

## Research on Performance Evaluation Index System of R&D Personnel in Start-Up Software Enterprises<sup>1</sup>

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**Abstract.** With the vigorous development of the Internet, the status of the information industry in the national economy has also been continuously improved. Software companies are representatives of the information industry. The 21st century is also the era of knowledge economy. Knowledge replaces capital and becomes the most important factor for enterprises to make enterprises competitive. Knowledge-based employees are an important factor for companies to grow and develop, and R&D personnel are representatives of knowledge-based employees. For knowledge-intensive software companies, a team of high-quality R&D personnel is the foundation of the company and a necessary guarantee and key factor for the development of the company. This paper adopts literature review method, interview method, key performance index method, 360 degree assessment, analytic hierarchy process as the theoretical guidance. Combining with the actual situation of Wuhan Jingzhi Company, it has established a performance assessment system for three types of R&D personnel: project managers, developers, and testers, and hope to help other similar companies retain R&D personnel.

### Introduction

Informatization is the trend of development in the 21st century and the symbol of advanced productive forces. Since the 21st century, information technology has played a powerful role in promoting the development of national economy and the improvement of social production efficiency. Many countries and regions have gradually realized the importance of information industry, which is closely related to the overall situation of national economic and social development. With the rapid development of China's society, the increasing economic strength and the increasing popularity of the Internet, the degree of informatization in China has been continuously improved, followed by the vigorous development of software enterprises in China. At present, China's software industry is in a period of rapid development. In 2016, China's software and information technology services industry realized a total income of 4.9 trillion Yuan, an increase of 14.9% over the same period last year.

The 21st century is the era of knowledge economy. Rapid development of knowledge industry is the premise of knowledge economy. Land is the first factor of production in the era of agriculture economy. Capital is the first factor of production in the era of industry economy. In the era of knowledge economy, knowledge replaces capital as the first factor of production, and high-tech industry becomes the pillar of the first economy. In the era of knowledge economy, the success or failure of an enterprise depends on the mastery and application of knowledge, which depends on the knowledge workers who carry knowledge resources. As the representative of knowledge workers, R&D personnel are the mainstay of software enterprises, and play an irreplaceable role in the development of enterprises. Whether R&D talents can be attracted, motivated and retained is the key to the success of enterprises. To achieve this, a scientific and reasonable performance appraisal

system is indispensable. Most start-up enterprises lack a scientific performance appraisal system for R&D personnel, which is very unfavorable to the growth and development of enterprises. Therefore, the establishment of R&D personnel performance appraisal system is an urgent problem for start-up software enterprises. Working characteristics and performance appraisal of R&D personnel in start-up software enterprises.

Software enterprises are representatives of high-tech industries, and R&D personnel are the core of software enterprises, and are the most basic and most important resource elements. Most of the start-up enterprises lack a scientific performance appraisal system. The purpose of this paper is to establish a scientific performance appraisal system for R&D personnel of start-up software enterprises by combining the specific situation of Wuhan Jingzhi Science and Technology Co., Ltd. with qualitative and quantitative methods. It is hoped that it will be helpful to the development of performance appraisal system for R&D personnel in software enterprises, improve the level of performance management, and help enterprises carry out scientific performance appraisal so as to retain the talents needed by enterprises and realize the sustainable development of enterprises.

## **Join Technology R&D Personnel Performance Assessment Indicator System Design**

### **Join Technology Overview**

#### *Join Technology Profile.*

Wuhan Join technology co., ltd. was founded in 2016. Its vision is to build a education Internet platform for children's quality, provide convenient mobile admission management services for children's training institutions, and provide information acquisition and sharing services for parents. The product "lei xiaofeng" was launched in apple APP Store and Android APP stores last summer, and is currently in the stage of promotion and operation, with a bright market prospect.

"Lei xiaofeng" is the main product of Join technology co., LTD. It is a simple management APP dedicated to art training institutions, focusing on education training of children's interests between 3 and 12 years old, especially art and calligraphy training institutions, providing a professional mobile recruitment management tool. It provides the process management of core links such as enrollment, teaching, teaching affairs, operation and communication for interested training institutions, standardizes the complex business process, liberates the headmaster from the complex management, at the same time, promotes the teachers to pay attention to teaching and service, also helps to build the brand, create public praise, in order to recruit more new students.

