



**International Journal of Technology Management**

ISSN online: 1741-5276 - ISSN print: 0267-5730

<https://www.inderscience.com/ijtm>

---

**Analysis on the production technology innovation and management path of industrial enterprises under the trend of Industry 4.0**

Qing Zhang, Abdul-Rashid Abdullah, Choo-Wei Chong, Mass-Hareeza Ali

**DOI:** [10.1504/IJTM.2023.10052644](https://doi.org/10.1504/IJTM.2023.10052644)

**Article History:**

Received:	09 June 2021
Last revised:	26 July 2021
Accepted:	17 September 2021
Published online:	20 December 2022

---

## **Analysis on the production technology innovation and management path of industrial enterprises under the trend of Industry 4.0**

---

Qing Zhang\*, Abdul-Rashid Abdullah,  
Choo-Wei Chong and Mass-Hareeza Ali

School of Business and Economics,  
University Putra Malaysia,  
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia  
Email: qingzh@36haojie.com  
Email: fenggaoxq@sina.com  
Email: ianhengze@sina.com  
Email: a0Zhangyanzz@outlook.com  
\*Corresponding author

**Abstract:** In order to improve the development of production technology of industrial enterprises, this paper puts forward the analysis method of production technology innovation and management path of industrial enterprises. Based on the characteristics of production technology innovation of industrial enterprises, this paper analyses the existing problems of production technology innovation of industrial enterprises, constructs the evaluation model of production technology innovation ability of industrial enterprises according to the analysis results, and puts forward the corresponding production technology management path of industrial enterprises under the trend of Industry 4.0. The case study shows that this method can effectively reduce production costs, and the efficiency of internal management is always higher than 90%.

**Keywords:** Industry 4.0 trend; industrial enterprises; production technology innovation; management path.

**Reference** to this paper should be made as follows: Zhang, Q., Abdullah, A-R., Chong, C-W. and Ali, M-H. (2023) 'Analysis on the production technology innovation and management path of industrial enterprises under the trend of Industry 4.0', *Int. J. Technology Management*, Vol. 91, Nos. 1/2, pp.53–67.

**Biographical notes:** Qing Zhang obtained her PhD in Management from the Putra University in 2020. Currently, she is a student in the Economic and Business School in Putra University. Her research interests include innovation management, family business sustainability and supply chain.

Abdul-Rashid Abdullah got his PhD diploma in the Hiroshima University. He is a Senior Lecturer in the School of Business and Economics in University Putra Malaysia. His majors are management, human resource management, technology management and tourism management.

Choo-Wei Chong received his PhD in Time Series Analysis and Forecasting from the Oxford University in 2008, Post-doctoral (Management Studies/Decision Science) from University of Oxford in 2011. He is an Associate Professor in the School of Business and Economics in Putra of University. His interests research are forecasting, financial time series analysis,

GARCH, combining forecasts, volatility forecasting, exponential smoothing, smooth transition exponential smoothing, model selection, neural networks and robust methods.

Mass-Hareeza Ali got his PhD diploma at the Huddersfield University, UK in 2008. She is the Director in the Centre of Entrepreneurial Development and Graduate Marketability-CEM Putra University. She is an expert in Business communication and service management.

---

## 1 Introduction

The development of industrial economy has gradually evolved from Industry 1.0 to Industry 4.0, which is a process from mechanisation to intelligentisation. Industry 1.0 is the use of mechanisation to replace traditional industrial technology. Industry 2.0 is mainly based on the era of electrification as the main productivity. Industry 3.0 is automation. In the era, the use of automation, informatisation, computer, aerospace and other high-tech industrial transformations, Industry 4.0 is a brand-new era of intelligence. It is an industrial strategy launched by the German government at the Hannover Messe. After the sub-industrial revolution, through the Internet of Things information system, the procurement, manufacturing, and sales links in the production of industrial enterprises were designed, and the industrial manufacturing information, supply information and sales information were digitised, so that the production technology of industrial enterprises was innovated and the industrial production was reduced. Cost, to improve the technological innovation capabilities of industrial enterprises and the technological level of industrial enterprises under the trend of Industry 4.0. In 2011, China became the world's second largest economic power. However, due to the low level of industrial technology, industrial productivity, and technological innovation, the industrial technology, industrial production and scientific and technological achievements are not as good as some developed countries (Han, 2019). This is because China's industry started late and the production technology innovation is not high. Moreover, Chinese industrial enterprises are labour-intensive enterprises with high costs but low production efficiency. The independent innovation drive is not strong, leading to serious transformation of industrial enterprises and waste of resources. Larger, eventually leading to a large gap between my country's industrial development and industrial development in developed countries, and a large number of enterprises in order to increase the total industrial output value, without considering the problem of environmental pollution, causing serious emissions of air pollutants from industrial pollution sources. Therefore, it is an urgent problem to be solved at present to innovate the production technology of industrial enterprises and analyse the management path (Zhang, 2018).

