ISSN 2616-5902 Vol. 5, Issue 15: 71-81, DOI: 10.25236/AJBM.2023.051512

Research on R&D Management System of Small and Micro Enterprises in Modern Service Industry of Science and Technology

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Abstract: *Based on the existing problems in the R&D management system of China's science and technology modern service industry enterprises, this paper focuses on how to build an efficient R&D management system of small and micro enterprises in science and technology modern service industry from different perspectives: mode, structure, resources, strategy, process, cost and risk. Taking YJ Company, a company engaged in the new technology development of scattered metal metallurgy and material preparation as an example, this paper puts forward some optimization methods matching with the business development of enterprises from multiple aspects based on the characteristics and existing problems of YJ Company's operation, so as to provide reference for small and micro enterprises in science and technology modern service industry to create new R&D management system.*

Keywords: *small and micro enterprises; modern service industry; R&D management system*

1. Instruction

Currently, there is no unified definition of modern service enterprises. Compared with traditional service industries, modern service industries are generally considered to provide services for modern production (including agricultural production and industrial production). Modern service industries are usually developed with the innovation of modern management concepts and science and technology. Rather than goods or labor services, they provide services to the market[1]t. Since the 1980s, the global economic industrial structure has presented a trend of transforming from "industrial economy" to "service economy"[2]. Science and technology modern service industry enterprises mainly refers to the financial securities, accounting, wealth management, lawyer services, education, e-commerce and other related institutions emerging and developing in the process of China's economic transition [3-4]. They are the results of developing new industries, new business patterns and new models, and the suppliers of "Specialized, refined, special and new" products and services [5].

Small and low-profit enterprises are referred to as "small and micro enterprises", including both small enterprises and microenterprises [6]. The concept of small and low-profit enterprises comes from the Enterprise Income Tax Law of the People's Republic of China and its Implementation Regulations, which refers to "small" scale and "low-profit" that comply with the tax law, generally excluding individual industrial and commercial households. The number of general employees of small and micro science and technology enterprises is less than 150. The proportion of scientific and technological personnel engaged in R&D and technological innovation is not less than 10 %, and the proportion of R&D investment in sales revenue is more than 3%. They are mainly engaged in the R&D of new products and technologies, and the added value of products and services is high [7].

2. Overview and Analysis of the Status Quo

For small and micro enterprises in modern service industry, the CPC, central government and local governments have successively issued many policies and supporting measures to support enterprise innovation, and strengthen the cultivation, financial support, and tax preference of small and micro

ISSN 2616-5902 Vol. 5, Issue 15: 71-81, DOI: 10.25236/AJBM.2023.051512

enterprises in the sci-technology modern service industry [8-10]. In recent years, the proportion of enterprises with R&D activities has increased year by year, and the willingness of enterprises to establish R&D institutions has continued to increase. In enterprises which conduct R&D activities, the number and level of R&D personnel and the R&D investment rise year by year. Additionally, the number and quality of patent applications, and the number of scientific papers published in terms of output have increased steadily [11].

The construction of enterprise R&D management system has always been the focus of domestic and foreign academic research, but most of them are aimed at large, medium-sized enterprises and listed companies. For small and micro enterprises engaged in technological innovation in modern science and technology service industry, they tend to go to two extremes in the construction of R&D management system [12]. One is to copy the mature foreign model of large enterprises without considering the unmatched manpower and funds; the other is small workshop style that merely relies on experience rather than establishing a R&D management system. In order to enable the small and micro enterprises in the modern service industry of science and technology to successfully pass a stable period in the early stage of development, and also for the steady and rapid development in the later stage, it is necessary to establish an appropriate technological R&D management system that conforms to the actual situation of the company [13].

3. Optimization of R&D Management System for Small and Micro Enterprises in Science and Technology Modern Service Industry

The R&D management system is a series of coordination activities of team building, process design, performance management, risk management, cost management, project management and knowledge management at the information platform during the R&D process based on the R&D structure design and various management theories. In addition to technology development, generalized R&D management system also covers the whole life cycle of new products, from the generation of product idea, product concept formation, product market research, product design, to product realization, product development, product pilot, product release and so on [14].

