Open Access Library Journal
2023, Volume 10, e10256
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Research on Enterprise Management in Intelligent Manufacturing Industry

Lingran Lin, Jialan Wu, Xinyue Mou

College of Education, Zhejiang Normal University, Jinhua, China
Email: 2535327101@qq.com

How to cite this paper: Lin, L.R., Wu, J.L. and Mou, X.Y. (2023) Research on Enterprise Management in Intelligent Manufacturing Industry. *Open Access Library Journal*, **10**: e10256.
https://doi.org/10.4236/oalib.1110256

Received: May 15, 2023
Accepted: October 28, 2023
Published: October 31, 2023

Abstract

The manufacturing industry is moving towards a new stage of system reconstruction, and intelligent manufacturing has become a new track for manufacturing enterprises to transform and leap forward. In the wave of changing times, how to build its own ecosystem and flourish in the industry is a question that every enterprise needs to think about. Yalong Intelligence, as a manufacturing, service-oriented and innovative intelligent manufacturing enterprise, not only has more than 30 years of experience in developing and manufacturing intelligent equipment, providing professional intelligent equipment, intelligent units and industrial software, and becoming a demonstration base of the national key R&D program for intelligent robot key special institutions; or providing enterprises with intelligent technological reform diagnosis and consultation, digital upgrading, intelligent transformation projects, intelligent equipment and industrial software, etc. It is an intelligent manufacturing system supplier recognized by the Ministry of Industry and Information Technology. With its strong technical capability, massive product resources and wide circle of partners, Yalong has the initial conditions to build its own ecosystem. Therefore, Yalong Intelligence is selected as the object of this case study, aiming to analyze the process of building Yalong's intelligent manufacturing innovation ecosystem through various aspects such as theory and model. Based on literature and research, this paper uses explanatory phenomenology to refine the factors of Yalong Intelligent Manufacturing Innovation Ecosystem and constructs Yalong Intelligent Manufacturing Innovation Ecosystem Explanatory Structure Model (ISM). And further analyze the conditions and paradigm of the formation of Yalong intelligent ecosystem from the aspects of driving force, strategic resources, capability base and strategic posture of the innovation ecosystem to provide reference experience for the intelligent development of China's engineering manufacturing industry.

Subject Areas

Business Management

Keywords

Yalong Intelligent, Manufacturing, Innovation Ecosystem, Ecological Advantages

1. Research Background

At present, the new round of global scientific and technological revolution and industrial change is advancing deeply, and the country has put forward the new development concept of innovation, coordination, green, openness and sharing to jointly grasp the opportunities of digitalization, networking and intelligent development, so that the deep integration of informationization and industrialization can bring infinite possibilities for the innovation and butterfly transformation of Chinese industry [1]. The manufacturing industry is the mainstay of the national economy, the foundation of the country, the instrument of the country's prosperity and the foundation of the country's strength. To take the new road of industrialization with Chinese characteristics, to accelerate the deep integration of a new generation of information technology and manufacturing industry as the main line, accelerate the development of a new generation of information technology and manufacturing technology integration, intelligent manufacturing as the main direction of the deep integration of the two; focus on the development of intelligent equipment and intelligent products, promote the intelligence of the production process, cultivate new production methods, and comprehensively improve the intelligence of enterprise R&D, production, management and service level.

From the perspective of market demand, the market demand of intelligent manufacturing industry shows a blowout growth and the market scale keeps expanding [2]. The main contradiction of the current development of intelligent manufacturing industry is the contradiction between the urgent demand of intelligent transformation of manufacturing industry and the insufficient supply capacity of intelligent manufacturing industry. China is the largest manufacturing industry in the world, and the intelligent manufacturing market will also be the largest, fastest growing and most complex market in the world. In addition, China's manufacturing fixed asset investment has maintained positive growth in recent years. The sustained boom of the industry will also promote the continuous improvement of the technical capacity of manufacturing enterprises and the orderly release of production capacity, thus promoting the certainty of the company's performance and the improvement of economic efficiency.

