CIS         | 0.873092 | 0.721609 |
| ¬CIS        | 0.346374 | 0.389485 |
| AIS         | 0.810115 | 0.822675 |
| ¬AIS        | 0.409351 | 0.367294 |
| PI          | 0.889313 | 0.681287 |
| ¬PI         | 0.330153 | 0.415865 |
| II          | 0.668893 | 0.811343 |
| ¬II         | 0.538168 | 0.422156 |
| IEIS        | 0.876908 | 0.811838 |
| ¬IEIS       | 0.331107 | 0.324906 |
| DLI         | 0.555344 | 0.470113 |
| ¬DLI        | 0.665076 | 0.724532 |

Note: the symbol “¬” stands for logical “non,” indicating that the variable does not exist.

### Table 8: Necessity analysis of innovation system failure.

| Consistency | Coverage |
|-------------|----------|
| CIS         | 0.506076 | 0.459779 |
| ¬CIS        | 0.693576 | 0.857296 |
| AIS         | 0.358507 | 0.400194 |
| ¬AIS        | 0.841146 | 0.829623 |
| PI          | 0.578125 | 0.486842 |
| ¬PI         | 0.621528 | 0.860577 |
| II          | 0.329861 | 0.439815 |
| ¬II         | 0.858507 | 0.829623 |
| IEIS        | 0.331107 | 0.324906 |
| ¬IEIS       | 0.876908 | 0.811838 |
| DLI         | 0.555344 | 0.470113 |
| ¬DLI        | 0.430555 | 0.515592 |

Note: the symbol “¬” stands for logical “non,” indicating that the variable does not exist.

### 5. Result Analysis

FsQCA is a set-theoretic approach for analyzing causal complexity, presenting multiple concurrent causal relationships. The holistic perspective of fsQCA is rooted in configuration thinking, which holds that organizations are best understood as clusters of interrelated structures and practices rather than subunits or loosely integrated entities, and thus cannot be understood in terms of analyzing components in isolation [41]. Configuration thinking is based on causal complexity, and considers that the first-order elements are concurrent, and the formation of various higher-order configurations may have equivalent effects on the results [44]. Because fsQCA is asymmetric. The asymmetry of causality means that the presence or absence of an effect requires different “causal combinations” to be explained separately [38]. If the reasons for success and failure are different, the opposite of the reason for success cannot simply be used to explain failure [47]. Conditioning asymmetry means that a given cause, when combined with some conditions, may have a positive effect on the outcome, and when combined with other conditions, it may have a negative effect. The purpose of this paper is to explore the driving mechanism of innovation in the manufacturing industry of products for the elderly. In view of the causal asymmetry of the fsQCA method, which means that the occurrence of a certain result requires different cause combinations to be explained separately, in order to more comprehensively and deeply explore the innovation-driven mechanism of the old-fashioned product manufacturing industry, this paper analyzes the positive factor of condition combination, that is, the
5.1. Configuration of Influencing Factors of the High-Performance Manufacturing Industry Innovation System of Products for the Elderly. Table 13 reports the condition configuration corresponding to the high-performance innovation system. From the data in the table, we can see that the overall consistency of the samples is 0.707061, which is greater than 0.7 required by fsQCA method, and has a high reliability. The total coverage of the sample is 0.889556, that is, the combination of the two factors can explain 89% of the total sample, which has a good interpretability. The specific explanation of each combination is as follows.

5.1.1. Dual Driving Type of “Subject-Environment” (CIS × AIS × PI × IEIS × ~DLI). This path shows that the manufacturing industry of products for the elderly has higher requirements on the completeness and ability of innovation subjects in the industry. At this time, the manufacturing industry of products for the elderly ignores the incentive effect of the system, and relies on perfect infrastructure, breaks through the interactive barriers between knowledge network and social network, attaches importance to the efficiency of interaction between innovation subjects, actively maintains and establishes new inward-looking partnerships, and actively establishes learning organizations to govern knowledge networks. At the same time, innovation subjects get rid of the dependence on the technology and brand of leading enterprises through broader technological innovation activities and business models, that is, the degree of lock-in inertia of this path is low.

Wearable device manufacturing industry is a typical case of this conditional configuration. Enterprises, universities, research institutes, promoters of innovative product diffusion and other subjects form a network to actively participate in the innovation of this industry, and continuously extend to the high-end links of the value chain of bracelet (watch) wearable device manufacturing industry. Innovators have increased investment in scientific and technological research and development. Huawei company has successfully developed Kirin A1, a wearable device chip, and Huangshan No.1 independently developed by Huami Technology company has been mass-produced and applied to a variety of wearable devices. Goer company has launched a series of

Table 9: Parsimonious solution of high-performance innovation system.

| Model: ISP = f (CIS, AIS, PI, II, DLI, IEIS) |
|--------------------------------------------|
| Algorithm: Quine-McCluskey |
| frequency cutoff: 1 |
| Consistency cutoff: 0.845638 |
| AIS × IEIS | 0.73855 | 0.73855 | 0.893764 |
| solution coverage: 0.73855 |
| solution consistency: 0.893764 |

Table 10: Intermediate solution of high-performance innovation system.