Based on the business characteristics of small and micro enterprises in modern science and technology service industry engaged in technological innovation, this paper proposes corresponding optimization suggestions from the perspectives of R&D modes and organizational structure, resource acquisition, process design, risk control, cost control and achievement protection.

3.1 R&D Modes and Organizational Structure

R&D modes include independent R&D, commissioned R&D and cooperative R&D with industry, universities, and research institution. Small and micro enterprises in science and technology modern service industry should attach great importance to selecting an appropriate R&D mode based on the characteristics of R&D projects, required resources, and their own technical strength and business strategy. For some enterprises that do not have professional talent reserves and require R&D projects of large facilities and equipment but with no access to, priority should be given to cooperative R&D and commissioned R&D. However, enterprises should have independent R&D capabilities in a certain field and their technical personnel should be able to complete the core tests, which can be done by renting sites, borrowing or leasing large facilities, equipment and test instruments if necessary. “Enterprises should try to maintain different forms of technical cooperation such as technical alliances, cross licensing, technological agreements, joint ventures with the external parties, but should also “pay great attention to maintaining independent position and to gradually developing their own R&D and innovation capabilities during the cooperation with large enterprises [15].

Generally, large enterprises set up a three-tier R&D architecture, with the group technical research institute at the top level to the product center, development center and technology center of each intermediate company or department in the middle, and the research laboratory or research group of each department at the bottom. For the organizational structure of the R&D department of small and micro enterprises in the science and technology modern service industry, setting too many levels is not advisable. They could establish thematic R&D project teams under the leadership of the chief engineer or vice technical president. Each R&D project team should have at least one full-time R&D personnel. The organizational structure of the entire R&D department adopts the form of weak matrix, which is more conducive to cross-sectoral communication and the full use of resources.

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3.2 Resources

R&D management involves resources, including human resources, facilities and equipment, R&D funds, as well as laboratory license qualification, measurement ability check, and purchase rights of flammable, explosive materials and drug precursors.

3.2.1 Human Resources

Training is of utmost importance because it is impossible for enterprises to recruit all kinds of R&D personnel that meet their needs from the human resource market. In order to maximize the use of training resources and ensure the training effectiveness, enterprises should first conduct training demand analysis from the aspects of enterprise, business and employees [16], and adopt various forms of on-the-job and off-job training based on the field of R&D projects.

The loss of key technical personnel has a great impact on small and micro technological enterprises, so enterprises need to quickly respond to and solve the flow of key technical personnel [17]. The new partner system, including the introduction of new equity mechanisms such as employee shareholding, and the sharing plan of R&D personnel to enjoy the industrialization profits of R&D projects, can effectively reduce the turnover rate of technical personnel.

3.2.2 Facilities and Equipment

There are a variety of channels from which small and micro enterprises in the modern science and technology service industry can obtain facilities and equipment to conduct R&D work. Enterprises should purchase the frequently used and low-value equipment as R&D investment cost according to their business scope and business direction. And they should try to lease or borrow the infrequently used facilities and equipment with high price and operation cost.

3.2.3 R&D Funds

Small and micro enterprises in the modern science and technology service industry, especially those in the start-up stage, are generally lack of funds, with seriously insufficient investment in R&D. Previously, R&D was mostly funded by sales income, equity capital and loans. In recent years, with the increasing national support for SME, enterprises can also apply for the titles of “high-tech enterprise technology” , “Standardized Project”, “Special Subsidy Plan for Science and Technology”, “Intellectual Property Demonstration Enterprises” and “Science and Technology Small and Medium-sized Enterprise”, etc. These titles can help the enterprises obtain policy subsidies and tax exemptions from departments such as Science and Technology, Industry and Information Technology, Development and Reform, Environmental Protection of the central and local governments, which can directly or indirectly make up for the shortage of R&D funds. For enterprises with promising prospects and leading technology, they can further increase their R&D capital investment through angel investment or seed fund support.