Literature (Zhou et al., 2020) puts forward the management path analysis method of the 'industrial engineering' technology development of modern enterprise innovation and development. First, it analyses the problems existing between the current industrial enterprise management and the development of manufacturing technology in China, and based on the analysis results, through case analysis, Innovatively explain the production technology of industrial enterprises, use advanced technology of modern industrial design engineering, obtain production technology management measures of industrial

enterprises, and provide technical and decision-making support for industrial enterprise managers. Although the method can effectively improve the management effect of industrial enterprises, the method is less innovative and can not provide the impetus for sustainable development of enterprises. Literature (Zhou, 2018) puts forward an analysis method of industrial enterprise production technology innovation and upgrade path under the trend of Industry 4.0, integrates traditional industrial design data, production data, and operating data through a cyber-physical platform. According to the integration results, digital means, network means and Intelligent means innovate the production technology of industrial enterprises, and manage the production technology platform of industrial enterprises, the production information channels of industrial enterprises, and the production and supply of industrial enterprises under the trend of Industry 4.0, laying the foundation for the upgrading of industrial enterprises. This study provides a long-term path for the development of enterprises by upgrading the production technology of enterprises, but it can not solve the existing bottleneck in the development process of industrial enterprises, and there are some drawbacks. Literature (Zheng, 2018) researches the production technology innovation and management path of industrial enterprises according to the acatech Industry 4.0 maturity index, collects the production technology innovation data of acatech industrial enterprises, constructs the acatech Industry 4.0 maturity model, and proposes the corresponding industry according to the model enterprise production technology management path. This method has a good advantage in the support of innovation data, but the data generated in the process of innovation is not fully available, so it needs further innovation data screening.

In this paper, based on the trend of Industry 4.0, this paper proposes the analysis method of production technology innovation and management path of industrial enterprises. Through analysing the connotation and characteristics of industrial 4.0 backgrounds, and according to the characteristics of industrial enterprise production technology innovation, the problems in development are determined. The specific research route is as follows:

- 1 The connotation and characteristics of Industry 4.0 are analysed.
- 2 The paper analyses the characteristics of industrial enterprise production technology innovation under the trend of Industry 4.0, and analyses the problems existing in the production technology innovation of industrial enterprises according to the characteristics, including the constraints of traditional industrial thinking, the poor independent innovation ability of production technology of industrial enterprises, the weak production technology of industrial enterprises, the lack of technical talents, and the backward marketing mode.
- 3 The evaluation model of the production technology innovation ability of industrial enterprises is established.
- 4 In the trend of Industry 4.0, the corresponding production technology management path of industrial enterprises is proposed.

## **2 Analysis of the connotation and characteristics of Industry 4.0**

Nowadays, people can use big data, cloud computing, wireless interconnection and other technologies to realise the sharing of production information of industrial enterprises, the

transmission of production information of industrial enterprises, and the integration of production information of industrial enterprises through the internet of things. These technologies are exactly what Industry 4.0 has means (Long and Liu, 2020). Use these methods to connect the production information of industrial enterprises with people in real time, transform centralised control into decentralised enhanced control, establish a personalised, digital, and intelligent industrial enterprise production model, and create a brand-new industrial enterprise production model through this model of industrial products belonging to Industry 4.0 (Hong et al., 2019). The five core features of Industry 4.0 are shown in Table 1.

