

Construct Post Competency Model Based on the Big Data Technology

Feng Jing

Business Administration, aSSIST University46, Ewhaycodae 2-gil, Seodaemun-gu, Seoul, Korea

Mail id: 1145433501@qq.com

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Abstract:

This study aimed to explore one construction method of competency model by big data technology. In the first stage, The data were collected from the recruitment website by Web Crawling. The data analysis was done through text mining using Python to obtain the characteristics of competency elements. In the second stage, part of the data came from the questionnaire survey. The data were analyzed by factor analysis, analytic hierarchy process, and k-means cluster analysis using SPSS, which was to give weight through subjective and objective combination. The results of this study revealed that the competency model of the company's software project manager is constructed. The model included five dimensions: professional ability, self-improvement, personal charm, personal characteristics, and work practice. The weights account for 28.59%, 15.36%, 15.17%, 18.58% and 22.31% respectively. The five dimensions contain 34 indicators, among which the top ones are organization and coordination ability of 7.9%, systematic thinking ability of 6.99%, problem analysis and problem-solving ability of 4.65%, correct values of 4.84%, unity, and cooperation of 4.81% and forward-looking ability of 4.13%. Traditional methods lack a quantitative way in the data collection and analysis stage, resulting in the lack of objectivity of the results. The study improved this situation. The method of a building competency model is enriched by big data technology. At the same time, the subjective and objective combination weighting method effectively avoided the limitations of being too subjective or too objective.

Keywords: Big data technology, Competency model, Text mining, Software project manager, Python

1. Introduction

McClelland (1973), a famous psychologist at Harvard University, firstly put forward the concept of competence in the research on the method of selecting diplomats and believed that competence is the individual character of the designated organizational environment and it can distinguish individual performance. However, post competency should meet the general characteristics of the industry, then the organizational needs of the company, and finally, the needs of the post responsibility. The construction method of the traditional competency model is subjective. Big data technology makes data sources more diversified. Massive data can be deeply mined, which can help improve the scientificity of decision-making.

Shum et al. (2018) studied the competency model of senior executives from the perspective of strategic management. They found that in the stage of strategy formulation, senior executives' competency mainly consists of five elements: global concept, decision-making and judgment ability, information capture ability, rational analysis ability, and change and innovation ability. In the stage of strategy implementation, senior executives' competency consists of team cooperation ability, coordination and organization ability, authorization and empowerment, incentive leadership ability Human communication ability and corporate culture construction are composed of six elements (Caena & Redecker, 2019). In the stage of strategic control and evaluation, it is composed of five elements, namely insight, self reflection, quick response, financial statistics and stress tolerance (Dzwigol et al., 2020). From the perspective of institutional capacity, believed that the entrepreneurial institutional capacity is the ability of private entrepreneurs to implement institutional innovation

and act on the growth of enterprises (Reis et al., 2020). In addition, other scholars focused on the ability to capture opportunities, commitment, learning ability, thinking ability, integrity spirit and practical spirit (Xu et al., 2009).

In the above research, although it reflects the relatively macro division of competency dimensions of senior managers and the more fine-grained description of competency elements, this division of competency dimensions is mainly based on the perspective of strategic management and has limitations in application. At the same time, in reflecting the core connotation of the definition of competency, it neglects the investigation of entrepreneur personality and knowledge management. In general, the biggest shortage of the literature related to general competence is the lack of situational background analysis of specific types of enterprises, which leads to doubts about the value of practical application.

In the relationship between competency and performance, career development, Teimouri et al., (2018) proposed that employees' competency can positively predict their job performance, and employees' salary plays a regulating role in it. The empirical research of Shet et al. (2019) points out that individual competence can not only significantly improve individual performance, but also has a significant positive relationship with organizational performance. By constructing structural equation model, it is confirmed that employability based on competency has a positive impact on employees' current performance and career success. Annisa et al., (2020) takes human resources professionals as the research object, and through empirical research, it is confirmed that the competency of human resources professionals has a strong correlation with individual performance. To sum up, the existing research has clearly defined the concept of competency, and also explored its application from various aspects. Among them, competency model is widely used in employee performance and career management. In terms of recruitment, enterprises mostly apply it to interview selection, but rarely involve it in resume screening.