3.3 R&D Strategy and System Documentation

Small and micro enterprises in the modern science and technology service industry also need to develop R&D strategy that are consistent with the overall corporate strategy. Instead of directly producing goods, these enterprises often provide advanced technology of commodity manufacturing to the market. Their R&D strategy should start from improving the existing production technology, reconstructing and promoting the mainstream process flow of the industry, and innovate from multiple dimensions and perspectives such as process, equipment, testing, materials, cost, safety, and environmental protection.

Like the three major management systems of quality, environment, occupational health and safety and financial management system, R&D system documentation should also include manuals, procedures, records, operating procedures, etc., which can be divided into three to four levels. The R&D system documentation runs through the whole process of R&D, stipulating R&D planning, input and output, personnel responsibilities, and how to conduct R&D evaluation and verification. Small and micro enterprises in the modern science and technology service industry should focus on clarifying “what to develop”, “how to develop” and “how to evaluate R&D results” in the R&D system documentation.

3.4 R&D Process Design

Process-oriented is the basic feature of modern enterprise operation management. And “how to accelerate product and technology development process” and “how to carry out R&D” are the problems

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to be solved in R&D process design. The common R&D process is “demand analysis - R&D project establishment - R&D plan writing- implementation of R&D plan - testing and evaluation”. Some processes are also divided into four or eight stages. Small and micro enterprises in science and technology modern service industry can adopt a simplified five-stage R&D process, as detailed in Figure 1.

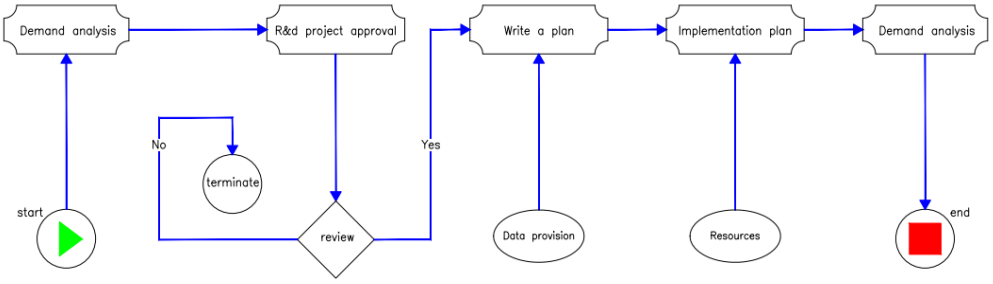

Figure 1: Five-Stage R&D Flow Chart of Small and Micro Enterprises in Science and Technology Modern Service Industry

To further clarify the approval nodes, workflow and data transmission, Figure 1 can be further refined. The R&D process of an enterprise is not static and requires continuous improvement to ensure the continuity, standardization and advancement of the R&D process design and improvement. Iterative and incremental agile project management methods are among the important methods. See Figure 2 for details of the R&D process that introduces the agile iterative model.