2. Smart Manufacturing Enterprise Innovation Ecosystem

The manufacturing industry is moving towards a new stage of system reconstruc-

tion, and smart manufacturing has become a new track for manufacturing enterprises to transform and leap forward. Smart manufacturing enterprises combine advanced information technology and intelligent manufacturing equipment, connecting production equipment internally and supply chain and service chain externally [3]. As a complex system intersected by multiple subsystems, the innovation ecosystem interacts with each other and dynamic coordination is the key to the stable and sustainable development of the system. The innovation ecosystem is the engine that accelerates the pushing out of knowledge innovation and the successful transformation of knowledge, and is a new pattern formed in the process of the deep integration strategy of industry-university-research. There are three main fields after the formation of innovation ecosystem: knowledge field, business field and environmental field. The center of the innovation ecosystem is the knowledge field, the knowledge circle formed by the natural science composed of engineering knowledge, technical knowledge, scientific knowledge, etc. and the social science composed of humanistic knowledge, artistic knowledge, market knowledge, etc. The two promote the continuous innovation and upgrading transformation of knowledge through deep integration and dynamic synergy. There are many criteria for dividing innovation ecosystem, and the most representative one is divided into regional innovation ecosystem, enterprise innovation ecosystem and industrial innovation ecosystem according to research objects.

3. Case Selection

This study applies the exploratory case study method and adheres to the principle of problem-oriented sample selection, and selects Yalong manufacturing industry as the research sample. Ltd. is located in Yongjia Industrial Park, Wenzhou City, Zhejiang Province. Founded in 1983 and established in 2008, Yalong Intelligence is a leading enterprise in the domestic education equipment industry with the mission of "striving to bring technology and skills to more people around the world". For more than 30 years, Yalong Intelligence has been insisting on the road of technological innovation, providing the overall solution service of "doing, learning and teaching" talent training for China's engineering education, vocational education, science and technology museums, industry enterprise training centers, etc. It is a national high-tech enterprise, national intellectual property advantageous enterprise, innovative enterprise in Zhejiang Province, and one of the top ten tax-paying enterprises in Yongjia County. It is a national high-tech enterprise, national intellectual property advantage enterprise, innovative enterprise of Zhejiang Province, and top ten tax-paying enterprise of Yongjia County.

4. Influencing Factor Association

We will analyze the factors influencing Yalong Smart's "Smart Manufacturing Enterprise Innovation Ecosystem" model from the following 10 aspects: strategic positioning, social atmosphere, technology support, open innovation platform,

talent training, market pull, value co-creation, industry-education integration, resource integration and coordination, and corporate culture, which can objectively reflect the construction process of Yalong Smart's Smart Manufacturing Enterprise Innovation Ecosystem (Figure 1).