Through the application of big data technology, the competency model can be built more quickly and effectively, and presents dynamic characteristics with the times and enterprise development. That is, when the organizational structure of the enterprise changes, when the external market changes or the employees with outstanding performance change, the system can timely analyze the data and dynamically adjust the competency model (Mehmood, 2021). Manual statistical analysis is prone to errors, heavy workload, low efficiency and other shortcomings, while the emergence of big data can effectively avoid these problems.

This paper takes software project manager competency as the core, starting from the current project management situation of DW Company, analyzes some problems existing in the current project manager post competency, and obtains the necessity of building a post competency model. Firstly, the competency index of the software project manager of DW company is determined. By using web crawler and text mining under big data technology, the high-frequency words of software competency are extracted from the demand data of massive recruitment websites, and then the competency index suitable for DW company's software project manager positions is extracted from the company's strategic objectives, job responsibilities and key behavior interviews. Secondly, the weight of each index is determined, the subjective and objective sample data for competency indicators are obtained through questionnaire survey, factor analysis and difference analysis are carried out by SPSS, and the objective weight of competency indicators is determined by principal component analysis. Finally, the objective weight and subjective weight are combined by the mean value method to form subjective and objective combined weights. The competency model of software project manager in DW company is constructed.

The purpose of this paper is to construct the competency model of software project manager of DW company, and explore the application of this model in the selection, recruitment, training and performance evaluation of software project manager positions, so as to better meet the demand and development needs of DW company for software project manager, and hope to make some contributions to the human resources work of DW company. Under this plan, DW Company pays more attention to the quality and structure of software project managers, rather than the required number of people, so as to better help DW Company realize its strategic transformation goals, realize its future vision and maintain its competitive advantage in the software information industry.

The theoretical significance of this study is that the research on competency model in China has developed rapidly in recent years. There are many kinds of competency models of human resource management,

involving enterprises in different industries. However, there are relatively few studies on the application of competency models to the talent cultivation of software enterprise. Based on the DW competency model, this study analyzes the training needs of employees in DW Software Company, and puts forward relevant suggestions for improving the company's employee training. It can effectively make up for the lack of theoretical research.

The practical significance of this study is to explore the application of the model in the selection, recruitment, training and performance appraisal of software project managers, so as to better meet the needs and development needs of DW Company for software project managers, and expect to make certain contributions to the human resources work of DW Company. Under this kind of planning, DW Company pays more attention to the quality and structure of software project managers than the required number, so as to better help DW Company achieve its strategic transformation goals and achieve its future vision.

The contribution of this paper is that in terms of research methods. It uses technologies related to big data, obtains massive data from recruitment websites for job requirements, and uses text mining technology for analysis, as an important link in the extraction of competency indicators. The result is to supplement the deficiencies of the traditional competency model, enrich the number of samples, and improve the regional limitations of the samples. At the same time, the traditional method is mainly evaluated from the perspective of its own work, which is not considered from the perspective of Party A's real needs. This has been improved through big data. Secondly, the combination of subjective and objective weighting effectively reduces the absolute nature of objective weighting and the artificial influence of subjective weighting. It has certain reference significance to build competency models for people in different industries and positions. This paper takes the position of software project manager as an example, selects DW of a software company, and establishes a competency model for the position of software project manager.

Use the web crawler to capture the recruitment information of the recruitment website, and conduct text mining on the job description and job responsibility fields in the recruitment information to obtain the characteristics of job competency elements. Take DW enterprises as specific research cases to collect the actual needs of DW companies to optimize the characteristics of competency elements. Use factor analysis for objective weighting, analytic hierarchy process for subjective weighting, and mean method for combination weighting to establish a software manager competency model with element characteristics and weights.