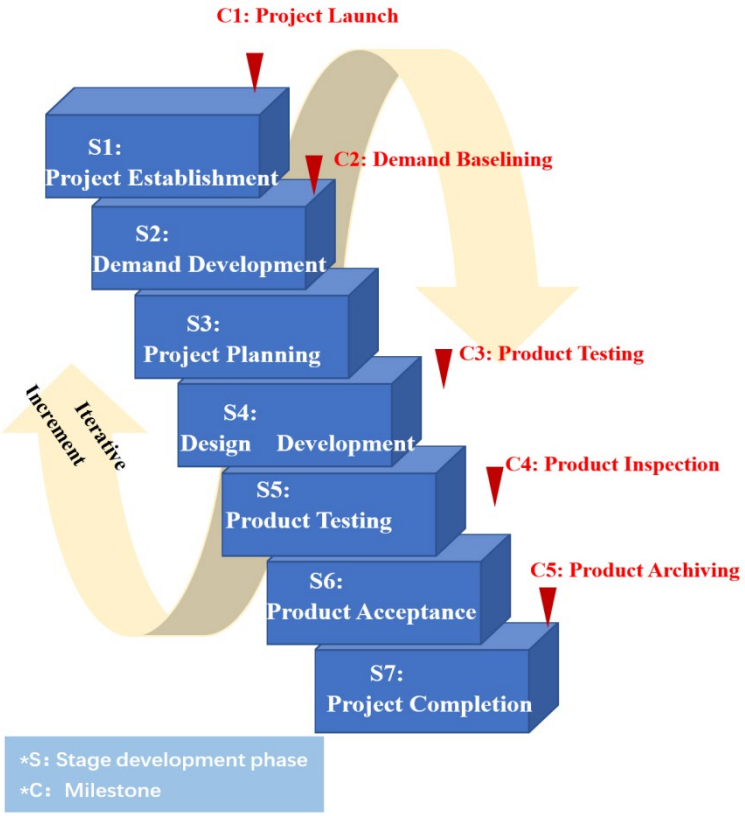

Figure 2: Extension Diagram of Five-stage R&D Process of Small and Micro Enterprises in Science and Technology Modern Service Industry

R&D management requires cross-sectoral and cross-system collaboration. For virtual teams, it also requires cross-regional communication and cooperation. The R&D management process involves communication, coordination and decision making to achieve the purpose of completing R&D tasks as soon as possible, which often requires complex R&D processes, such as the adoption of cross-sectoral R&D management framework IPD (Integrated Product Development) introduced, digested and absorbed by Huawei from IBM in the United States. However, IPD scheme is only suitable for large multinational enterprises to improve the development and manufacturing of hardware and software products because domestic SMEs cannot afford to buy or use it.

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To develop technologically advanced and customer-recognized products or technologies in the complex and volatile market environment, small and micro enterprises in the modern science and technology service industry should make full use of their characteristics of small size and simple organizational structure. They can adopt the R&D process of agile iteration mode by referring to the CMMI system developed by the Institute of Software Engineering of Carnegie Mellon University in the United States, and continuously improve the original model. Domestic self-developed R&D process solutions for small enterprises such as Mainsoft, an integrated R&D management platform, are suitable options. They can also establish standardized and systematic R&D process design and management methods by means of the path management process in project management technology to create a R&D process that suits their needs.

3.5 R&D Risks

R&D risks mainly come from the internal and external environment of R&D, as well as R&D personnel, R&D facilities and equipment, R&D process, R&D information risks and R&D achievements risks.

3.5.1 R&D personnel may be "poached" by rivals, revealing secrets and causing business losses

The loss of R&D personnel, especially core personnel, will be accompanied by leakage of business secrets. In more severe cases, malicious damage to enterprises will cause great losses to enterprises. For example, the events of "deleting data and running away" occur from time to time.

3.5.2 Risks of Facilities and Equipment

The risks of facilities and equipment mainly come from the installation, commissioning and operation. Many R&D facilities and equipment should run in high temperature, high pressure, strong acid and alkali environment. And the experiment may involve flammable, explosive and toxic reagents. Therefore, during the experiment, it is necessary for the experimenters to operate in accordance with safety regulations and wear protective equipment to avoid safety accidents.

3.5.3 R&D Risks Process

The R&D process is full of risks even if a detailed and rigorous R&D implementation plan is formulated, which often lead to R&D failure. Risks in the R&D process vary from different industries and enterprises. Statistics show that some industries have less than 10 % success rate in R&D and innovation of new products and technologies, and only 10% of the conversion rate of patent results [18-19]. This mainly results from the inability to eliminate or control the risks in the R&D process.

3.5.4 R&D Information Risk and R&D Result Risk

R&D information risk refers to the risk that R&D information may be leaked or damaged by R&D personnel, or risked by natural disasters, accidents or other attacks. R&D result risk refers to the risk that the products or services developed may be obsolete or unpopular, or that excessive R&D investments outweigh the benefits or cause business risks. Small and micro enterprises in sci-tech modern service industry are often lack of talents in risk control, sound management regulations, and scientific corporate decision-making systems, so they will face greater risks of R&D information and R&D results.