With excellent products and good promotion and operation, Join technology develops rapidly and has a promising future. After obtaining seed round financing in 2017, it has obtained millions of angel round financing in February 2018.

#### *Join Technology R&D Team Status and Performance Status.*

Due to the short establishment time, join technologies has a small R&D team of 8 people, which is mainly divided into two parts: development and testing. The development team has 3 people in charge of background development, 2 people in charge of front-end development, 2 people in the test group and 1 project manager. The R&D team tends to be younger, mainly people under 30 years old.

Join technology's current performance assessment is still in the mode of subjective evaluation by superiors, and there is no objective performance assessment system for R&D personnel.

### **Design of Performance Appraisal System**

#### *Work Analysis of R&D Team.*

(1) The project manager.

The responsibility of the project manager is to ensure that the product can be completed on time with quality and quantity guaranteed. He is the manager of the whole product development process.

The main work of the project manager is to first analyze the requirements and make plans. Then, the project was decomposed to clarify the division of labor of each member of the R&D team and

determine the schedule of the project; Then, in the process of R&D, we should ensure the normal operation of the project, deal with various affairs, provide a good R&D environment for the R&D team, coordinate and motivate team members, improve team cohesion, control the progress of the project and complete it on time with quality and quantity guaranteed, and often communicate with team members to make relevant adjustments.

(2) The developer.

The responsibility of the developer is to complete the planned coding tasks with high quality and quantity within the specified period. The main work content is to carefully analyze my own work tasks after receiving the task division of the project manager, understand the product requirements, and predict the possible problems in the coding process; Then, I worked with the team to finish the code writing as planned, and actively cooperated with the testers to find out the defects in the test stage and quickly modified and improved them [6].

(3) The tester.

The tester's responsibility is to understand the requirements and functions of the product, and then find the defects in the software in less time through various test methods, so as to ensure the product's function and stability. It is also necessary to write test specifications and create test cases. The work content is to make test plans, plan test cases, test the internal operation and function of the software through white box, black box and other test methods, and then comprehensively evaluates the software according to the problems and defects found.

### ***Performance Appraisal Index Design.***

Because R&D personnel have strong innovation, low degree of visualization of work process, difficult to quantify work results and other characteristics, and R&D personnel's work results are the key to the success of the enterprise, the enterprise can achieve the goal of the impact of a large degree, so the idea of key performance indicators to design R&D personnel performance evaluation indicators.

KPI design can adopt the analysis method of fishbone diagram. Fishbone graph is an effective tool for decomposing strategy and extracting index. The core idea of fishbone diagram is that the strategic goals of organizational strategy can usually be decomposed into several sub-goals. There is an internal relationship between these sub-goals and the main business processes of the organization. If the main business processes are connected with the sub-goals, the key performance indicators can be obtained. Through fishbone diagram, KPI of the company is decomposed from department to department and then from department to each position, and key performance indicators of each position of each department are determined.

Combined with the characteristics and working characteristics of R&D personnel, this paper divides the R&D personnel performance assessment indicators into three categories. Achievement index, achievement index reflects the degree of contribution of R&D personnel to the enterprise on their posts and reflects their personal value. For example, the project manager focuses on the management of the project team and communication and coordination between the upper and lower levels, while the developer focuses on the requirements analysis of the program and the compilation results of the code. Behavioral indicators, which reflect the behavioral emotions and personal feelings of R&D personnel in R&D work, tend to be consistent among R&D personnel in various positions, including the spirit of cooperation, sense of responsibility and other aspects. Capability index, which reflects the capabilities required by the work of R&D personnel, varies from position to position. The ability of project manager will focus on communication and leadership, while the ability of developer will focus on analysis, understanding, technology and other aspects[7].