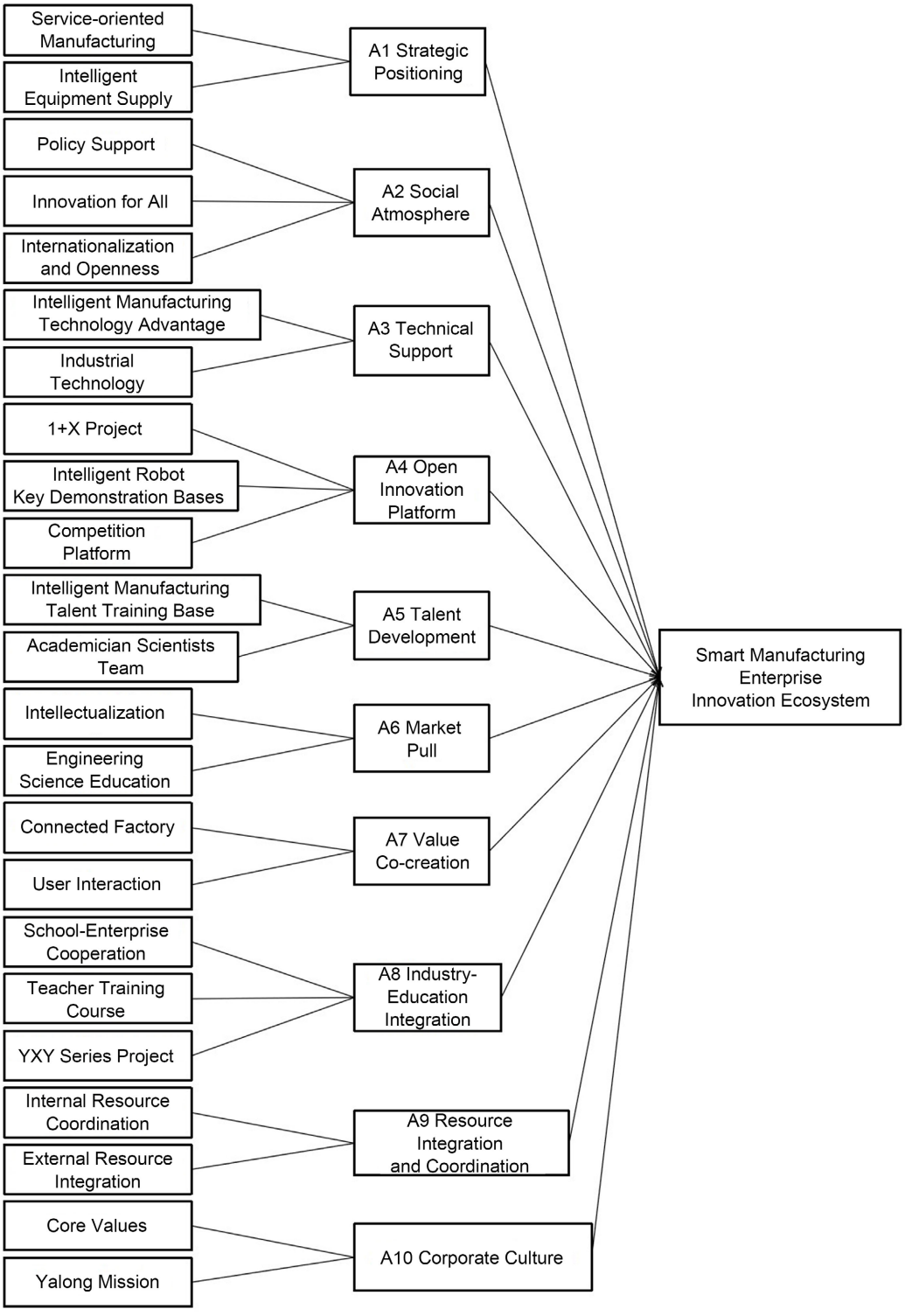

Figure 1. Yalong Smart's "Smart Manufacturing Enterprise Innovation Ecosystem" model.

5. Binary Relationship Analysis

According to the investigation and study of the innovation ecosystem model of Yalong intelligent manufacturing enterprises and the establishment of the explanatory structure model, it is necessary to determine the adjacency relationship between each influencing factor and each other. 10 elements have mutual relationship with each other, and binary analysis is conducted for each two elements in turn, and there are four types of transitions: one is a one-way relationship between factor A and factor B; one is a one-way relationship between factor B and factor A; three is a two-way relationship between factor A and factor B; four is no influence between factor A and factor B. There is a two-way influence between factor A and factor B; fourth, there is no influence between factor A and factor B. Through the refinement and purification of the literature and the implementation of the steps of the explanatory structural model, the 10 influential factors were arranged sequentially in rows and columns to establish the adjacency matrix, as shown in Table 1.

6. Modeling the Explanatory Structure and Its Application

6.1. Generate Adjacency Matrix

In a system we use the adjacency matrix $A=\left(a_{ij}\right)_{m*n}$ to indicate the direct influence relationship to determine whether there is a direct influence factor between the factors in the influence set. We stipulate: if S_i has influence on S_j, the element a_{ij} is assigned as 1; if S_i has no influence on S_j, the element a_{ij} is assigned as 0.

$$a_{ij}=\begin{cases}1 \text{ if } S_i \text{ has influence on } S_j\\ 0\ S_i \text{ has no influence on } S_j\end{cases}$$

Then the adjacency matrix generated by the combined results of the expert judging relationship obtained by combining the development status and information details of Yalong Intelligence is shown in the following Figure 2:

Table 1. Matrix of logical relationships of factors affecting the innovation ecosystem of Yalong smart manufacturing enterprises.

	A1	A2	A3	A4	A5	A5	A7	A8	A9	A10
A1	0	0	0	1	0	0	1	1	0	0
A2	0	0	0	0	0	0	0	0	0	1
A3	0	0	0	1	0	0	1	1	0	0
A4	0	0	0	0	0	0	0	0	0	0
A5	0	0	1	0	0	0	1	1	0	0
A5	1	0	0	0	0	0	0	1	1	1
A7	0	0	0	0	0	0	0	0	0	0
A8	0	0	0	0	0	0	0	0	0	0
A9	1	0	1	1	0	0	0	0	0	0
A10	1	0	0	0	1	0	1	0	0	0

$$A = \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

Figure 2. Adjacency matrix.