Therefore, small and micro enterprises in sci-tech modern service industry should take risks as their main control goal and strengthen their R&D risk management by formulating a series of effective rules and regulations and taking more practical measures to bring R&D risks below the acceptable level. In the process of risk management, the steps of "r risk identification - risk assessment - prevention strategy - risk response" should be followed, which means they should first analyze and assess, and then develop plans and implement.

3.6 R&D Quality Management

Up to now, there have been very mature theoretical systems, tools and methods of quality management. R&D quality management is carried out in the five steps of "product definition, product design, design verification, design approval and product release" in the R&D process [20]. The quality of R&D projects is formed during the R&D process and guaranteed by the R&D and management personnel. By controlling the time, cost, quality and risk of the project, enterprises can achieve the expected project result and make the R&D investment more economical and efficient [21].

The traceability of product quality can further prove "quality by design (QbD)". R&D quality

ISSN 2616-5902 Vol. 5, Issue 15: 71-81, DOI: 10.25236/AJBM.2023.051512

management runs through the whole process of product design, manufacturing and application. And the quality of R&D results determines the quality level of products and services of small and micro enterprises in science and technology modern service industry [22].

Limited by their own conditions, small and micro enterprises in science and technology modern service industries cannot introduce a large number of high-level R&D talents or purchase high-end R&D equipment on a large scale. But they can establish their own R&D quality management system in line with the characteristics of their enterprises, industries and products by referring to the procedures and documents of R&D in ISO quality management system to improve R&D quality.

3.7 R&D Cost

R&D costs mainly include development costs, testing costs and labor costs. With the advent of the micro-profit era, enterprises should save costs from all aspects, including R&D. R&D cost control does not mean to scale down R&D or reduce R&D investment, but to reduce unnecessary expenditure in R&D and obtain larger R&D results with less investment, which can make reasonable use of R&D costs. Such choice has already become a trend for major technological enterprises [10]. The R&D cost control should take the benefits of R&D results into consideration and R&D should have different inputs in different product life cycles. For example, when new products are developed, the R&D input is large, but the R&D benefit is almost none. Once the newly developed products are welcomed by the market, the R&D investment should be increased to improve the product performance. By the time the products are mature and the market competition is fierce, the investment in product improvement and R&D should be gradually reduced until it is completely removed.

Small and micro enterprises in sci-tech modern service industry are small in scale and weak in strength. They can cooperate with universities, research institutes and large enterprises to control R&D cost, making full use of the talent resources and technical advantages of external institutions, and the guiding role of large enterprises in the industry. For those work they cannot independently complete and do not have advantages in, they can entrust the development to outsourcing companies.

Large instruments and equipment are often expensive but seldom used. To reduce the pressure of capital occupation, they should give priority to leasing of equipment. Equipment used intermittently can be considered for short term leasing and those used continuously for a longer period of time can choose financial leasing.

Labor cost accounts for a considerable proportion of R&D costs. In addition to precise job and staffing, a reasonable salary system should be designed to avoid inefficiency caused by a single-minded reduction in labor costs.

3.8 Knowledge Management and Intellectual Property Management

Knowledge is usually divided into explicit knowledge and implicit knowledge. Knowledge management aims to reuse existing knowledge and generate new knowledge[21].The scope of knowledge management includes not only explicit knowledge such as documents, protocols and programs that can be recorded, but also invisible knowledge that exists in the minds of relevant personnel such as operational skills and experiences. Knowledge management should run through the entire R&D process, not just the presentation of the final R&D results. The basic data including experimental records in the process of R&D establishment and implementation are also important objects of knowledge management.

R&D achievements of enterprises mainly include patents, copyrights, and also kept proprietary technology (also called technology secrets). Small and micro enterprises in modern service industry of science and technology should make process records during the design and implementation of R&D, archive R&D achievements periodically, and initiate the protection of R&D results after the completion of R&D.

