



Rule-Based Cloud System for Performance Appraisal of Staff in Chinese Universities

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Abstract. Data-driven policies have prevailed among universities globally. Universities hope that the outcomes of faculty members are high quality and in a large quantity. Therefore, universities motivate staff to work hard with annual remuneration bonuses. However, the tedious application process frustrates teachers and brings adverse effects if no suitable systems are available. The paper presents a rule-based cloud computing system to evaluate performance for annual bonus payment applications in Chinese universities. The criteria can be encoded with if-then expressions. Department administrators can add new rules or update existing ones flexibly with this rule-based system. Teachers can upload their achievements through a web browser on different devices. Faculty members know the mark of each item input into the system. The system calculates the final points automatically. Members of the school committee can review and return applications to applicants. All criteria are publicly available for all faculty members. The system simplifies the process of the annual bonus pay application. The transparency encourages teachers to participate in applying for annual bonus pay. The experimental results show that the designed system helped evaluate performance-based annual bonus applications. Teachers spent less time requesting yearly bonus salaries with the rule-based cloud system than with traditional approaches.

Keywords: Big Data · Cloud Computing · Performance Appraisal · Rule-Based System

1 Introduction

Faculty members are paid based on credentials and performance in universities. Certifications and years of work experience determine the monthly paid salaries. Outcomes and performance decide the extra money. Universities offer annual bonuses to motivate faculties to work hard and achieve more [9]. Bonus payments based on productivity increased [11]. The central or state governments provide all salaries and bonuses for public universities in China. There is no little disputation about monthly wages. But different options appear for the annual bonuses. The amount of the yearly dividends is a fixed

number for a year. All staffs share and compete for the premium based on productivity. Therefore, performance determines the extra rewards for a faculty member.

Although many administrators and faculty members herald productive-based payment, universities should improve and simplify the process. Some universities designed complex criteria. Staffs have to recollect and provide supporting material in a short time. The process is complicated and tedious. For example, each university department may have different criteria for performance. Even for the same school, rules change yearly. Faculty members feel frustrated. Staff motivation is adversely affected by the frustration of tedious, complex, and laborious procedures [13].

Higher education should provide the faculty members with non-academic administrative processes to serve their non-academic needs. Therefore, this paper presents a rule-based cloud system evaluating performance for the annual bonus.

2 Literature Review

2.1 University Salary Structure

University salary levels differed among geographic regions globally. Overall salary level affects job satisfaction [16]. Women staff earned less than men a half-century ago [5]. But with the development of social society, the discrimination of the gender salary gap has been diminishing [1]. For example, female faculty members earn the same salary as their counterparts of male colleagues in Chinese universities. Every faculty member enjoys equal rights because each university has explicit salary policies. Therefore, achievement levels instead of sex composition determine salary levels [4].

Faculty salaries are composed of a base salary, further remuneration, and fringe benefit in Chinese universities [8]. Formal staffs enjoy a respectful social status and higher salaries besides adequate subsidies and bonuses in Chinese universities. The base salary for the identical rank position is almost the same in public universities all over the nation. The central or state government provides the basic salary and remuneration to support the public universities. The fringe benefits include different subsidies and bonuses. The grant from the government and the financial situation of a university determines the fringe benefits. In contrast, salary and fringe benefits depend on income from student tuition. Teachers have to teach more classes if they seek bonus pay.

Universities have offered annual salary bonuses to motivate faculty [9]. Public universities have been focusing on annual bonus remuneration policies to spur faculty effort in China. Bonus strategies based on performance vary among universities. The incentive plans may differ from one school to another at a university. The process for annual bonus claims is complex and tedious. Faculty members feel frustrated about the extra yearly payment. Higher education should provide a convenient and straightforward administrative process for non-academic needs [13]. The effects of salary dispersion can be strengthened when salary information is publicly available [14].

2.2 Rule-Based System

A Rule-based system is a kind of expert system. The system can automatically generate output according to defined rules. Annual bonus policies can be encoded with rules. A rule can be written in a production form as follows:

Performance \rightarrow bonus point

Moreover, the above rule can be expressed in a human-friendly way as follows:

IF Performance, THEN bonus point.