| Model: ISP = f (CIS, AIS, PI, II, DLI, IEIS) |
|--------------------------------------------|
| Algorithm: Quine-McCluskey |
| frequency cutoff: 1 |
| Consistency cutoff: 0.845638 |
| CIS* | 0.57729 | 0.0782442 | 0.868006 |
| AIS * PI* IEIS ~DLI |
| CIS* AIS* PI* II* IEIS | 0.628817 | 0.129771 | 0.942775 |
| Solution coverage: 0.707061 |
| Solution consistency: 0.889556 |

Table 11: Parsimonious solution of innovation system failure.

| Model: ~ISP = f (CIS, AIS, PI, II, DLI, IEIS) |
|--------------------------------------------|
| Algorithm: Quine-McCluskey |
| frequency cutoff: 1 |
| Consistency cutoff: 0.909699 |
| ~CIS* × IEIS | 0.736111 | 0.736111 | 0.940133 |
| Solution coverage: 0.736111 |
| Solution consistency: 0.940133 |

condition configuration of high-performance innovation system, and through the operation of the fsQCA3.0 truth table, the configuration and path of the non-high-performance innovation system are further analyzed by setting nonset methods. The results are shown in Tables 13 and 14.

After counterfactual analysis to obtain the intermediate solution, that is, assuming that the presence of each condition variable is likely to improve the manufacturing industry innovation performance of products for the elderly, fsQCA obtains two configurations and paths that produce high innovation systems. As shown in Table 13, and the consistency indicators of the two configurations are 0.868 and 0.943, respectively, which indicates that both configurations are sufficient conditions for a high-innovation system. The consistency index of the solution is 0.707, which further shows that the two configurations covering most of the cases are also sufficient conditions for the performance of the high innovation system. The coverage of the model solution is 0.890, indicating that the two configurations explain about 89% of the high innovative system performance. At the same time, assuming that the absence of each condition variable may lead to non-high innovation performance, fsQCA draws two configurations and paths that produce non-high innovation performance, and the two configurations covering most cases not only constitute sufficient innovation system failures conditions, and explain why about 94% of innovation systems fail.

In order to improve the presentation of research results, referring to the point of view of Fiss [41], the solutions output by fsQCA (as shown in Tables 9–12) are generally converted into a more readable table (as shown in Tables 13 and 14). Typically, the presence of the condition is indicated by a “○,” the absence is indicated by a “⊗,” and the “do not care” condition is indicated by a space. Overall coverage describes the extent to which the results can be interpreted by all configurations, similar to $R^2$ for regression methods.

Wearable device manufacturing industry is a typical case of this conditional configuration. Enterprises, universities, research institutes, promoters of innovative product diffusion and other subjects form a network to actively participate in the innovation of this industry, and continuously extend to the high-end links of the value chain of bracelet (watch) wearable device manufacturing industry. Innovators have increased investment in scientific and technological research and development. Huawei company has successfully developed Kirin A1, a wearable device chip, and Huangshan No.1 independently developed by Huami Technology company has been mass-produced and applied to a variety of wearable devices. Goer company has launched a series of
blood pressure sensors, differential pressure sensors and high-precision MEMS sensors that can be applied to a variety of wearable devices by unlocking intelligent hardware solutions and technologies. With the continuous growth of market penetration rate of domestic smart hardware devices, domestic smart bracelets (watches) wearable devices are gradually popularized in the field of smart and healthy elderly care. At the same time, with Huami, Huawei and other enterprises as the leaders, national R&D laboratories, public service platforms and common technology R&D platforms will be established to allocate innovative resources in this industry. Smart bracelet (watch) wearable device manufacturers establish cooperative relations with Internet companies and medical and health enterprises for production, education and research, and jointly build an ecological chain of smart elderly care service systems. As the main manufacturer of wearable devices with bracelets (watches) is a large-scale Internet manufacturer, it can flexibly open up more technology sources channels through innovative activities to get rid of the dependence on the technology and brand of leading enterprises.

5.1.2. The Type of Comprehensive Coupling of “Subject-Environment-Interaction” (CIS × AIS × PI × II × IEIS). This configuration means that the innovation system of manufacturing industry of products for the elderly pays more attention to the improvement of the completeness and

### Table 12: Intermediate solution of innovation system failure.

| Condition variable | Factor combination |
|--------------------|--------------------|
| Subject factor     | Completeness of innovation subject (CIS) | H1 | H2 |
| Environmental factor | Perfection of infrastructure (PI) | ⚫ | ⚫ |
| Interactive factor  | Interactive efficiency of innovative subject (IEIS) | ⚫ | ⚫ |

| Condition variable | Factor combination |
|--------------------|--------------------|
| Subject factor     | Completeness of innovation subject (CIS) | ⚫ | ⚫ |
| Environmental factor | Perfection of infrastructure (PI) | ⚫ | ⚫ |
| Interactive factor  | Interactive efficiency of innovative subject (IEIS) | ⚫ | ⚫ |

### Table 13: Condition configuration analysis results of high-performance innovation system.

| Condition variable | Factors combination |
|--------------------|--------------------|
| Subject factor     | Completeness of innovation subject (CIS) | ⚫ | ⚫ |
| Environmental factor | Perfection of infrastructure (PI) | ⚫ | ⚫ |
| Interactive factor  | Interactive efficiency of innovative subject (IEIS) | ⚫ | ⚫ |

### Table 14: Condition configuration analysis results of innovation system failure.

| Condition variable | Factor combination |
|--------------------|--------------------|
| Subject factor     | Completeness of innovation subject (CIS) | ⚫ | ⚫ |
| Environmental factor | Perfection of infrastructure (PI) | ⚫ | ⚫ |
| Interactive factor  | Interactive efficiency of innovative subject (IEIS) | ⚫ | ⚫ |
ability intensity of the innovation subject. With the help of national and local policies and measures to link the entire industry chain, build value-added and collaborative networks of resources, technology, and knowledge through industry-university-research and collaborative cooperation. At the same time, innovative resource allocation means are strengthened to promote the development of the innovation system of manufacturing industry of products for the elderly.