**Table 1** Five core features of Industry 4.0

<i>Name</i>	<i>Introduction</i>
Smart industrial enterprises	Through the end-to-end engineering manufacturing covering manufacturing process and products, the seamless integration of digital and material systems is realised, and the increasingly complex manufacturing process is controllable for staff.
Smart industrial products	It has unique identifiability, communication ability and perception ability. It can understand how it is produced and used, ensure that it plays the best role in the scope of work, confirm its loss degree at any time, and provide information to the intelligent factory.
Direct customer involvement	Customers can directly participate in all stages of product design, construction, reservation, planning, production, operation and recycling, and temporary demand changes can be realised.
Employee positioning	Intelligent manufacturing resource network and production steps can be controlled, adjusted and configured according to the situation and environment sensitive objectives. More focus on innovative and high value-added production activities can achieve better coordination between work and personal needs.
Production equipment	Through the service level agreement to further expand the relevant network infrastructure and specific network quality of service, it can meet the data intensive applications with high bandwidth requirements, as well as the service providers with runtime guarantee.

According to Table 1, Industry 4.0 is an industrial optimisation strategy proposed under German manufacturing. It has five core characteristics, namely smart industrial enterprises, smart industrial products, direct customer participation, employee positioning, and production equipment.

The adoption of the Industry 4.0 strategy can realise the automatic supervision and control of the production equipment and production processes of industrial enterprises, and help industrial enterprises adapt to the innovation of production technology in the shortest time, shorten the time from occurrence to execution, thereby reducing the occurrence of equipment failures in industrial enterprises, The waste of production resources and the production of industrial pollution improve the economic benefits of industrial enterprises (Wang et al., 2019).

### **3 Analysis on the characteristics and problems of production technology innovation of industrial enterprises under the trend of Industry 4.0**

Industrial enterprise production technology innovation is a use of scientific and technological means to transform the production technology of industrial enterprises. This article analyses the production technology innovation of industrial enterprises from the characteristics of industrial enterprise production technology innovation and the problems existing in industrial enterprise production technology innovation under the trend of Industry 4.0. (Kingdom and Du, 2019). Among them, the problems of industrial enterprise production technology innovation include the constraints of traditional industrial thinking, the poor independent innovation ability of my country's industrial enterprises, the weak production technology of industrial enterprises and the lack of technical talents, and the excessively backward marketing models.

#### *3.1 Characteristics of production technology innovation in industrial enterprises*

Generally speaking, industrial enterprises are full of innovative desires, but not all industrial enterprises in all industries are like this. Moreover, the desire of industrial enterprises to innovate does not mean that their innovation efforts can be transformed into an increase in the competitiveness of the enterprise and bring about an increase in profits (Li, 2019b). Through the influencing factors of the profitability of industrial enterprises, it can be seen that the relationship between investment and profit is not great, while the production technology managers of industrial enterprises, independent innovation capabilities of production technology, marketing models, enterprise production technology, and production technical talents of industrial enterprises have an impact on the impact The profitability of industrial enterprises has a large factor (Li, 2019a).

At present is the era of technology commercialisation. Among industrial enterprises, technical talents and leaders are the most valued. The capabilities of both are derived from their own knowledge base and technical capabilities. A good company has the technical capabilities of its managers. Must be strong, and marketing methods must be too strong in order to gain a foothold in the market. Therefore, among the above-mentioned influencing factors, the main factors that affect the profitability of industrial enterprises are enterprise production technology and industrial enterprise production technical personnel. These two factors are industrial and important factor for the success of enterprise technological innovation. The ability of industrial enterprises to develop new products is not inferior to other industries, but they will face greater difficulties in the process of product commercialisation, and market factors should receive more attention than technical factors (Yu, 2020). Furthermore, compared with other enterprises, the production technology innovation system of industrial enterprises has a greater impact on their innovation activities, and suppliers and customers, production quality, and technical capabilities are all powerful conditions for assisting industrial enterprises' production technology innovation (Liu et al., 2019).

Based on the above research, we can summarise the characteristics of industrial enterprise production technology innovation:

- 1 Compared with RD investment, other factors of industrial enterprise production technology innovation, especially the role of entrepreneurs and scientific and technological employees, and the attention to marketing are equally important to the impact of industrial enterprise production technology innovation.
- 2 The production technology innovation of industrial enterprises is inseparable from technical personnel such as industrial technical personnel with high academic qualifications and senior technicians with strong basic knowledge.
- 3 Industrial enterprise leaders are the core of industrial enterprise production technology innovation. Therefore, talents with HR experience, advanced industrial technology level, strong sense of responsibility, and high marketing ability are selected as industrial enterprise leaders, so that they can win other enterprises in technology.
- 4 The production technology innovation system of industrial enterprises has a greater impact on their innovation activities, and suppliers and customers, production quality, and technical capabilities are powerful conditions for assisting industrial enterprises' production technological innovation. Good communication with suppliers and users can strengthen industrial enterprise production. The realisation of technological innovation.
- 5 Industrial enterprises are more focused on producing products for special field markets, rather than producing products for large-scale markets.
- 6 Industrial enterprises have frequent contacts with the outside world (Hou et al., 2018).