The condition can be a single condition like a simple equal judgment. Logical operators with simple requirements compose a complex one.

IF (Performance) and (the first author)

And the action part can comprise a single action or more actions. For example, we assign ten to a variable named point.

IF (Performance) and (the first author)

TEHN point = 10

A rule-based system consists of a set of human-coded rules. Although the most straightforward artificial intelligence system, rule-based systems are the best approaches for encoding human expertise [7].

The benefits of a rule-based system include simplicity, efficiency, and explicit expression. There are many differences between rule-based AI and machine learning systems. Firstly, rule-based AI models are deterministic. And machine learning systems are probabilistic. Secondly, a rule-based system does not require a large amount of data to train the model as a machine learning system does.

Concrete and determining criteria are needed to ensure the same results for the same input. Therefore, a rule-based system is appropriate for processing annual bonus applications.

2.3 Big Data

Data has been generated rapidly in recent years. Personal devices connected to the Internet contribute to the growing data. The expansion leads to extensive data research to utilize the increasing data. Although there is no uniform definition of big data, different meanings share some standard features. The characteristics of big data include velocity, volume, value, variety, and veracity [3].

Reporting and compliance are crucial application domains for big data in higher education [2]. The annual performance bonus is related to one kind of achievement reporting application.

Although big data technology is efficient in some cases, there are some disadvantages if not correctly used [12]. For example, faculty members have to search the changing bonus policy and find applicable criteria. The tedious non-academic process is tedious and frustrating.

2.4 Cloud Computing

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [10]. The characteristics of cloud computing include on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service.

There are three cloud service models, including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) [15]. These service models provide different levels of abstraction. Several deployment models of cloud computing exist, such as private and public clouds. Cloud resources are exclusively offered for a specific organization with a private cloud. The cloud resources are available to the public with a public cloud. A community cloud works like a private cloud, but resources are exclusive to two or more organizations rather than a single one. And the hybrid cloud composes of at least two cloud models above [6].

We adopted the private cloud deployment model and the software as a service model. With a private cloud deployment model, the system is only accessible to the staff at our university. And all information is stored in our data center. With the SaaS service model, faculty members can access the system on different devices anytime.

3 The Architecture of the Rule-Based Cloud System

This performance appraisal system consists of three components: the frontend, the backend, and the cloud servers. The cloud service provider offers the hardware and software platforms, such as database servers, application servers, rule engine servers, and web servers.

The backend includes management functions of the system, such as performance categories management, achievement, and monetary value management. The backend is a crucial part of the system. Different schools can design bonus policies independently. For example, one college may add the employed rate as an indicator of performance into the system. The existing type of achievements could be updated or deleted. The rule management model satisfies the requirements of varying policies and provides flexibility for schools. A new criterion could be added to the system. And existing rules could be updated without affecting the application processes.

The front end provides all functions for staff and members of school administration. Teachers upload their achievements through a web browser from anywhere. For each item, staffs set its properties by selecting from the performance database without guessing or keyboard input. This selecting feature reduces the probability of error inputs. Faculty members do not need to search the bonus policies with the system. Therefore, the system reduces the workload for teachers.

The architecture of the rule-based cloud system is shown in Fig. 1.

School administrators should set performance categories, premises, and rules before staff upload achievements. All performance categories, antecedents, and criteria would be stored in the rule database.

Faculty members could apply for annual bonus pay by uploading achievements. Staffs select and set the properties for each item when inputting an achievement into