The manufacturing industry of smart physiotherapy equipment is a representative case of this configuration. The smart physiotherapy device manufacturing industry has developed rapidly under the multidimensional institutional incentives such as the promotion and application of the government and the establishment of a standard system. Xiangyu Medical, a leading enterprise in the industry, has established a provincial key laboratory for rehabilitation physiotherapy equipment in Henan Province, participated in a number of national key research and development projects, and held the 13th National Exercise Therapy Conference and International Rehabilitation Equipment Expo. Based on intelligent physiotherapy technology, Xiangyu Medical has expanded to intelligent training, health assessment and other businesses, thus becoming an enterprise with comprehensive R&D and production capacity of rehabilitation medical devices. In 2020, Yu Xiang Medical established the cooperative relationship of production, education and research with Changzhi Medical College and Anyang Institute of Technology, deepened the original cooperative relationship with Xinxiang Medical College, and established the training base of production, education and research for knowledge integration and incubation. At the same time, it has established long-term strategic cooperative relations with rehabilitation equipment R&D and production enterprises in Germany, South Korea and other countries, and introduced foreign rehabilitation concepts and technologies. It has improved the industrial chain resources of intelligent physiotherapy equipment, linked global partners to actively deploy overseas markets, and established and developed a global sales and service network.

5.2. Configuration of Obstacles to the Failure of the Innovation System of Manufacturing Industry of Products for the Elderly.

By running the program of fsQCA3.0, Table 14 reports the condition configuration corresponding to the failure of the innovation system. It can be seen from the data in Table 14 that the overall consistency of the sample is 0.736111, which is greater than 0.7 required by the fsQCA method, and has high reliability. The overall coverage of the sample is 0.940133, that is, the combination of these two types of factors can explain 94% of the total sample, which is highly explanatory. Specific explanations for each combination are as follows.

5.2.1. The Type of Technology Lock. In this condition configuration, there is a lack of innovative subjects or insufficient number. Innovative subjects such as enterprises, knowledge production institutions and innovative service institutions have not yet fully developed, upstream and downstream supporting constraints, innovation chain and industrial chain are unbalanced, and there are many weak links. At the same time, enterprises do not have sustainable independent realization ability in the key aspects of independent innovation such as technology design, research and development, testing, which leads to the inability to realize the transition from the original technology track or technology paradigm to a higher technology track or technology paradigm, resulting in "capability failure." Lack of support for the construction of material infrastructure and scientific and technological infrastructure, although some policies have been introduced to encourage the development of the industry, the relevant supporting policies have not kept up, failing to provide sufficient conditions for manufacturing industry of products for the elderly, and failing to form a perfect innovation system. In addition, this configuration shows that Chinese manufacturers of products suitable for the elderly are prone to fall into the predicament of "lock-in failure" once there is imitation innovation or plagiarism.

The intelligent elderly care equipment industry is a typical representative of this configuration. The United States, Japan and other developed countries have developed intelligent elderly care equipment earlier and have the ability to manufacture intelligent elderly care equipment in large quantities. For example, Stryker Medical in the United States and Bock in Germany have the intellectual property rights and pricing rights of these devices, and only set up factories and sales centers in China. Although domestic small and medium-sized elder product manufacturers have begun to get involved in the research and development of intelligent elderly care equipment and small batch production, most of them are simple imitations or equipment agents, products with low technical content and no independent innovation technology, and these enterprises have strong dependence on the design, technology and brand of foreign leading enterprises. Because economies of scale cannot be realized, the vast majority of enterprises do not have the foundation to establish an industrial science and technology innovation platform, nor have they established a perfect consumer market circulation channel for intelligent elderly care products. Relevant supporting policies are lacking, and the development of innovation systems is imperfect.

5.2.2. The Type of Resource-Dominated. The manufacturing industry of products for the elderly in this configuration only pays attention to the completion of the innovation subject, supplemented by the improvement of the infrastructure. However, due to the lack of power for technology lock-in innovation, it is still not conducive to continuous innovation and the perfection of the innovation system. Among them, manufacturing companies that produce products for the elderly lack independent innovation capabilities and continuous innovation capabilities, and they mainly rely on the introduction of mature technologies or the transfer of relatively simple technologies to obtain corresponding experience and knowledge. The configuration of resource-oriented type indicates that the industrial soft and hard
systems for producing suitable products for the elderly have failed, and the relevant policies are "focusing on the supply side and neglecting the demand side," which leads to insufficient support for the application and promotion of products and technologies suitable for the elderly and insufficient financial subsidies for the consumer market. In addition, this type of configuration also shows that the industry that produces applicable products for the elderly lacks elderly care technology and elderly service standards, and there are few innovation norms and access standards, lack of monitoring and evaluation standards, and insufficient regulatory basis. Even if some measures have been taken to strengthen the allocation of innovative resources and increase the number of innovative subjects, the results are not satisfactory.