### *3.2 Problems existing in production technology innovation of industrial enterprises*

Based on the above-mentioned characteristics of production technology innovation of industrial enterprises, analyse the main problems in the production technology innovation of my country's industrial enterprises under the trend of Industry 4.0, including the constraints of traditional industrial thinking, the poor independent innovation ability of industrial enterprises' production technology, and the weak production technology of industrial enterprises and the lack of technical talents. If the problems in these four areas are not paid attention to and cannot be solved, it will inevitably produce many unfavourable factors for the production technology innovation of my country's industrial enterprises.

#### *3.2.1 Bound by traditional industrial thinking*

With the popularisation of the Internet, netizens have exploded, and the areas covered by the internet have gradually expanded to the industrial category. Due to the constraints of traditional industrial thinking, the thinking of production technicians in some industrial enterprises still stays at Industry 2.0 and Industry 3.0. Industry 2.0 and Industry 3.0 model to conduct market research, and some industrial enterprise production technicians did not obtain the research market demand information and began to involve, produce, process, and sell industrial products, which eventually led to consumers being forced to

accept Industry 2.0 and industry. With 3.0 strategy products, consumers are dissatisfied with the appearance and function of the product to give feedback to industrial enterprises, and enterprises get feedback in time, and it takes a long time to innovate the production technology of industrial enterprises. Moreover, industrial enterprises are different from large state-owned enterprises in that their strength is relatively low. Even if they carry out technological innovations in industrial enterprises, it is relatively difficult. The final products produced are inconsistent with consumer preferences, causing industrial enterprises to face a large amount of surplus inventory (Sun, 2019).

### *3.2.2 My country's industrial enterprises have poor capacity for independent innovation in production technology*

Due to the small scale of my country's industrial enterprises and the lack of funds, the lack of funding for scientific research on industrial production technology has led to unsatisfactory scientific research results, low R&D capabilities, and lack of professional technical personnel, resulting in a relatively high capacity for independent innovation of production technology in my country's industrial enterprises (Wang, 2019). According to the survey, my country's industrial enterprises are technologically backward, and most industrial enterprises still need to rely on foreign technical support to produce parts and technologies, such as circuit chips and nano-chips. They lack advanced materials, stacking manufacturing and other industrial enterprises' production technology independent innovation. The independent innovation ability of industrial enterprises' production technology is a problem that needs to be solved urgently in our country.

### *3.2.3 Industrial enterprises have weak production technology and lack of technical personnel*

At the beginning of the reform, the state advocated self-employment, which led to a gradual increase in the number of industrial enterprises. However, due to the small investment, small scale, lack of technical personnel, and technology cannot keep up with the trend, most industrial enterprises are low-end industries, resulting in a gradual increase in the number of industrial enterprises. The development of industrial enterprises in my country is slow. Only a small number of industrial enterprises in my country have scientific and technological research and development institutions, while most industrial enterprises in developed countries have their own research and development institutions, and my country does not pay attention to scientific research and technical personnel in industrial enterprises, resulting in a relatively small number of scientific research personnel and a serious lack of high-quality industrial enterprises high-tech talents. My country developed industrial robots only when automated production began in foreign countries. Weak production technology and lack of technical talents are the main factors leading to slower production technology innovation in industrial enterprises, and they also limit the production technology innovation of my country's industrial enterprises. The fundamental issue of development (Zhao and Zhao, 2018).

### *3.2.4 The marketing model is too backward*

The continuous development of technology has created a phenomenon that netizens have gradually increased. The masses have begun to shift their shopping models to the

Internet. Online shopping marketing has been strongly sought after by consumers and has become the mainstream of sales. Netizens observe the credibility and transaction volume of the product through the Internet, and will eventually choose the buyer with the highest credibility and the best performance to place an order. However, due to the lack of understanding of the internet by the current industrial enterprises, their thinking is still stuck in the pre-Industry 4.0 sales model. Although the sales performance is considerable, compared with Internet marketing, the sales performance is quite different, and the company's own financial resources are weak. Being too backward has caused the marketing model of industrial enterprises to fail to keep up with the trend of the times (Wang, 2020).