6.2. Generate Reachable Matrix

The reachability matrix is a matrix that describes the extent to which the nodes of a directed graph can be reached after a certain length of pathway between them [4]. Both the adjacency matrix and the reachability matrix can represent the relationship between the elements, but the former can only reflect the direct relationship between the elements, while the latter can reflect the direct and indirect relationship between the elements, and the reachability matrix can help us further clarify the hierarchical relationship between the elements. Therefore, to fully analyze the relationship between the factors, we need to solve the reachability matrix. The reachable matrix is obtained by summing the adjacency matrix A and the unit matrix I. The operation stops when the power operation of $A + I$ satisfies the following conditions. The condition $A = \left(a_{ij}\right)_{m*n}$. The reachable matrix is calculated by using the operation property of Boolean matrix, according to which the positive integer n is obtained, and the reachable matrix can be expressed as $M = \left(A + I\right)^n$ (**Figure 3**).

6.3. Accessible Matrix Layering

To build the ISM model of factors, it is necessary to divide the factors in the reachability matrix into hierarchical levels, and then divide the factors into different regions and levels to judge the relationship and connectivity between factors [5]. The hierarchy of the reachable matrix, through the list, to summarize the influence relationship between each factor and the influenced relationship, to $A\left(S_i\right) = R\left(S_i\right) \cap Q\left(S_i\right)$ as the condition to determine the uppermost level elements, after the upper level elements, it will be eliminated from the table, and then in the same way to seek the next level of the elements, and so on, the elements can be divided according to the level one by one. The factors can be divided into levels until the bottom factor set is found out, and the main influencing factors can be rearranged based on this matrix to list the hierarchical decomposition table. Influencing factors can reach the set, with $R\left(S_i\right)$, which is generally composed of the elements of the reachable matrix S_i corresponding to the elements in the rows corresponding to the value of 1 corresponding to the column elements; affected factors that is the set of antecedents, with $Q\left(S_i\right)$,

$$M = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$$

Figure 3. Reachable matrix.

which is usually composed of the elements of the reachable matrix S_i corresponding to the elements in the columns corresponding to the value of 1 corresponding to the row elements together.

Analyzing the ISM model of factors influencing the "innovation ecosystem of intelligent manufacturing enterprises" of Yalong Intelligence, we can see that Yalong Intelligence is a five-level hierarchical system. The influencing factors at the top of the hierarchy are direct and those at the bottom of the hierarchy are relatively more general. The first level factor is the structural goal of the "Smart Manufacturing Enterprise Innovation Ecosystem" model of Yalong Intelligence, which is the core issue of this study. The second influence factor includes open innovation platform, value co-creation, and industry-education integration. The third level of influencing factors includes price technology support, talent cultivation, and strategic positioning. The fourth level influencing factors are resource integration and coordination, corporate culture, and directional guidance of Yalong Intelligence. The fifth level influencing factors include social atmosphere and market pull, which are the general environment of the "intelligent manufacturing enterprise innovation ecosystem" model of Yalong Intelligence.

Therefore, it can be seen that Yalong's "Innovation Ecosystem of Intelligent Manufacturing Enterprise" model is divided into three aspects and four levels, and Yalong integrates the "Innovation Ecosystem of Intelligent Manufacturing Enterprise" model into the whole process of its R&D, business and management. integration, to create an ecosystem around itself.

The driving factors of Yalong's "Innovation Ecosystem for Intelligent Manufacturing Enterprises" are divided into three aspects, which can be subdivided into four major areas. On the basis of analyzing and systematically using the external favorable development environment to boost its own development, Yalong summarizes and summarizes the guiding ideology that contains the concept of enterprise development, and puts the whole enterprise under the same goal to work together and twist into We will put our efforts under the same goal and unite as one. At the same time, we put the theory into practice and invest our energy to obtain solid technical foundation and talent reserve, so as to achieve the strategic goal and vision of the enterprise with excellent basic skills.