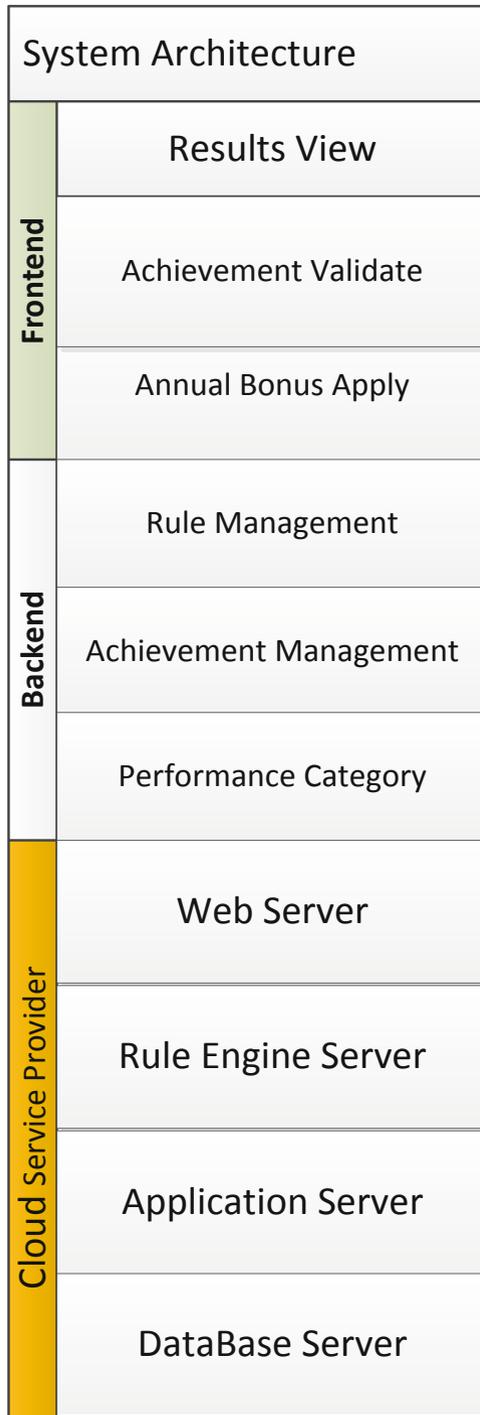


Fig. 1. The system architecture.

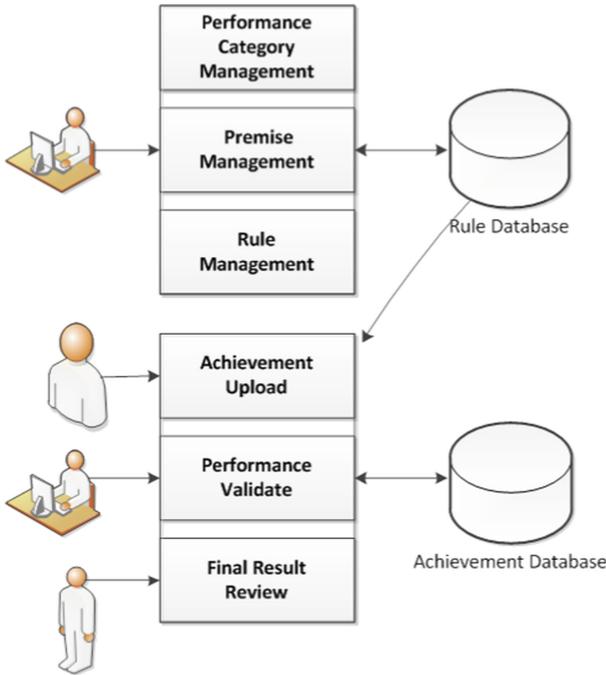


Fig. 2. The system functions

the system. All achievements will be stored in the achievement database. The rule database and the application database enhance the reuse ability. The design also optimizes operations for rules management and application management.

After faculty members submit their applications, members of the school committee can validate their achievements. If the members have any doubt, they can return the application to the teachers. Then the teachers could update and resubmit achievements.

All staff can review the final results to improve transparency. The final result review model has three objectives. One aim is to ensure every member has the right to apply for an annual bonus. No one will be ignored because every submission is published online. Another goal is to keep equality among all members. The same criteria are applied to every staff equally. The third purpose is to spur faculty effort to work hard and achieve better performance. The different roles and functions are shown in Fig. 2.

4 Experiment

Different annual bonus policies exist in Chinese universities. Policies may change every year at a university. For example, yearly bonus criteria vary in other schools at the Beijing Institute of Graphic Communication (BIGC).