Using the idea of key performance indicators and combining with the characteristics and work analysis of the above R&D personnel, the following assessment indicators are determined:

(1) The project manager

Table 1. Project manager performance appraisal index table

Level indicators	The secondary indicators	Indicator description
Results the indicators	Cost control rate	The ratio of the actual cost of a project to the budgeted cost
	Project benefits	Short-term project net profit, long-term product market share and product visibility and competitiveness
	Project production ratio	Ratio of project net profit to project cost, which can be compared with similar products to understand project performance;
	Project time control rate	The ratio of actual time spent in each stage of project development to planned time spent
	Degree of product function realization	The product functionality reaches the desired level of functionality
	Number of team conflicts	The number of abnormal conflicts generated by the project team, and the results of coordination by the project manager team were evaluated
	User satisfaction	Customer satisfaction with product functionality and maintenance
Behavioral indicators	The sense of responsibility	Ability to be responsible and responsible for the work
	discipline	Ability to comply with company rules and regulations and follow superior's instructions
	Teamwork spirit	Ability to comply with company rules and regulations and follow superior's instructions
	Active learning consciousness	Ability to coordinate and cooperate with team members as a team
The target	Communication and coordination ability	Ability to communicate with superiors and subordinates to promote team harmony
	Analysis ability	Ability to analyze the needs of target customers and related problems in the development process
	Decision-making ability	Ability to make decisions on team members' work arrangement, schedule arrangement, cost arrangement and various emergent problems
	Team motivation	Use appropriate motivation methods to motivate team members and maintain their ability to work enthusiastically
	Professional knowledge level	Knowledge of customer requirements, product market conditions, software development, etc.

(2) Development personnel performance appraisal index design

Table 2. Developer performance appraisal index table

Level indicators	The secondary indicators	Indicator description
Results the indicators	Task function realization rate	The ratio of what the code in charge can achieve to what is expected to be achieved
	Mission time control rate	The ratio of the completion time of part of the code under my charge to the expected completion time
	Product stability	Whether the product can run stably for a long time and whether the upgrade and revision of the product will affect the stable operation of the product
	Thousand line BUG generation rate	The ratio of the number of bugs generated by the part responsible to the number of lines of code divided by a thousand
	Second thousand line BUG generation rate	After the BUG has been tested and fixed, the ratio of the number of bugs produced to the number of lines of code divided by 1,000 when tested again
	Develop document normalization	Ratio of the number of development documents that meet the specification standards to the total number of development documents
Behavioral indicators	The sense of responsibility	Ability to be responsible and responsible for the work
	discipline	Ability to comply with company rules and regulations and follow superior's instructions
	Teamwork spirit	Ability to coordinate and cooperate with team members as a team
	Active learning consciousness	Ability to actively learn new job-related knowledge and skills
The target	Coding ability	The developer has the ability to use development tools and write code
	The innovation ability	Based on their own knowledge, developers use new development tools to write innovative code, so that the product has unique capabilities
	Cooperation ability	Ability to communicate and cooperate with other team members to solve problems and complete product development
	The ability to learn	Ability to learn new knowledge and skills to solve problems in a timely manner

(3) Design of performance assessment indicators for testers.

Table 3. Performance evaluation index table of testers

Level indicators	The secondary indicators	Indicator description
Results the indicators	Test case quality	Whether the test case structure is optimized, whether the content description is concise and complete, and whether it is executable
	Effective rate of BUG	It's really the ratio of the number of bugs that affect the functionality of the product to the number of bugs that are running
	No BUG rate found	The ratio of bugs discovered by non-testers, such as developers or customers, to total bugs
	The BUG description	Whether the detailed description of the BUG is clear and whether the location of the BUG is accurate
	Test the level of documentation	Whether the test documents are prepared in a timely manner, whether the documents of completed test tasks and the documents of the tasks under test can be checked at any time. The level of test documentation can reflect the tester's understanding of the project and test level
Behavioral indicators	The sense of responsibility	Ability to be responsible and responsible for the work
	discipline	Ability to comply with company rules and regulations and follow superior's instructions
	Teamwork spirit	Ability to coordinate and cooperate with team members as a team
	Active learning consciousness	Ability to actively learn new job-related knowledge and skills
The target	Testing capability	Ability of testers to use test tools, design test cases, analyze test results, and write test documents
	Understanding ability	Ability of tester to understand requirement analysis and system design
	Ability to communicate	The tester's ability to communicate with colleagues to grasp the difficulties of testing tasks and communicate with developers about bugs found
	The ability to learn	Ability to learn and apply new test tools and methods to work