The direct influence layer is the channel of Yalong's "innovation ecosystem of intelligent manufacturing enterprises" model, and the influence of other factors will be reflected to the innovation ecosystem; the indirect influence layer is the channel of Yalong's "innovation ecosystem of intelligent manufacturing enterprises" model, and the indirect influence layer is the channel of Yalong's "innovation ecosystem of intelligent manufacturing enterprises" model. The indirect influence layer is the key factor of "intelligent manufacturing enterprise innovation ecosystem" model, which is the cornerstone of the existence of the ecosystem; the deep influence factor is the bridge of the ecosystem, which is deeply related to the direct influence factor and interacts with the basic influence factor; the basic influence factor is the foundation of the model, which promotes the output of products and services to users and achieves the fundamental purpose of the enterprise. purpose.

The construction of Yalong intelligent manufacturing innovation ecosphere can initially start from four aspects: R&D, management, business and society, and build a solid bottom ecological small circle in each of the four circles, and then further integrate and build the core ecosphere.

7. Conclusions

7.1. Vigorously Introduce Outstanding Talents and Promote Industrial Technology Innovation

High-end talents are an effective carrier to promote the combination of industry, academia and research, and an important engine to promote the leapfrog development of Yalong Intelligence in science and technology innovation and realize intelligent transformation. Yalong Intelligence has formed the initial atmosphere and ecology of science and technology innovation in terms of density of science and technology innovation, intensity of scientific research, proportion of high-tech projects, gathering of science and technology talents and economic pulling power, etc. It is also transforming from a traditional manufacturing leading enterprise to a national advanced manufacturing center. Yalong Intelligence has completed the transformation from traditional "attracting big capital" to "attracting innovation and wisdom", continuing the introduction and training of technical talents, retaining key talents in science and technology innovation, enhancing the core competitiveness of manufacturing industry, accumulating and precipitating talents, technology and other key elements of science and technology innovation for the construction of science and technology innovation center, It will also accelerate the cultivation of digital talents, support leapfrog development, and promote a number of science and technology innovation projects with development potential to become stronger and larger [6].

7.2. Focus on Product Ecological Advantages, Deep Integration of Educational Equipment

Intelligent transformation is the trend of the times, Yalong Intelligence follows

the trend of the development of the times, timely adjustment of corporate policy, in the big wave of the market, and won its own world. The construction of innovation ecosystem can empower the high-quality development of Yalong Intelligence. In this context, Yalong Intelligence should focus on four dimensions of technological innovation, industrial upgrading, digital economy and green ecology in the next step. Fully implement digitalization, promote high-quality industrial development, and let the overall industrial structure transform to intelligence, high-end, and service. In particular, strengthen the intelligence, cultivate products led by digitalization, bring new models and new business models, and create new employment and new dynamic energy. At the same time, we will do a good job of green ecological transformation, add endogenous power to respond to the "green water and green mountain is the silver mountain", and inject green power source for the high-quality development of the innovation ecosystem.

7.3. Solidly Laying the Foundation of Capacity and Expanding the Breadth of Ecological Advantages

Yalong Intelligence has taken the lead in forming the innovation ecosystem among a group of similar enterprises, accelerating the speed and intensity of the whole innovation system and seizing the high point of technical standards, and getting a breakthrough. Innovation ecosystem is the engine to accelerate knowledge innovation and successful transformation of knowledge, and is a new pattern formed in the process of deep integration strategy of industry-university-research. Yalong Intelligence starts from four aspects of R&D, management, business and society, and builds solid bottom ecological small circles in each of the four circles, then further integrates to build core ecosystem and manufacture innovation ecosystem, while solidly laying down its own dual capabilities, learning and exploring parallel, maintain the ability of strategic innovation and entrepreneurship, continuously optimize product quality, expand the circle of services, and then expand the breadth of ecological advantages.

8. Revelation

8.1. Smart Manufacturing Reconstructs Old Elements and Generates New Momentum for Development

As the global economy steps into the era of Internet economy and open innovation 2.0, the innovation ecosystem of intelligent manufacturing enterprises is changing to an open innovation ecosystem. Smart manufacturing is an important historical intersection of a new round of technological revolution and industrial change, and the most fundamental goal for enterprises to realize intelligent manufacturing system is to improve quality and increase efficiency and high-quality development [7]. The deeper task of intelligent manufacturing is to build a digital platform for traditional process manufacturing industry clusters, so as to achieve the goal of significantly improving the efficiency of production process, significantly increasing the flexibility of responding to the market and

the digital-physical integration system of the whole process of R&D, production and operation. At present, there is still much room for Yalong Intelligence to apply the new generation of information technology to improve the efficiency of traditional manufacturing industry, and enterprises should continue to strongly promote the transformation of manufacturing industry to digitalization and intelligence, promote the value of data production factors, and improve the efficiency of total factor production.