Usually, schools set up rules for the last year’s performance after the money is available this year. Schools designed their criteria for the year 2021 annual remuneration in

March 2022. The department of mechanical and electrical engineering set up rules covering four categories, including teaching performance, academic achievement, student work, and laboratory efforts. Each accomplishment should fall into only one of the four categories. Each item was assigned a mark. The rules specify how much the impact for an item is. For example, for a reward of national teaching, the function is:

$$f(y) = \begin{cases} 1000, & y \in [\text{the 1st reward of national teaching}] \\ 800, & y \in [\text{the 2nd reward of national teaching}] \\ 600, & y \in [\text{the 3rd reward of national teaching}] \end{cases} \quad (1)$$

To encode the above function with IF-THEN rules, we first transferred the condition into atom ones.

- A₁ → the first class
- A₂ → the second class
- A₃ → the third class
- P₁ → National teaching reward

Then we designed the following rules:

- IF A₁ ^ P₁ THEN point = 1000
- IF A₂ ^ P₁ TEHN point = 800
- IF A₃ ^ P₁ THEN point = 600

When faculty members apply for an annual bonus, they input valid achievements from four categories. The system would determine the points for each item input. And the final grade of staff was calculated by adding points from all items with the following function.

$$f(x) = \sum_{i=1}^4 \sum_{j=1}^n \text{point}_{ij}, \quad i \in [1, 4], j \in [1 \dots n] \quad (2)$$

Where point_{ij} is the point for an item j in category i.

The money for a single point is related to the total bonus for the school and the sum of points.

$$p = \frac{\text{TotalBonus}}{\sum_{i=1}^n \text{point}_i}, \quad j \in [1 \dots n] \quad (3)$$

Where n is the number of staff applying for an annual premium.

The final yearly extra pay for a faculty member is calculated with the following formula.

$$m(x) = p * f(x) \quad (4)$$

Where p is the unit money for a single point, and f(x) is the total points for staff x.

We employed this system for processing the annual performance bonus evaluation in March 2022. The department is mechanical and electrical engineering at BIGC.

5 Results

All faculty members from the department applied for the annual performance bonus of 2021. Sixty-one faculty members were working in the department.

All faculty members input information and upload related achievement documents into the cloud system. For each item input, the system could show them the corresponding points of the item according to the rules. The system calculated and displayed the sum grade dynamically. All staff submitted their data within a single day. Usually, it took members one week to fill the excel sheets and submit their material without the system.

When information and documents were in the system, the committee member of the school could validate each item. If there were any doubts, the committee would return them to the teacher. And the staff could modify and resubmit the information. If the committee approved the items, all faculty members could review the final results. All work was done on the cloud system.

6 Discussion

The presented rule-based cloud system allows faculty members to submit their materials online for applying the annual bonus. Staff could view the point for each item input and the final sum points of their achievements. The system facilitated the annual bonus application process. The characteristics included easy usage, transparent rules, and instant calculation. Experimental results showed that the staff finished their submissions in a shorter time with the system than with traditional ways. The rule-based system allowed teachers to focus on their achievement according to the criteria. Faculty members do not worry about the specific points for each item. The system will display the grade for each achievement. The sum is calculated automatically and highlighted in red, as shown in Fig. 3. Therefore, the system could motivate staff to put more effort to achieve more.

Although the system shorted the time needed for staff in applying for an annual performance bonus, teachers had to collect material related to their achievements last year. It may be challenging to recall achievements gained in the previous year. It is also tedious to look for supportive documents for each item. Therefore, we will work to minimize members' workload in the future.

Achievement

Attachment

Achievements List Total Points: **1000**

Category	Achievement	Points	Action
Teaching	National Reward and first Class	1000	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

Fig. 3. The automatic calculating interface

7 Conclusion

The rule-based cloud system evaluated performance and calculated the annual bonus of staff in Chinese universities. The system enabled faculty members to input their documents online and to view the point for each item input. The final sum was calculated automatically according to the rules set by the school. The system lessened the burden on teachers for applying annual performance bonuses. The rule-based cloud system could motivate staff to work hard to achieve more by providing transparent public rules and easy usage. We will improve the information collection process to reduce the workload in the future.

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