Taking nursing robot manufacturing industry as an example, the industry started late and the market demand was limited. Although, Haiji Intelligent Technology Company and Shenyang Xinsong Company have established close ties with knowledge production institutions such as universities and research institutes, as well as innovative service institutions such as investment companies and consulting companies, and established production, education and research institutions, and an exhibition platform including Nursing Robot Industry Expo has been set up, but many enterprises still rely on imports for key core technologies and components. In view of the difficult problems of elderly care such as bathing, eating and toileting, the common key technologies such as robot flexible structure design, motion intention perception and environment recognition, attitude detection and control have not yet been broken. The nursing robot manufacturing industry is subject to the ability barrier of innovation subject. In addition, the ability of cross-industry integration is weak, and various preferential policy documents and corresponding guidance are lacking, so the innovation efficiency is relatively low.

5.3. Analysis of Core Elements in Configurations. Fuzzy set qualitative comparative analysis shows that the ability of innovation subject and the interaction efficiency of innovation subject play a core role in perfecting the innovation system of product manufacturing industry for the elderly. Because a parsimonious solution is a simplified form of a complex solution based on reducing assumptions, it presents the most important conditions that no solution can ignore, which are called core conditions and automatically identified by fsQCA [38]. It can be seen from Table 13 that in the configuration analysis of high performance for the manufacturing industry of products for the elderly, the ability of innovation subject and the interaction efficiency of innovation subject both appear in two paths, and the simplified solution is the combination of the ability of innovation subject and the interaction efficiency of innovation subject (as shown in Table 9). Therefore, it can be determined that the ability of innovation subject and the interaction efficiency of innovation subject are the core elements to improve the innovation system of the elderly product manufacturing industry. In addition, from the analysis of the reachability matrix, it can be seen that the dimension at the highest level is the key element. From the grounded analysis using the reachability matrix, it can also be concluded that the dimensions of the ability of innovation subject and the interaction efficiency of innovation subject exist at the highest level, and the data obtained from the reachability matrix can also verify the ability of innovation subject and the interaction efficiency of innovation subject are the core elements.

The product consumption market for the elderly has great potential in China. Only by improving knowledge management capabilities, organizational learning capabilities and R&D capabilities can enterprises realize the transition of technology paradigm, effectively locate from potential collaborators in the market. Innovative subjects tend to find entities they are familiar with directly or indirectly to establish cooperative links, which will lead to homogeneous redundant information and hinder the development of innovative subjects. Therefore, only by changing the innovation network structure of product manufacturing industry for the elderly, connecting the industrial chain with the innovation chain, and paying attention to establishing the innovation cooperation network with each interface can the ability and performance of the whole innovation system be improved.

Shanghai Kesheng, a well-known enterprise in rehabilitation assistive device manufacturing industry, paid attention to improving its independent research and development capability. Based on increasing investment in scientific research, the first generation of myoelectric controlled bionic hands and Kesheng modern bionic hands in China were developed. It also launched the world's first prosthetic hand product with human sensory feedback, built an innovative network cluster through cooperative innovation, and continuously upgraded technology and product iteration, so that China's high-tech upper limb and prosthetic limb market basically broke through the monopoly of leading countries. Ali Health, in conjunction with dozens of medical and health equipment manufacturers such as Lexin, Omron and Sannuo, jointly launched an intelligent health management plan, which automatically formed a health trend report with the help of wearable devices such as bracelets (watches) and big data technology, and transmitted it to medical service providers for remote diagnosis, providing users with personalized full health management services.

5.4. Comparative Study

5.4.1. Comparison of Configuration of High-Performance Innovation System. By comparing the two configurations of innovation systems that affect the high performance of manufacturing industry innovation system of products for
the elderly, it is found that according to the coverage index, H1 explains 58% of the outcome variables, H2 path exceeds 5% of H1 path, which explains 63% of the result variables, and is more likely to effectively promote the performance of innovation systems, that is, most industries and enterprises suitable for the elderly achieve high innovation performance through H2 path. By comparing the two configurations, it is also found that the completeness of innovation subject and the ability of innovation subject have complementary effects, which can deeply and strongly affect the performance of innovation system. At the same time, the institutional incentives involved in the two paths play a substitute role in explaining the performance of the innovation system, that is, if the completeness and ability of the innovation subject are high, the high performance of the innovation system can be promoted as long as the single condition of institutional incentives is met or the condition of low locking inertia is met at the same time.

5.4.2. Comparison of Configuration of Innovation System Failure. Comparing the coverage index of configuration NH1 with that of configuration NH2, the coverage of combined NH2 is 47%, the coverage of configuration NH1 exceeds 15% of configuration NH2, which explains 62% of the result variables, that is, most industries and enterprises for the elderly fail their innovation systems because of NH1. By comparing the above two configurations, it is also found that subject factors and environmental factors also play a substitute role in explaining the failure of innovation system, that is, when the ability of innovation subject is lacking, the interaction efficiency is low and the locking inertia is low, as long as the innovation subject is incomplete or the infrastructure is imperfect, it will lead to the failure of innovation system.