#### 4 Evaluation of production technology innovation ability of industrial enterprises

Based on the above-mentioned analysis of the characteristics of production technology innovation of industrial enterprises and the problems existing in the production technology innovation of industrial enterprises, this paper constructs the evaluation index system of production technology innovation ability of industrial enterprises, and obtains the evaluation indicators that affect the production technology innovation ability of industrial enterprises.

**Table 2** Evaluation index system of production technology innovation ability of industrial enterprises

<i>First level indicators <math>C_i</math></i>	<i>Secondary indicators <math>C_{ij}</math></i>
Innovation environment $C_1$	Employees' desire for innovation $C_{11}$
	Enterprisers' initiative and foresight in innovation $C_{12}$
	Enterprise financial resources
	Government support $C_{13}$
Innovation management $C_2$	Can we build a strong cooperation alliance $C_{14}$
	Rationality of organisation $C_{21}$
	Proportion of new product projects $C_{22}$
	Adoption rate of modern manufacturing technology $C_{23}$
	Innovation frequency $C_{24}$
	Proportion of employees with bachelor degree or above $C_{25}$
Innovation investment $C_3$	Investment in information management
	Ability to acquire technology resources and explore technology direction $C_{26}$
	Input intensity $C_{31}$
	Non input intensity $C_{32}$
	Staff training input intensity $C_{33}$
Innovative marketing $C_4$	Technology purchase $C_{34}$
	Proportion of R&D personnel $C_{35}$
	Understanding of users $C_{41}$

**Table 2** Evaluation index system of production technology innovation ability of industrial enterprises (continued)

First level indicators $C_i$	Secondary indicators $C_{ij}$
Innovative marketing $C_4$	Distribution network $C_{42}$
	Market share of new products $C_{43}$
Innovation output $C_5$	Technical level index $C_{51}$
	Proportion of new product revenue $C_{52}$
	Number of awards for scientific and technological achievements $C_{53}$

According to the evaluation index system of production technology innovation ability of industrial enterprises constructed above, the evaluation indexes of production technology innovation ability of industrial enterprises are obtained (Jia and Su, 2019). Then analyse the relationship between the indicators and create a hierarchical structure:

$$C = \{C_1, C_2, C_3, C_4, C_5\} \tag{1}$$

Compare the importance of the production technology innovation capability evaluation index  $i$  of the two industrial enterprises at one level with the importance level of the production technology innovation evaluation index  $j$  of the industrial enterprise at the previous level, and construct a judgment matrix  $B$  based on the comparison results. The expression is:

$$B = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1j} \\ b_{21} & b_{22} & \cdots & b_{2j} \\ \vdots & \vdots & \vdots & \vdots \\ b_{i1} & b_{i2} & \cdots & b_{ij} \end{bmatrix} \tag{2}$$

In the formula,  $b_{ij}$  represents the degree of influence of industrial enterprise production technology innovation ability evaluation  $i$  on  $j$ .

Use the sum-product method to normalise all the judgment indicators in  $B$ , and the processed matrix expression is:

$$B' = b'_{ij} = \frac{b_{ij}}{\sum_{i=1}^n b_{ij}} \tag{3}$$

Add matrix  $B'$  by row to get matrix  $W$ :

$$W = \sum_{j=1}^n b'_{ij} \tag{4}$$

The above results are normalised, and the analytic hierarchy process is used to calculate the weight of the evaluation index of the production technology innovation ability of industrial enterprises based on the normalised results:

$$W' = \frac{W}{\sum_{i=1}^n W} \tag{5}$$

According to the above formula, obtain the weight coefficient  $\gamma$  of each indicator:

$$\gamma = \frac{1}{2} \frac{W'}{\sum_{i=1}^n W'} \quad (6)$$

Construct an evaluation model for the production technology innovation capability of industrial enterprises:

$$C = \gamma C B i \quad (7)$$

According to the evaluation index system of production technology innovation ability of industrial enterprises constructed above, the evaluation indexes affecting the production technology innovation ability of industrial enterprises are obtained.

## 5 Production technology management path of industrial enterprises under the trend of Industry 4.0

According to the evaluation model of production technology innovation capacity of industrial enterprises constructed above, the corresponding production technology management path of industrial enterprises is proposed under the trend of Industry 4.0.