For outsourced R&D projects and cooperative R&D projects, the ownership and use of R&D results should be clearly stipulated in commercial contracts and technology agreements, and intellectual property management should be carried out in various flexible ways, such as independent declaration or cooperative declaration.

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4. Case Analysis

Nanjing * * Engineering Technology Co., Ltd. (hereinafter referred to as YJ Company) is a start-up science and technology-oriented small and micro-sized enterprise in the modern service industry, focusing on the new technology R&D and promotion of resources recycling, purification and related semiconductor material deep processing of germanium, indium, gallium and other scattered metals. The founder team members mainly come from a large germanium, indium and gallium production enterprise in China. They have received systematic professional education, and have rich experience in on-site installation, commissioning and operation. The core competitiveness of YJ Company comes from the continuous research and development of new technologies for energy saving and environmental protection as well as the grasp of the core technology of rare metal resource recovery and material preparation. Currently, YJ Company has accumulated more than 20 intellectual property rights, which can significantly improve the technical and economic indicators of rare metal producers after promotion.

YJ company has 16 employees and 4 full-time R&D personnel. It is a typical small and micro enterprise in modern science and technology service industry. It has four departments, namely, operation, technology, administration and finance, and the organizational structure is typical functional type. The work of the R&D Department is mainly divided into two aspects, one of which is new process development, mainly including the selection and combination of pyrology, wet method and electrochemical technology. The other is the development and production of new materials and non-standard equipment, including functional polymer adsorbent materials, special process equipment.

At present, YJ Company has undertaken the technology development contract for the comprehensive recovery and deep processing of germanium resources for a large germanium plant in China. To survive and further develop, the company urgently needs to establish a set of R&D management system suitable for itself and develop new technologies that can be recognized by the market.

This study uses the 5why analysis method to explore the causes of the problems from all aspects of enterprise operation. After diagnosis, it is concluded that YJ's R&D management system mainly has certain problems in six aspects: model and structure, resources, processes and documentation, process control, and intellectual property management, which leads to low R&D efficiency. The root cause analysis diagram is shown in Figure 3.

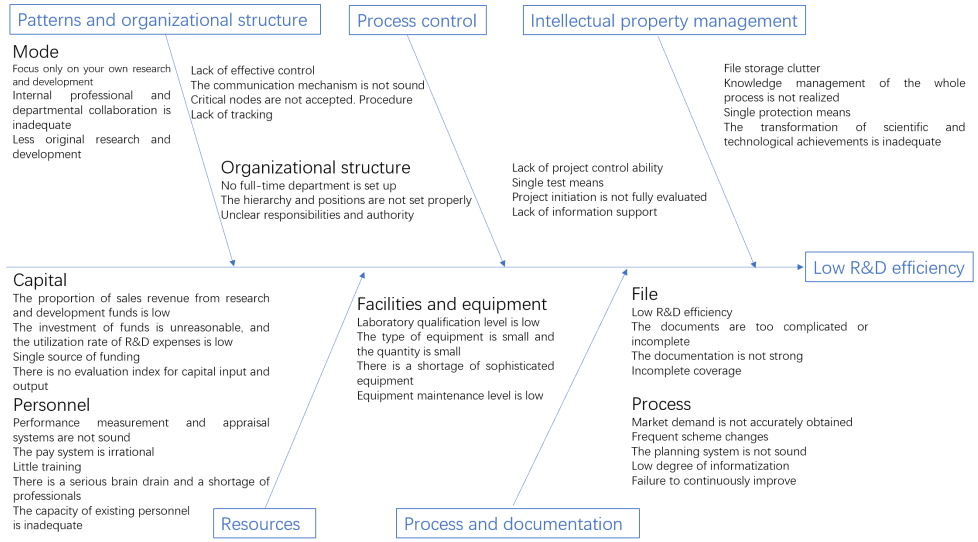

Figure 3: Analysis of the root causes of low R&D efficiency of YJ Company

In order to develop new technology and equipment that meet the needs of the industry and customers, YJ company can optimize the existing R&D management system from the following aspects. //To improve R&D efficiency and develop new technology and equipment that meet the needs of the industry and customers, YJ company can optimize the existing R&D management system from the following aspects according to the influencing factors listed in Figure 3.