8.2. Based on Its Own Ecological Advantages, Comprehensively Enhance the Value of the Circle

Yalong Intelligence has many advantages, including the ability of product iteration and innovation, the ability of core technology cluster breakthrough, the advantage of industry-education integration, and the advantage of value co-creation, etc. In the process of intelligent transformation, Yalong Intelligence makes full use of its advantages and starts from its strong points, plus Yalong Intelligence realizes the flow of data, uses optimal decision-making to reconfigure traditional production factors and resolves the uncertainty of complex systems in order to improve efficiency and create new value. Ultimately, Yalong Intelligence has won the recognition of the government and the community with its strong scientific research strength. For Yalong's ecosystem to form an advantage, it needs to both expand the scope of the ecological position and improve the location centrality of the ecology. In the future, Yalong can further incubate the cluster ecology and focus more on linking different value chain activities within the industry.

8.3. Widely Absorb Experience and Build an Open Innovation Ecosystem

Digitalization makes the study of innovation chain gradually change to the study of innovation ecosphere, and enterprises have the need for open linkage, and the carrier is innovation ecosphere [8]. The new road of development of Yalong's intelligent construction of innovation ecosphere can be summarized as follows: play its technical foundation, engineering science education interactive empowerment, make the enterprise platform and market platform connected, integrate resources, form clustering effect, and finally build enterprise innovation ecosphere. At home and abroad, there are many excellent cases of core enterprises building their own ecosystem, while Yalong's innovation ecosystem should not stop here, but leaders should make a more global thinking from the perspective of innovation ecosystem and Internet integration. In this way, Yalong Intelligence will not be eliminated by the times, stand firm in the new era, and be brave to the tide.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Dong, K.J. and Yang, M.X. (2018) Analysis on Innovation System and Innovation Ecosystem. *Science and Technology Management Research*, **38**, 1-9. (in Chinese) https://kns.cnki.net/kcms/detail/detail.aspx?FileName=KJGL201814001&DbName=CJFQ2018

[2] Zhu, G.J., Xuan, C.Y. and Sun, J. (2021) The Process Mechanism of the Formation of Innovation Ecological Advantages in Intelligent Manufacturing Core Enterprises: An Exploratory Case Study Based on Haier Company. *Modernization of Management*, **41**, 40-47. (in Chinese)

[3] Zhang, L.Q. and Yang K. (2020) Imagination of an Innovation Ecosystem Based on Deep Integration of Industry, Academia, and Research. *Journal of Suihua University*, **40**, 114-116. (In Chinese)

[4] Eisenhardt, K.M. (2000) Paradox, Spirals, Ambivalence: The New Language of Change and Pluralism. *Academy of Management Review*, **25**, 703-705. https://doi.org/10.5465/amr.2000.3707694

[5] Duncan, R.B. (1976) The Ambidextrous Organization: Designing Dual Structures for Innovation. In: Kilman, R.H., Pondy, L.R. and Slevin, D.P., eds., *The Management of Organization Design*: *Strategies and Implementation*, North Holland, New York, 167-189.

[6] March, J.G. (1991) Exploration and Exploitation in Organization Learning. *Organization Science*, **2**, 71-87. https://doi.org/10.1287/orsc.2.1.71

[7] Diaz-Fernandez, M., Pasamar-Reyes, S. and Valle-Cabrera, R. (2017) Human Capital and Human Resource Management to Achieve Ambidextrous Learning: A Structural Perspective. *BRQ Business Research Quarterly*, **20**, 63-77. https://doi.org/10.1016/j.brq.2016.03.002

[8] Li, Y., Wei, Z., Zhao, J., *et al.* (2013) Ambidextrous Organizational Learning, Environmental Munificence and New Product Performance: Moderating Effect of Managerial Ties in China. *International Journal of Production Economics*, **146**, 95-105. https://doi.org/10.1016/j.ijpe.2012.11.008