The study introduced the background and significance in the introduction section, and combed the relevant literature on the construction of competency model in the literature review section. The key module of this paper in the research method section, which specifically showed the construction method of competency model based on big data technology. Finally, the main conclusions of this paper are summarized in the conclusion section.

2. Literature review

Previous scholars have published a large number of research results on the competency of managers, business managers and senior managers. However, there are few research results on team competence, especially on senior managers' competence. Margerison (2001) put forward nine key factors, including suggestion, innovation, promotion and development, to build a team competency model. Chouhan & Srivastava (2014) put forward that team competence includes three dimensions: (1) knowledge, principles and concepts needed by the team to perform tasks effectively; (2) Skills and behaviors required to perform tasks effectively; (3) The attitude of team members to encourage effective team performance. The content of the three dimensions consists of nine elements: cognitive ability, problem-solving ability, organizational ability, communication, cooperation, motivation and so on.

Chandrasekaran et al. (2016) discussed the applicability of competency model in R&D team management of high-tech enterprises. Chandrasekaran et al. (2016) also analyzed the concept and characteristic dimensions of entrepreneurial team competency, the correlation between entrepreneurial team competency and entrepreneurial performance, and the influencing factors of entrepreneurial environment, and built a relationship model between entrepreneurial team competency and entrepreneurial performance. Cardon et al. (2019) studied the relationship between entrepreneurial team competency structure and corporate performance. Beatty & Queen's (2019) established the competency model of M&A enterprise senior management team by combining

theoretical analysis, qualitative research and empirical test research methods.

The following discusses the construction method of competency model. The development and construction of competency model is generally divided into two stages, namely, the development and construction of transitional competency model and the verification and confirmation of competency model. Through model development and verification, the transitional model development is to establish a competency model with excellent performance by studying and determining the characteristic factors of excellent performance competency, that is, knowledge, skills, experience, personality and other dimensions (Podmetina et al., 2018).

Scholars have done a lot of research on the construction methods of the post competency model, including questionnaire research, expert evaluation, interviews, etc., and introducing quantitative analysis. Wang et al. (2013) constructed the competency model of bank executives through the case study, questionnaire investigation, and factor analysis method. Through literature summary and expert interviews, combined with statistical data methods, established the intelligence personnel factor competency model. Expert evaluations and reliability analyses were conducted to construct an internationalized senior management team competency model including three dimensions. Shi et al. (2019) conducted behavioral event interviews with a random stratified sampling of public health professionals from 14 provinces in China. And constructed a competency model for public health personnel, including seven competency dimensions. Katuuk et al. (2019) collected data through interviews and found that performance is related to competence. Pouria et al. (2020) established a competency model for rural youth who start small and medium-sized enterprises.

Hitt et al. (2018) built a competency model based on behavioral event interview, which has been widely recognized and applied at home and abroad. The main process includes: determining the effective performance evaluation criteria, such as sales, profit, superior and subordinate evaluation, peer evaluation, etc., and selecting high-performance employees and general performance employees in research positions as the first group of samples. Define and measure the competency that can distinguish the performance of the two types of employees by using the methods of on-site observation, behavioral event interview, theme analysis and so on. Using hypothesis generation, topic analysis and concept formation to establish competency model; Re-select two sets of samples to verify the competency model and further improve the model; Application ability model.

Pinzone et al. (2019) believed that the influence of competency, job requirements and organizational environment on job performance was interactive. In different organizations, the competency characteristics of employees at the same or similar jobs were also different. Continuing this idea, Caena & Redecker, (2019) focused on the future trends that would affect the organization, job content, job or occupation by constructing the competency model. First of all, it isolates the key changes or trends that affect the organization, job content, job or occupation.

In management practice, some well-known multinational companies have established human resource management systems based on competence, and achieved good application results (Sabuhari et al., 2020). Competency-related research results are not only widely used in enterprise human resource management, but also applied to public education and government management in some countries (Coombe et al., 2020).