5.4.3. Overall Comparison among Configurations. From the overall situation of the condition configuration corresponding to high performance innovation system and innovation system failure, the number of conditions in the configuration with high innovation performance is obviously more than that of the configuration with driving factors of innovation system failure. There are 4–5 core or edge conditions in the two paths corresponding to the configuration with high innovation performance, while there is only one core and edge condition in the configuration path corresponding to the failure of innovation system. This means that the diversification of driving factors plays a positive role in perfecting the innovation system of manufacturing industry of products for the elderly. This is consistent with the multilevel promotion of innovation network formation and policy combination in the field of manufacturing industry policy in recent years, and it also fully reflects the law of diversity of the innovation system.

By comparing the four configurations that affect the manufacturing industry innovation system of products for the elderly, we find that the reasons that affect the industrial innovation system are asymmetric, and the two paths of innovation system failure are not opposite to the two paths of high-performance innovation system. At the same time, the perfection of innovation subject and infrastructure are also asymmetric. That is, the combination of the innovation subject is highly complete, the ability of innovation subject is strong, perfect infrastructure, high interaction efficiency of innovation subject and low locking inertia can promote high-performance innovation system (H1). Although the innovation subject is highly complete and the infrastructure is perfect, the innovation system failure (NH2) can be caused by the combination of weak ability of the innovation subject, the lack of institutional incentives, the low interaction efficiency of the innovation subject and the high locking inertia.

5.4.4. Robustness Test. Configuration thinking adopts an overall and systematic analysis approach, that is, the case-level configuration rather than a single independent variable is used to analyze the results [46]. A given combination of causes may not be the only path to produce a specific result, and other combinations may also produce the same result [47]. In this paper, two path combinations that can produce high-performance innovation system are obtained by fsQCA3.0 software, and when combined with other conditions, the path combination of negative impact of innovation system failure are produced. The proposed algorithm is effective and conforms to the counterfactual and asymmetric properties of the fsQCA method.

In view of the sensitivity of fsQCA analysis results to coding values, it is necessary to carry out a robustness test on the results of the software analysis [38]. This study adjusted the assignment standard of the result variable, namely the innovation performance of the manufacturing industry of products for the elderly. The previous value was 0.8, and we reset it to 0.85. According to the new evaluation standard, we re-evaluate and calculate the data, and find that the software output results are consistent with the previous results. The results of necessity analysis of a single conditional variable show that the consistency and coverage of conditional variables are highly consistent with the previous results. The types of conditional combinations presented by conditional combination analysis are consistent with the previous results, and the overall coverage of combinations is high, which shows that the solutions to achieve high innovation performance and innovation system failure in the manufacturing industry of products for the elderly have good robustness, and can obtain the influence of various factors robustly and explain the path obtained by software.

6. Conclusions and Implications

6.1. Main Conclusions

(1) Based on 22 original innovation cases of the manufacturing industry of products for the elderly, this paper uses grounded theory to extract 6 major influencing factors that affect the innovation system of the manufacturing industry of products for the elderly, namely the completeness of the innovation subject, the ability of innovation subject, the
perfection of infrastructure, institutional incentives, interactive efficiency of innovation subjects, and degree of lock-in inertia. Among them, the completeness of the innovation subject and the strength of the innovation subject’s ability are the main subject factors that affect the product manufacturing industry innovation for the elderly. The perfection of infrastructure and institutional incentives constitute environmental factors. The interaction efficiency and lock-in inertia of the innovation subject are the interactive factors of manufacturing industry of products for the elderly. The S-E-I influencing factor model of manufacturing industry of products for the elderly is constructed.

(2) This paper identifies the configuration of influencing factors of manufacturing industry of products for the elderly corresponding to high performance and innovation failure. Generally speaking, diversified innovation-driven combinations are helpful to improve the performance of products manufacturing industry innovation system for the elderly. Different configurations constitute different influence paths, which are “subject-environment” dual-drive type and “subject-environment-interaction” comprehensive coupling type that help improve the efficiency of product manufacturing innovation system for the elderly. The paths of “resource-oriented type” and “technology-locked type” only pay attention to the driving factors of the completeness of innovation subjects and the completeness of infrastructure or high degree of technology dependence, which makes it difficult to effectively improve the efficiency of products manufacturing innovation system for the elderly.

(3) The ability of the innovation subject and the high interaction efficiency of the innovation subject are the core driving factors to improve the performance of the manufacturing industry innovation system of products for the elderly. Table 3 shows that the ability of the innovation subject and the interaction efficiency of innovation subject are the core conditions that exist in the two high-performance configurations. It can be seen that the ability of the innovation subject and the interaction efficiency of the innovation subject have a significant influence on the innovation system of manufacturing industry of products for the elderly.