4.1 R&D Model and Organizational Structure

The R&D model is mainly based on independent research and development, and has not yet

ISSN 2616-5902 Vol. 5, Issue 15: 71-81, DOI: 10.25236/AJBM.2023.051512

established close cooperation relationship with colleges, universities, and research institutes. It should cooperate with organizations that have a strong professional background in non-ferrous metallurgy and material preparation as soon as possible to outsource development or or cooperate on areas where YJ is weak.

For the special materials and non-standard equipment for the experiment, YJ should take the lead and jointly carry out R&D with manufacturers.

Among the four full-time personnel engaged in research and development positions, there are two experimental personnel, one testing personnel, and one material and equipment production personnel. According to the specific situation of enterprise personnel structure, the R&D organizational structure should be project-oriented, with R&D engineers as project managers, which can avoid the unclear end responsibility of multiple leaders and improve the effective use of resources and efficiency of R&D [23].

4.2 Resources

YJ Company has few technicians, low R&D investment, and few types and quantities of equipment. How to obtain resources and make good use of resources to serve R&D activities is the focus of R&D system management.

4.2.1 Human Resources

YJ is engaged in a relatively niche industry with a narrow circle, so it is difficult to recruit suitable personnel externally. It can introduce excellent talents in the industry by recommendation from acquaintances.

The training includes business training and corporate culture training. The business training mainly focuses on both the theories and practices of nonferrous metal metallurgy, with special emphasis on the application of new materials, automation, and intelligent manufacturing in rare metal metallurgy, as well as the significance of cross-disciplines to R&D [24]. In terms of corporate culture, since YJ is at the start-up stage, it is not affordable to provide too high a basic salary. It is advisable to adopt a salary system that is combined with project contribution assessment. YJ should first grade the employees, and then given options, shares and dividends to the “core staff”.

The performance appraisal of R&D personnel should be different from the functional departments. It can be combined with the comprehensive evaluation of R&D project input and output indicators, and the evaluation results can be considered as one of the bases for salary determination.

4.2.2 Laboratory Facilities and Equipment

YJ company has a 25 m² laboratory. The laboratory has simple ventilation and is unable to carry out flammable, explosive, high temperature and high-pressure experiments due to limited facilities and qualifications. The company can lease qualified laboratories and procure common instruments, drugs and consumables. For large experimental and testing instruments, it can lease or participate in shared labs to meet experimental needs. In addition to procurement, non-standard equipment can also be customized by drawing diagrams. Supporting facilities should implement transformation according to the purpose of the experiment, the characteristics of the material and the site and control costs on the premise of meeting the requirements.

4.2.3 R&D Funds

There are various channels for YJ company to raise R&D funds, but it’s more advisable for YJ to make use of national, provincial, municipal and regional support policies and special fund subsidies, such as declaration of high-tech enterprises, technology-based SMEs, intellectual property demonstration enterprises. It can actively participate in various declaration activities organized by the NDRC, Ministry of Industry and Information Technology, State Taxation Administration, Ministry of Science and Technology and other functional ministries.

Commercial banks and other financial institutions also have low-interest loans for technology-based SMEs.

In financing, especially equity financing, YJ should be cautious to avoid the “wild development” of the company after the injection of funds and the loss of control by the founder, not to mention the use of “private high-interest loans”.

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4.3 R&D Strategy and System Documentation

According to the characteristics of the target market, YJ company established a positive "offensive" strategy combined with its enterprise development strategy, focusing on the industry difficulties and "pain points" in the field of rare metal metallurgy and materials and selected the topics with high technical difficulty and wide market prospect to enter the niche market. Currently, the company takes the research and development of "secondary enrichment technology of germanium resources" as a breakthrough to open up the market and promote its corporate brand.