American Association of Middle School Principals established an index system for principals' ability (Grissom & Loeb, 2011). In the early 1990s, Britain developed the competency model for managers, which focused on skills and behaviors, professional qualifications, quality and characteristics, which greatly promoted the research and application of competency in public education (Iobst et al., 2010). Chinese scholars' research on competency model and related fields began in 1990s, and the initial research focused on the application of competency model in enterprise human resource management (Liu et al., 2019). In the 21st century, many scholars began to study the competency model of employees in the government and related public sector. Kim (2020) proposed to build the competency model of civil servants in provincial organs, providing a basis for the selection and training of civil servants in provincial organs.

With the advent of the era of big data, the corporate competency model has changed a lot (Prifti et al., 2017). The continuous development and application of the Internet, big data, cloud computing, etc. make a person's portrait clearer and clearer. Through big data, the competency model of a post is scientifically analyzed, forming a multi-dimensional, quantifiable and three-dimensional vivid portrait (Zang & Ye, 2015).

Entering the age of digital intelligence, it is often necessary to make decisions based on data to solve practical problems, which requires people to have the ability to collect, analyze and explain data, that is, the post

competency of data (Balakrishnan & Dwivedi, 2021). However, in the face of the massive, complex and diverse data generated by the use of big data technology, it is impossible to deal with these data effectively and timely only by human's own perception and computing ability. At this time, the intervention of big data can quickly, accurately and efficiently complete the collation and processing of data, and put forward suggestions for decision-making based on data. Only when people have the competence of artificial intelligence can they give full play to the role of artificial intelligence, treat the analysis results of artificial intelligence rationally, and make decisions that meet the actual needs and ethics (Long & Magerko, 2020). It can be seen that the competency of mathematical intelligence is the effective response of people to the current situation of the integration of mathematical intelligence, the adaptation to the "mathematical intelligence" environment, the application of mathematical intelligence technology and the pursuit of higher competitive goals. Mathematical intelligence competency is the organic integration of data competency and artificial intelligence competency, which reflects the new requirements and skills of the digital intelligence era.

Relevant theories of job competency. Competency is an important foundation for the development of various activities of enterprise human resource management and the construction of modern human resource management system, an effective basis for the effective training of employee recruitment, employee training and performance appraisal, and an effective means to promote enterprise performance improvement, core competitiveness construction and organizational change (Swanson et al., 2020).

The connotation of the theory of trait factors is to compare and match the subjective and objective conditions with the social vocational posts on the basis of a clear understanding of the subjective conditions of individuals and the requirements of social vocational posts, and finally choose a career that matches with the individual. It can be said that the theory of trait factors is based on the evaluation of human characteristics. It puts forward the idea of matching people with their jobs in career decision-making, and most of the theories on talent assessment widely used in today's enterprises are developed on the basis of this theory (Batool et al., 2022). In particular, the recruitment and selection of talents based on the post competency of enterprises strive to meet the requirements of people's knowledge, skills, personality, values, etc. and competent posts, which is also a reflection of the theoretical requirements of trait factors.

In the quality hierarchy of iceberg model, knowledge and skills are at the top. Knowledge refers to the theoretical reserves of employees in specific fields related to their posts, such as management knowledge, which is the basis for effective completion of work. Skills are the ability of employees to complete a certain job by integrating their knowledge, such as expression ability, which is also an important factor of performance. Values, attitudes and social roles in the next level are closely linked. Values include employees' understanding of life, judgment of right and wrong, beliefs, etc., such as the spirit of cooperation. Attitude is the behavioral tendency and psychological drive of employees to deal with the persistence and stability of external things, such as sense of responsibility. Social role represents employees' understanding of social norms, and it is also an important embodiment of employees' behavior style, such as managers (Suoheimo et al., 2020). Self-image is a kind of self-display after employees have a clear understanding of their own abilities and roles, such as self-confidence, which often has a great impact on their performance. Personality and quality are the concrete manifestations of employees' personality traits, such as flexibility, which directly affect employees' typical behaviors. At the bottom, the internal drive and social motivation are expressed as the employees' inherent stable desire and demand, such as achievement orientation, which is the potential motivation for employees to work hard and achieve results, and also the key factor to produce high performance (Yastrebov & Bonnet, 2020).