6.2. Theoretical Implications. The theoretical contributions of this study are as follows: firstly, this paper enriches and expands the research on manufacturing of products for the elderly. At present, the research on product manufacturing industry for the elderly is still in the exploratory stage. Most of the existing studies focus on the description of the current situation of the manufacturing industry of products for the elderly in specific areas or explores the influence of single factors on the manufacturing industry of products for the elderly from different perspectives. The influence of industry has neglected the combined effect of multiple factors, and there are even fewer literature on the influencing factors of the products manufacturing innovation system for the elderly. In view of this, this paper explores the influencing factors and paths of products manufacturing innovation system for the elderly in order to break through the limitations of existing research. Secondly, this paper has positive significance for the theoretical development of industrial innovation system. Most of the existing research on industrial types concentrated in high-tech industry or traditional manufacturing industry, but there is no research on industrial innovation system of products manufacturing for the elderly. This study expands the research on industrial innovation system to make up for the gaps in existing research. In addition, in view of the incomplete theoretical framework of the existing products manufacturing industry for the elderly, this paper analyzes the actual problems to refine and identify the influencing factors and their relationship mechanism of products manufacturing industry innovation system for the elderly. The research not only puts forward the configuration path to promote high performance, but also explores the influencing factors that lead to the failure of the innovation system of products manufacturing industry for the elderly from the perspective of failure, and deepens the perfection and failure mechanism of products manufacturing industry innovation system for the elderly. The paper provides a holistic theoretical framework for exploring the products manufacturing industry innovation system for the elderly, which expands the research ideas of perfection of products manufacturing industry innovation system for the elderly. Based on grounded theory and fuzzy set qualitative comparative analysis, this study reveals the complex causal relationship between performance improvement and failure of products manufacturing industry innovation system for the elderly, and expands the research scope of innovation management theory and industrial innovation system theory.

6.3. Practical Implications. This paper guides the government to formulate the combined development strategy of the manufacturing industry of products for the elderly from the perspective of configuration, so as to provide practical support for the development of the manufacturing industry of products for the elderly.

First of all, through qualitative comparative research on fuzzy sets, this paper concludes that the ability of innovation subjects and the interaction efficiency of innovation subjects in the configuration are the core elements to improve the innovation performance of the manufacturing industry of products for the elderly. The government should cultivate perfect innovation subjects of manufacturing industry of products for the elderly, and effectively enhance the core competence of innovation subjects. On the one hand, the government should strengthen the dominant position of enterprises in the manufacturing industry innovation system of product for the elderly, and guide enterprises to cooperate with other innovation entities. Moreover, the government should increase R&D investment in knowledge production.
institutions and provide technical and knowledge support for enterprises. In addition, in order to link basic research with applied research, the government should establish a complete innovative service system, give full play to the role of intermediary service institutions such as industry associations, consulting companies and financial institutions as ties and knowledge bases, and provide knowledge sources and socialized technical and economic services for the products manufacturing industry for the elderly. On the other hand, enterprises should combine science-based learning and experience-based learning to play a complementary and cross-cutting role in promoting innovation. At the same time, we should actively learn from the United States, Japan, Germany and other countries with developed product manufacturing industries for the elderly, and strengthen independent research and development capabilities in order to break through key core technologies.

Secondly, the manufacturing industry of products for the elderly should establish a complete system of incentives, and build an innovative infrastructure for the manufacturing industry of products for the elderly. The government should improve the relevant supporting policy system, set up a special subsidy fund for the development of the manufacturing industry of products for the elderly, and reduce the payment pressure of the elderly's consumption through the national finance, social insurance or social welfare fund. It is necessary to establish a statistical system of industrial data, existing technical standards and other information that match the current development of the manufacturing industry of products for the elderly. In addition, it is necessary to form a product manufacturing industrial cluster with local characteristics for the elderly, and build a standardized industrial innovation platform such as a third-party quality testing and monitoring platform for the elderly, an information sharing platform, a common technology research and development platform and a public experimental platform. In order to break through the demand-side dilemma in the current consumer market of products for the elderly, various industries for the elderly actively hold fairs for products for the elderly, and use the Internet and digital technology to innovate participation methods.

Third, the manufacturing industry of products for the elderly should build a cooperation network of innovation subjects with small world characteristics, and break through inertia locking by using the “out-of-domain” innovation mode. The classical small-world model suggests that most nodes in cyberspace are connected to each other indirectly through several steps of connection with other nodes [48]. Therefore, it is suggested that the products manufacturing enterprises for the elderly should not only establish cooperative relations with the well-known local area networks, but also open up other local area networks, that is, unfamiliar networks to establish links, and form a small-world network for the manufacturing industry of products for the elderly, so as to quickly transmit and share information resources among various innovation subjects and realize the value-added of knowledge. In addition, in view of the fact that the manufacturing industry of products for the elderly in China is still in its infancy, the product innovation activities for the elderly are weak, especially the lack of core technology innovation, and they are facing the dilemma of lock-in failure. Many scholars believe that “out-of-domain” means breaking away from the original interactive relationship and reintegrating industrial boundaries can promote the efficiency and innovation of industrial clusters. Therefore, enterprises can use the “out-of-domain” innovation model to break through the inertial lock of the manufacturing industry of products for the elderly. On the one hand, the manufacturing industry of products for the elderly can weaken the characteristics of localization, carry out cross-regional industrial cooperation and reset the relocation of industrial locations.

On the other hand, the difference between the manufacturing industry of products for the elderly and traditional industries is that it also focuses on humanistic emotions. Therefore, in order to accurately locate the needs of elderly users, the manufacturing industry of products for the elderly should integrate ergonomics, gerontology, psychology and other related fields across borders in design and research and development, and expand similar industries in upstream and downstream industrial chains.