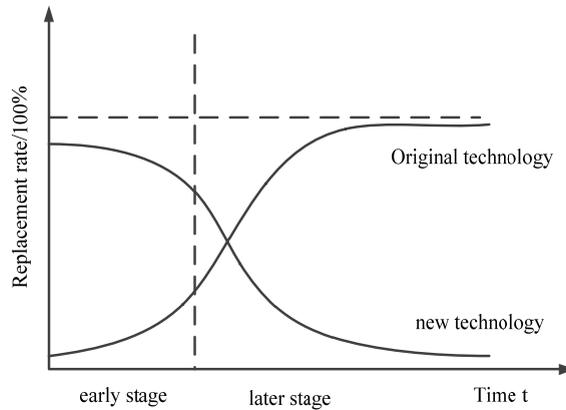
### 5.1 Must insist on independent innovation

The key to determining the height of national industrial enterprises lies in the level of technological research and development of independent innovation. ‘Technology can bring hope to poor countries, but the power of technology will also create poverty traps.’ Possession of 330 core technology is definitely a magic weapon for industrial enterprises to win. If independent innovation is lost, it will only blindly imitate other countries’ technology. The country fell into path dependence, was captured by developed countries, and further widened the technological gap with developed countries, thus entering the ‘low-end lock-in’ situation that could not be broken. Constructing a mathematical model of predictive technology replacement for technological change, that is, the research on the speed of replacement of original technology by new technology. Taking into account that technological progress is competitive, substitutable and related, it is mathematically

expressed as:  $\frac{1}{f} = \frac{df}{dt} = 2a(1-f)$ . When the original technology has the characteristics

of economies of scale, if a new technology enters the market during this period, it will not have any impact on the original technology. The crowding-out effect, on the contrary, the obsolescence of the original technology in the early stage is not significant. However, when the new technology matures and realises its economic scale, with the expansion of the technology scale and the improvement of the degree of progress, the original technology will no longer increase its market share, and there will be a downward trend (Li et al., 2019). In the later stage, the original technology will continue to decline or even be completely replaced. The new and old technology replacement curve is shown in Figure 1.

**Figure 1** Curve of replacement of new and old technologies



According to this model, combined with my country’s specific development conditions, it can be pointed out that the production technology development path of my country’s industrial enterprises must consider the needs of different technological development times and levels to formulate different types of independent innovation-driven paths.

### *5.2 Strengthen the main body construction of industrial enterprises*

The primary condition for the technological innovation of industrial enterprises in my country is to strengthen the main body construction of industrial enterprises and invest heavily in technological innovation research. At present, many foreign patented products are obtained through a large number of scientific research and industrial technological achievements. Therefore, industrial enterprises in my country should have talents. On the basis of training, establish a high-standard and high-efficiency research base, and conduct innovative research on industrial production technology through the research base. Technicians discuss scientific research products through academic exchange platforms, aiming to improve the production technology innovation capabilities of industrial enterprises. In addition, under the trend of Industry 4.0, Chinese industrial enterprises also need to learn from foreign industrial production equipment, strengthen industrial supporting capabilities, and create a brand-new and efficient industrial enterprise chain system to improve the coordination between upstream and downstream enterprises, so that business flows, Logistics and capital flow are unified.

### *5.3 Establish a diversified investment landscape*

Industrial enterprise production technology innovation requires a large amount of scientific research funds. Therefore, the establishment of a diversified investment pattern under the trend of Industry 4.0 can enhance the economic development of industrial enterprises, enhance their competitiveness, and ensure the development of industrial enterprise production technology innovation activities. The government should establish a research and development platform for special funds for independent innovation to support the production technology innovation projects of industrial enterprises, increase the use value of special funds, and solve the problem of lack of funds for industrial enterprises in production technology innovation. In addition, the government needs to

attract investment from international capital, so that Chinese enterprises can inject international capital, further enhance the production technology innovation capabilities of industrial enterprises, and make my country's strength closer to developed countries.