It is believed that Building competency models have many ways, such as factor analysis, principal component analysis, analytic hierarchy process, fuzzy evaluation, etc., based on key behavior event interviews, questionnaires, expert judgment, etc. By sorting out the relevant literature, we find that scholars build competency models in different industries and positions by introducing statistical methods such as factor analysis, principal component analysis, analytic hierarchy process, fuzzy evaluation, etc., based on key behavior event interviews, questionnaires, expert judgment, etc. However, it is not difficult to find that the main ways to obtain samples in the past are questionnaire research and interviews. Although the data is also objective, problems constrained by the sampling method may lead to a small amount of sample data, or due to the regional limitations of the survey samples, the limitations of different company requirements and other objective reasons leading to the limitations of the sample itself, the lack of quantitative indicators. At the same time, the actual

object of previous research is mainly the personnel in the target post, and the personnel in the post will more evaluate the importance of the competency index from the perspective of their own work, but lack of consideration from the perspective of Party A's needs, which to some extent can not meet the changing needs of personnel management in enterprises. The advent of new Internet technologies can make up for these shortcomings. This paper extends the research on these two issues. The development of big data technology provides new ideas for the research methods and injects new power into human resource management by data collection, data processing, data mining, data presentation ability, etc. On the extraction method of competency index, use big data technology to obtain samples, and use Python design program to capture a large amount of software project manager job recruitment information. From the point of view of the massive job requirements of Party A, this paper analyzes the high-frequency words of job competence through text mining, increases the sample size, and provides the extraction method. Traditional methods lack quantitative research methods in the stage of data collection and analysis, resulting in the lack of objectivity of the results. Big data technology makes data sources more diversified. Deep mining of massive data helps to improve the scientificity of decision-making. This paper puts forward the construction method of the competency model supported by big data technology. It uses web crawler technology to capture a large number of target job recruitment information on the recruitment website. Through text mining, the high-frequency words of post competency in a large number of samples are analyzed to complete the extraction of competency indicators. In the model construction process, the objective weight is determined by factor analysis, the analytic hierarchy process determines the subjective weight, and the subjective and objective combination weight is determined by the mean method formula. It effectively avoids the limitations of too absolute objective weight and too perceptual subjective weight. In the process of model building, use factor analysis to determine objective weights, analytic hierarchy process to determine subjective weights, and use the mean formula to combine subjective and objective weights, effectively avoiding the limitations of objective weights too absolute, subjective weights too perceptual, and highly influenced by human factors.

3. Research method

In the first stage, big data technology is used to extract the characteristics of competency elements. Firstly, the research uses a web crawler to capture the job recruitment information of the recruitment website. Secondly, it focuses on text mining of non-institutional fields such as job description and responsibility so as to obtain the characteristics of job competency elements. Finally, combined with the actual needs of enterprises, optimize the characteristics of competency elements. The second stage is to assign weight. Firstly, factor analysis is used for objective weighting, thirdly, the analytic hierarchy process is used for subjective weighting, and finally, the mean method is used for combination weighting. The result is that we build a competency model of software managers with element characteristics and weights. Details are shown in Figure 1.