6.4. Limitations and Future Research. The research still has the following limitations: Based on the collected cases of 22 industries in the manufacturing industry of products for the elderly, this paper refines the influencing factors of the manufacturing industry innovation system of products for the elderly. Due to the limitation of case detail and cases number, the number of antecedents proposed in this paper is limited to some extent. In the follow-up, we can expand the conditional variables from different theoretical perspectives and build a more comprehensive model to explore the influence of configuration effects among factors on the manufacturing innovation system of products for the elderly, so as to reveal the formation mechanism of improving high-performance innovation system more comprehensively. In addition, limited by the length of the paper, this study does not deeply explore the reasons for the failure of the path configuration of the manufacturing industry innovation system of products for the elderly, which can be further discussed in the future. The effectiveness of the strategies proposed in this paper can be measured by policy experiments, but is also limited by space. In future research, strategy simulation experiments can be carried out according to various scenarios such as optimistic and mesoscopic, and appropriate countermeasures and suggestions can be designed.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.
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References

[1] F. Kohlbacher, C. Herstatt, and N. Levsen, “Golden opportunities for silver innovation: how demographic changes give rise to entrepreneurial opportunities to meet the needs of older people,” Technovation, vol. 39-40, pp. 73–82, 2015.

[2] H. Moody, “Silver industries and the new aging enterprise,” Generations, vol. 28, no. 4, pp. 75–78, 2004.

[3] S. H. Lee, A. W. Mason, and D. Park, “Why does population aging matter so much for Asia? population aging,” Economic Growth, and Economic Security in Asia, Social Science Electronic Publishing, vol. 67, p. 284, 2011.

[4] R. R. Kato, “Government deficit, public investment, and public capital in the transition to an aging Japan,” Journal of the Japanese and International Economics, vol. 16, no. 4, pp. 462–491, 2002.

[5] A. R. Harris, W. N. Evans, and R. M. Schweb, “Education spending in an aging America,” Journal of Public Economics, vol. 81, no. 3, pp. 449–472, 2001.

[6] A. Martin-Matthews and L. Mealing, “Editorial: realizing the vision. The Canadian longitudinal study on aging as a strategic initiative of the Canadian institutes of health research,” Canadian Journal on Aging/La Revue canadienne du vieillissement, vol. 28, no. 3, pp. 209–214, 2009.

[7] B. Laperche, S. Boutillier, F. Djellal et al., “Innovating for elderly people: the development of geront innovations in the French silver economy,” Technology Analysis & Strategic Management, vol. 31, no. 4, pp. 462–476, 2019.

[8] Z. X. Yang, “Developing China’s aging industry and defining government functions,” Journal of Shanghai University (Social Sciences Edition), vol. 38, no. 3, pp. 105–117, 2021.

[9] L. Li, Y. F. Zhao, and J. Y. Ji, “Study on the coordinated development of aging career and industry under the background of population aging,” Macroeconomic Research, vol. 10, pp. 103–113, 2020.

[10] X. M. Luo, L. C. Huang, K. K. Wang, and Z. Qiao, “Research on competitiveness evaluation of regional emerging,” China Soft Science, vol. 2, pp. 49–58, 2020.

[11] L. C. Huang, J. Li, H. Miao, and F. F. Wu, “Research and development based on the needs of senior technology products,” Technology Economics, vol. 38, no. 1, pp. 19–27, 2019.

[12] Z. F. Wang, “Paths and countermeasures of the transformation and upgrading of the aging industry in China: from the perspective of the supply-side reform,” Scientific Research on Aging, vol. 9, no. 2, pp. 11–24, 2021.

[13] P. Cooke, “Regional innovation systems: competitive regulation in the new Europe,” Geoforum, vol. 23, no. 3, pp. 365–382, 1992.

[14] L. C. Huang, C. W. Liu, H. Miao, and F. F. Wu, “Thoughts on population aging based on innovation,” China Soft Science, vol. 341, no. 5, pp. 6–15, 2019.

[15] J. Coughlin, T. Sheridan, and V. Shepard, “Technology and aging: promises and challenges,” The Gerontologist, vol. 42, p. 252, 2002.

[16] W. Kearns, “Gerontechnology is it time for regulation?” Gerontotechnology, vol. 16, no. 2, pp. 63–64, 2017.

[17] A. Peine, I. Rollwagen, and L. Neven, “The rise of the ‘innosumer’-Rethinking older technology users,” Technological Forecasting and Social Change, vol. 82, pp. 199–214, 2014.

[18] J. L. Zheng, “Survey and policy recommendations on the development of the intelligent health service industry for the elderly in Foshan,” China Business Forum, vol. 9, pp. 122–124, 2017.

[19] K. Chen and A. H. S. Chan, “Predictors of gerontechnology acceptance by older Hong Kong Chinese,” Technovation, vol. 34, no. 2, pp. 126–135, 2014.

[20] O. Bock, K. Engelhard, P. Guardiera, H. Allmer, and J. Kleinert, “Gerontechnology and human cognition,” IEEE Engineering in Medicine and Biology Magazine, vol. 27, no. 4, pp. 23–28, 2008.

[21] C. Lee and J. F. Coughlin, “PERSPECTIVE: older adults’ adoption of technology: an integrated approach to identifying determinants and barriers,” Journal of Product Innovation Management, vol. 32, no. 5, pp. 747–759, 2015.

[22] D. Argoud, “Are gerontechnologies a social innovation?” Retraites et Sociétés, vol. 75, no. 3, pp. 31–45, 2017.

[23] V. T. Taipale, “Politics,policies,and gerontechnology,” Gerontechnology, vol. 11, no. 1, pp. 5–9, 2012.