According to the business scale and characteristics of YJ company, the requirements and contents of the R&D management system can also be supplemented to the quality management system. The various documents of the R&D management system are integrated with the quality management system documentation. At the same time, the design and development process (elements) of the quality management system are included in the R&D management system documentation [25].

4.4 R&D Process

YJ company can design its own software by referring to the five-stage R&D process, focusing on the R&D project and monitoring the R&D implementation process. Industry and customer trends should be tracked at any time during the R&D process. If the market changes and the basis of the R&D project changes, the R&D process should be terminated in time.

At the key nodes of the R&D process, there should be corresponding personnel approval before proceeding to the next step.

4.5 R&D Process

Although R&D risks are inevitable, YJ company can give full play to the advantages of its small scale and easy adjustment, fully assess the R&D risks and make contingency plans for different qualitative and quantitative risks. It should strengthen personnel training, equipment and facilities maintenance to prevent and eliminate R&D risk and develop a detailed and operable R&D plan and strictly follow it in the R&D process. As for the data and results in the R&D process, two sets of data systems, paper and electronic, should be established to prevent loss due to various reasons, and different data reading, access and storage permissions should be set for all levels and types of personnel.

4.6 R&D Quality

Before the establishment of R&D projects, sufficient research and literature reading should be conducted to understand the production situation and technological development of the industry. In addition, research progress of domestic and foreign counterparts should be checked to avoid duplication or invalid R&D activities.

And the quality index setting of R&D achievements should comprehensively reflect the R&D quality. In addition to paying equal attention to both technical and economic indicators, regulations and requirements on energy conservation and environmental protection should also be taken into account.

4.7 R&D Cost Control

R&D costs mainly consist of personnel salaries, travel expenses, instrument, equipment and facilities procurement costs, consumption of pharmaceuticals and consumables, and testing costs. YJ company can adopt the following measures to effectively reduce R&D costs. Eliminate unnecessary project to control costs at the source; strengthen the price comparison of experimental instruments, equipment and facilities, pharmaceuticals, auxiliary materials and consumables procurement to reduce procurement costs; reduce the consumption of disposable supplies and eliminate the waste of pharmaceuticals and materials in the R&D process; establish the company's own testing methods and means, and reduce the number of outsourced tests, which can not only reduce R&D costs, but also improve R&D efficiency.

4.8 Intellectual Property Management of R&D Results

YJ can arrange full-time personnel in charge of intellectual property management, and protect innovative achievements during and after R&D. For innovative R&D achievements, corresponding

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protection measures can be adopted according to different natures. For example, software copyrights should be applied for the program-type automation control software; new equipment should be declared as utility model patents; process methods can be applied for invention patents; and core technologies such as formulas can be used as "technical secrets" with security measures.

Through the above combing and analysis of YJ Company's business, we find out the main reasons for the inefficiency of its R&D business, and put forward corresponding optimization suggestions and methods based on the specific situation of enterprise development from different angles of R&D management system. After one year of implementation, the quantity and quality of YJ Company's R&D results have been improved to varying degrees, with a significant reduction in the average R&D cycle and controlled R&D costs.

5. Summary

With the national promotion and support for "mass entrepreneurship and innovation" in recent years, more and more small and micro enterprises engaged in technological innovation and popularization and application of science and technology modern service industry. They are also the most innovative and promising group among all kinds of enterprises [26-27]. For small and micro enterprises engaged in technological innovation in modern service industry, technological advancement and upgrading is particularly important for the development and even survival, and enterprises that cannot maintain continuous innovation are often eliminated by the market.

It is necessary to integrate the system with the knowledge management system and strengthen the knowledge search, that is, the R&D management system should be well connected with the market, production and other systems [28].

This paper focuses on how to optimize the R&D management system of small and micro enterprises in science and technology modern service industry. With YJ company as an example, this paper analyzes the causes of low R&D efficiency according to YJ's business characteristics. It then puts forward optimization measures and suggestions based on management theories and practical knowledge from various aspects, such as R&D model and organizational structure design, resource raising, R&D strategy and system documentation, R&D process design, R&D risk control, quality management, intellectual property management, etc.

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