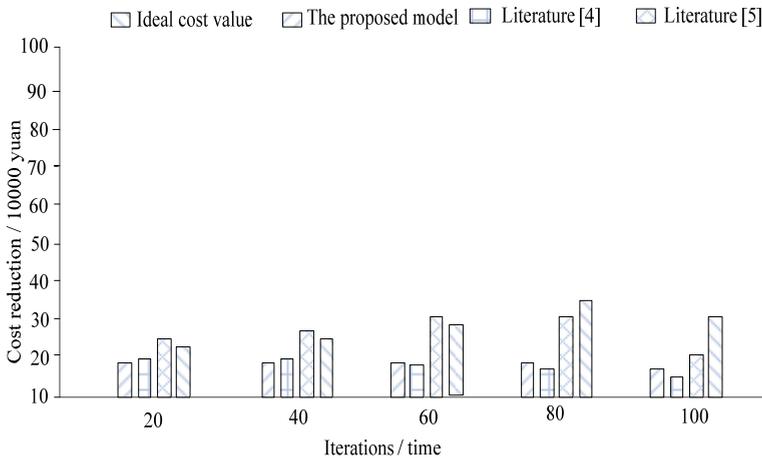
## 6 Case analysis

In order to verify the effectiveness of the production technology innovation and management path of industrial enterprises under the trend of Industry 4.0, this paper conducts a six-month experimental analysis on a small and medium-sized enterprise. At the same time, this paper studies the effectiveness of the enterprise's production technology innovation and management with the methods of this paper, literature (Zhou, 2018) and literature (Zheng, 2018). In the experiment, the six departments of the enterprise are divided into three groups, each group includes two departments, and the production efficiency and output of the three groups of departments are relatively consistent, which meets the data guarantee of the experiment. Three groups of corresponding research methods, literature (Zhou, 2018) and literature (Zheng, 2018) method are trained respectively, and the production cost and management efficiency of enterprises are taken as experimental indicators for comparative analysis. Among them, the initial values of the three groups of production costs set in the enterprise production cost are consistent, and the enterprise management efficiency is measured by percentage.

### 6.1 Analysis of enterprise production cost under different methods

In the experiment, the method of this paper, the method of literature (Zhou, 2018) and the method of literature (Zheng, 2018) are controlled for 6 months, and the results are shown in Figure 2.

**Figure 2** Production cost control results under different methods (see online version for colours)



By analysing the data in Figure 2, it can be seen that with the continuous change of iteration times, there are some differences in the effect of the research method, literature (Zhou, 2018) method and literature (Zheng, 2018) method on the production cost control of sample enterprises. Among them, the control result of this method is the closest to the ideal value, and with the constant change of the number of iterations, the control effect of this method is lower than the ideal result, which shows that this method has a certain effect. Although the cost of the other two methods is also in a reasonable range, there is still a certain gap from the ideal value. In contrast, the proposed method has better effect on enterprise production cost control.

### 6.2 *Analysis of enterprise production management efficiency under different methods*

In order to further verify the feasibility of the proposed method, this paper uses the method of this paper, the method of literature (Zhou, 2018) and the method of literature (Zheng, 2018) to analyse the overall efficiency of the three methods on enterprise management through a six-month management and control, including cost, performance and production efficiency as comprehensive indicators

**Table 3** Comparison of enterprise production management efficiency under different methods

<i>Iterations/times</i>	<i>Method of this paper</i>	<i>Literature (Zhou, 2018)</i>	<i>Literature (Zheng, 2018)</i>
20	95	89	87
40	94	85	84
60	95	86	89
80	93	84	84
100	95	87	86

By analysing the data in Table 3, we can see that there is a difference in the overall efficiency of enterprise management by using three methods for the cost, performance and production efficiency of sample enterprises. Among them, the overall control efficiency of this method is always higher than 90%, and the result of control efficiency is relatively stable, while the management efficiency of the other two methods is always lower than that of this method. This is because this method analyses the problems existing in the production technology innovation of industrial enterprises, and constructs the evaluation model of production technology innovation ability of industrial enterprises according to the analysis results, Under the trend of Industry 4.0, the corresponding production technology management path of industrial enterprises is proposed, which effectively improves the effectiveness of the method.

## 7 **Conclusions**

Based on the trend of Industry 4.0, this paper puts forward an analysis method of industrial enterprise production technology innovation and management path. Analyse the characteristics of industrial enterprise production technology innovation, and analyse existing problems based on their characteristics, including the constraints of traditional

industrial thinking, the poor independent innovation ability of industrial enterprises' production technology, the weak production technology of industrial enterprises, the lack of technical talents, and the excessively backward marketing models. Four aspects, on this basis, through the establishment of an evaluation index system for the production technology innovation capability of industrial enterprises, to obtain evaluation indicators that affect the production technology innovation capability of industrial enterprises, and use the analytic hierarchy process to construct an evaluation model for the production technology innovation capability of industrial enterprises. Under the current trend, it is necessary to insist on independent innovation, strengthen the main body construction of industrial enterprises, and establish a diversified investment pattern, such as the production technology management path of industrial enterprises.