[24] A. Zaidi, “Features and challenges of population ageing: the European perspective,” Policy Brief March, vol. 11, no. 9, pp. 1–16, 2008.

[25] L. Neven, “By any means? Questioning the link between gerontechnological innovation and older people’s wish to live at home,” Technological Forecasting and Social Change, vol. 93, pp. 32–43, 2015.

[26] A. Piu, E. Campo, P. Rumeau, and F. Nourhashemi, “Aging society and gerontechnology: a solution for an independent living?” The Journal of Nutrition, Health & Aging, vol. 18, no. 1, pp. 97–112, 2014.

[27] F. Malerba, “Sectoral systems of innovation and production,” Research Policy, vol. 31, no. 2, pp. 247–264, 2002.

[28] S. Breschi and F. Malerba, “Sectoral innovation systems: technological regimes, Schumpeterian dynamics, and spatial boundaries,” Systems of innovation: Technologies, institutions and organizations, vol. 132, no. 9, pp. 130–156, 1997.

[29] S. Gu, S. S. Schwaag, and B. A. Lundvall, “China’s innovation system: ten years,” Innovation, vol. 18, no. 4, pp. 1–8, 2016.

[30] J. W. Spencer, “Firms’ knowledge-sharing strategies in the global innovation system: empirical evidence from the flat panel display industry,” Strategic Management Journal, vol. 24, no. 3, pp. 217–233, 2003.

[31] D. Z. Yang, X. Y. Miao, and Y. Qiu, “Study on the competitive situation and countermeasures of the development of my country’s integrated circuit industry,” Science Research Management, vol. 42, no. 5, pp. 47–56, 2021.

[32] L. Zhou, Z. X. Zhang, and Z. Yang, “Research on the evolution of industrial innovation system—taking aerospace manufacturing as an example,” Journal of Yangtze University, vol. 43, no. 6, pp. 91–97, 2020.

[33] C. Villar-López and A. Lopez, “Organizational innovation as an enabler of technological innovation capabilities and firm performance,” Journal of Business Research, vol. 67, no. 1, pp. 2891–2902, 2014.

[34] C. Edquist, Systems of Innovation: Technologies, Institutions, and Organizations, Psychology Press, East Sussex, UK, 1997.

[35] W. Bauer and S. Schimpf, “Back to the future: scoping dynamics in industrial innovation,” IEEE Engineering Management Review, vol. 48, no. 2, pp. 72–82, 2020.

[36] Y. Chen, Y. Xu, and Q. Zhai, “The knowledge management functions of corporate university and their evolution: case
studies of two Chinese corporate universities,” Journal of Knowledge Management, vol. 23, no. 10, pp. 2086–2112, 2019.

[37] P. S. Donald, G. K. Hunter, P. A. Cola, and R. J. Boland, “Systems-savvy selling, interpersonal identification with customers, and the sales manager’s motivational paradox: a constructivist grounded theory approach,” Journal of Personal Selling and Sales Management, vol. 38, no. 4, pp. 391–412, 2018.

[38] O. I. Pappas and A. G. Woodside, “Fuzzy-set qualitative comparative analysis (fsQCA): guidelines for research practice in information systems and marketing,” International Journal of Information Management, vol. 58, no. 6, pp. 1–23, 2021.

[39] M. Lu, W. Lei, and Y. Gao, “If there appears a path to improve Chinese logistics industry efficiency in low-carbon perspective? A qualitative comparative analysis of provincial data,” Mathematical Problems in Engineering, vol. 2021, Article ID 9977497, 12 pages, 2021.

[40] A. Elena, T. C. Melewar, and F. Pantea, “Examining the influence of corporate website favorability on corporate image and corporate reputation: findings from fishcam,” Journal of Business Research, vol. 36, no. 1, pp. 1–18, 2018.

[41] P. C. Fiss, “Building better causal theories: a fuzzy set approach to typologies in organization research,” Academy of Management Journal, vol. 54, no. 2, pp. 393–420, 2011.

[42] C. Q. Schneider and C. Wagemann, Set-theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis, Cambridge University Press, Cambridge, MA, UK, 2012.

[43] D. Speldekamp, J. Knoben, and A. Saka-Helmhout, “Clusters and firm-level innovation: a configurational analysis of agglomeration, network and institutional advantages in European aerospace,” Research Policy, vol. 49, no. 3, pp. 103–121, 2020.

[44] Y. Park, P. C. Fiss, and O. A. El Sawy, “Theorizing the multiplicity of digital phenomena: the ecology of configurations, causal recipes, and guidelines for applying QCA,” MIS Quarterly, vol. 44, no. 4, pp. 1493–1520, 2020.

[45] Z. Papamitsiou, I. O. Pappas, and K. Sharma, “Utilizing multimodal data through fsQCA to explain engagement in adaptive learning,” IEEE Transactions on Learning Technologies, vol. 13, no. 4, pp. 689–703, 2020.

[46] O. R. Holsti, Content Analysis for the Social Sciences and Humanities, Addison-Wesley, Boston, USA, 1969.

[47] C. Curado and J. Graça, “Knowledge sharing in catholic organizations,” International Journal of Knowledge Management, vol. 17, no. 3, pp. 31–49, 2021.

[48] S. H. Strogatz, “Exploring complex networks,” Nature, vol. 410, no. 2, pp. 268–276, 2001.