**Weight Distribution of Performance Appraisal Indicators.**

(1) Weight distribution of performance assessment indicators for project managers

The weight of performance appraisal index can be determined by AHP. Due to the limitation of space, the calculation process is omitted in this paper.

Table 4. Project manager index weight table

jobs	Level indicators	The secondary indicators
The project manager	Achievement index (0.56)	Cost control rate (0.04)
		Project income (0.22)
		Project production ratio (0.09)
		Project time control rate (0.04)
		Product function realization degree (0.39)
		Number of team conflicts (0.15)
	Behavioral index (0.12)	User satisfaction (0.07)
		Responsibility (0.42)
		Discipline (0.23)
		Teamwork spirit (0.23)
	Capability index (0.32)	Active learning awareness (0.12)
		Communication and coordination ability (0.13)
		Analytical ability (0.28)
		Decision-making ability (0.22)
		Team motivation ability (0.12)
		Business knowledge level (0.13)

(2) Weight distribution of developer performance assessment indicators

According to the same method as the project manager, the developer performance appraisal index weight is determined as follows:

Table 5. Developer index weight table

jobs	Level indicators	The secondary indicators
The developer	Achievement index (0.56)	Task function realization rate (0.36)
		Task time control rate (0.09)
		Product stability (0.22)
		Task BUG generation rate (0.14)
		Secondary BUG generation rate (0.14)
		Normative development documents (0.05)
	Behavioral index (0.12)	Responsibility (0.42)
		Discipline (0.23)
		Teamwork spirit (0.23)
		Active learning awareness (0.12)
	Capability index (0.32)	Coding ability (0.48)
		Innovation ability (0.27)
		Ability to cooperate (0.16)
Learning ability (0.09)		

(3) Weight distribution of performance assessment indicators for testers

According to the same method as the project manager, the developer performance appraisal index weight is determined as follows:

Table 6. Test personnel index weight table

jobs	Level indicators	The secondary indicators
The tester	Achievement index (0.56)	Test case quality (0.18)
		Effective BUG rate (0.30)
		No bugs found (0.30)
		BUG description (0.13)
		Test documentation level (0.09)
	Behavioral index (0.12)	Responsibility (0.42)
		Discipline (0.23)
		Teamwork spirit (0.23)
		Active learning awareness (0.12)
	Capability index (0.32)	Test ability (0.52)
		Ability to understand (0.23)
		Communication skills (0.13)
		Learning ability (0.12)

## Conclusion

With the advent of information technology and knowledge economy era, information industry has become the pillar of national economy. As the representative of information industry, software enterprises are knowledge-intensive enterprises. Knowledge-based employees in software enterprises are the basis and pillar of their growth and development, and R&D personnel are the representatives of knowledge-based employees. Their work directly relates to the competitiveness and benefits of software enterprises. Most start-up software enterprises lack performance appraisal of R&D personnel, which is not conducive to the correct evaluation of R&D personnel's work results, as well as the incentive and retention of R&D personnel. By referring to the relevant literature on enterprise performance appraisal, this paper determines the general category of assessment indicators of start-up software enterprises and the method to determine the weight of indicators. Through interviews, the author learned about the status quo of Join technology company, and established a set of performance assessment indicator system for project managers, developers and testers of Join technology company, so as to provide reference for the establishment of performance assessment system of start-up software enterprises.

Due to the actual limitations of the research conditions, although the research results have made some progress, there are still many unreasonable points. For example, the selection of assessment indicators may not be in-depth enough, reliability and validity tests have not been conducted, and the evaluation criteria of indicators may not be perfect, and further improvement and learning are needed in the future.

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