## References

- Han, J. (2019) 'Case comparison and path innovation of intelligent manufacturing development in China', *Technical Economy and Management Research*, Vol. 270, No. 1, pp.90–97.
- Hong, Z., Zhang, Z. and Lin, W. (2019) 'Key technologies of industry 4.0 and intelligent manufacturing: industrial internet of things and artificial intelligence', *New Knowledge of Scientific Instruments*, Vol. 2019, No. 221, pp.19–25.
- Hou, W., Wang, P. and Liang, L. (2018) 'The road of China's industry 4.0', *Shanghai Auto*, Vol. 43, No. 9, pp.1–3.
- Jia, C. and Su, W. (2019) 'Analysis of digital transformation path of manufacturing industry in Germany and Germany', *Information Technology and Standardization*, Vol. 2019, No. 6, pp.43–46.
- Kingdom, L. and Du, Y. (2019) 'German industry 4.0 and the development of intelligent manufacturing of coal machinery and equipment in China', *Coal Science and Technology*, Vol. 47, No. 3, pp.1–9.
- Li, J. (2019a) 'Analysis of innovation capability of industrial enterprises in Guangxi', *Journal of Wuzhou University*, Vol. 29, No. 1, pp.6–14.
- Li, J. (2019b) 'The measurement and path of innovation activities of Chinese enterprises in the process of new industrial revolution', *Journal of Zhongnan University of Economics and Law*, Vol. 39, No. 5, pp.31–42.
- Li, W., Zhang, J., Lin, S., Han, F., Zhou, X. and Sun, Y. (2019) 'Development path of surface autonomous ship technology', *Ship Engineering*, Vol. 41, No. 7, pp.74–83.
- Liu, F., Sun, Y., Chen, J., Lai, C., Liu, X. and Li, Y. (2019) 'Research on the strategy of accelerating the transformation of manufacturing industry to intelligent manufacturing under the background of industry 4.0 in the new era', *Guangdong Economy*, Vol. 272, No. 3, pp.74–83.
- Long, D. and Liu, W. (2020) 'Research on the path to improve the intelligent development level of equipment manufacturing industry in Liaoning Province', *Modern Management*, Vol. 10, No. 1, pp.89–94.
- Sun, H. (2019) 'Research on application path of new generation artificial intelligence technology in German industry 4.0', *Outlook of Global Science and Technology Economy*, Vol. 34, No. 7, pp.37–46.
- Wang, P. (2019) 'The path of manufacturing innovation from the perspective of global industrial change', *China's Industry and Informatization*, Vol. 18, No. 11, pp.38–40.
- Wang, X., Liu, J. and Liu, X. (2019) 'Reflections on the cultivation of industrial engineering talents under the background of industry 4.0 and intelligent manufacturing', *Education and Teaching Forum*, Vol. 419, No. 25, pp.263–264.

- Wang, Y. (2020) 'Starting from the investment port of technological transformation', *China's Industry and Informatization*, Vol. 20, No. Z1, pp.68–71.
- Yu, L. (2020) 'Analysis of the transformation and upgrading path of Jiangsu manufacturing industry under the background of 'industry 4.0'', *Modern Marketing*, Vol. 2020, No. 10, pp.176–177.
- Zhang, J. (2018) 'New path of human resource management in manufacturing industry in the process of industry 4.0', *Liaoning Economy*, Vol. 410, No. 5, pp.52–53.
- Zhao, Z. and Zhao, Y. (2018) 'Consideration and countermeasures of industrial process personnel training mode', *Information Recording Materials*, Vol. 19, No. 10, pp.160–162.
- Zheng, W. (2018) 'Research on digital transformation path of manufacturing enterprises – based on acatech industry 4.0 maturity index', *Technology and Economy*, Vol. 31, No. 4, pp.51–55.
- Zhou, X. (2018) 'Research on the transformation and upgrading path of China's manufacturing industry based on industry 4.0', *Economist*, Vol. 47, No. 10, pp.25–26.
- Zhou, Z., Jiang, S., Gao, F., Wang, F., Zhu, L. and Chen, S. (2020) 'Research on the management path of 'industrial engineering' technology development promoting the innovation and development of modern enterprises', *Hunan Agricultural Machinery*, Vol. 37, No. 1, pp.38–39, p.41.