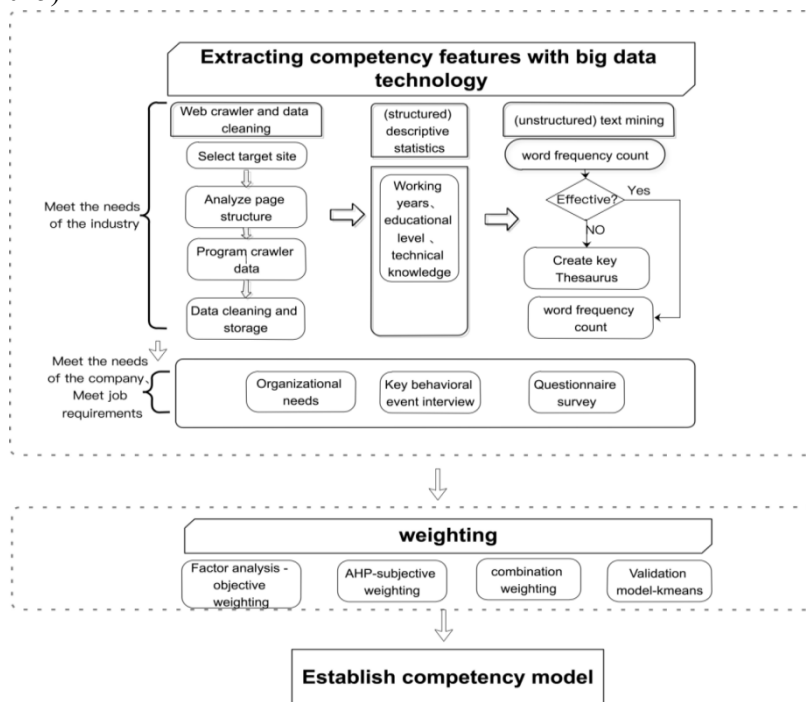


Figure 1. Flow chart of building competency model with big data technology

3.1. Sample for Data Collection

In this study, we use the python programming web crawler to obtain source data, then conduct text mining on the obtained post information data, and use Excel software as the data storage tool. The program automatically captures the recruitment information about the software project manager position on the recruitment website every day. The total amount of updated data on that day is about 600. In order to ensure the sufficiency of samples and the randomness of data, the program runs for 15 days. We finally eliminated duplication and obtained a total of 7355 recruitment information. In the study, we also used 34 related ability scales. Firstly, the questionnaire investigates the general situation of the respondents, including the company's position, age group, working years, the highest education and so on. Secondly, it contains 34 related ability Likert scale. Questionnaires were distributed to software project managers and experienced senior software engineers who have served as project managers. Questionnaires were collected and collected through questionnaire Star online survey, and a total of 79 questionnaires were recovered. 76 valid questionnaires were obtained, with an effective rate of 96.2%.

3.2. Web crawler and data cleaning

3.2.1. Select target site

In the study, we selected 51 job recruitment websites. On the one hand, the website has a large demand for talent recruitment. On the other hand, the job description and responsibility field structure is regular, which is more suitable for network crawling. This paper uses Python for website data crawling, inputs keywords, and the software project manager for directional crawling.

3.2.2. Analyze the page structure of the target website

The list page can collect the fields of position name, company name, publishing time, salary, and workplace. The fields on the details page are divided into two categories. One is structured data fields with regular structure, including position name, position responsibilities, position requirements, position category, company nature, company scale, company business direction, years, education, region, and release time. The second type of field is job responsibilities and job requirements, which belong to unstructured data. This paper needs to mine the unstructured fields of the detail page to get the word frequency related to competency.

3.2.3. Implementation of web crawler

Python program automatically captures the recruitment information of the software project manager on the recruitment website every day. The program flow is designed as follows:

Select each piece of data, in turn, find the corresponding network link URL, and form the URL list queue

of the recruitment details page.

Use regular expressions to analyze each URL in the URL list queue and jump to the corresponding details page.

Parse the detail page data using regular expressions.

Data package and download.

3.2.4. Bypass anti crawler

Most websites have set up anti crawler strategies. In order to get the content of the target page, the crawler must bypass the anti crawler policy. This paper replaces a randomly user-agent strategy to bypass the interception. Fake-user agent is a third-party open-source library, which can be used to change users _ agent randomly. Import the fake-user agent third-party library, then use the method of user agent random.

3.2.5. Data cleaning and storage

Clean the data obtained by the crawler. Eliminate incomplete data and invalid data, and roughly eliminate duplicate data according to the total length of the field content matched with the company name. Five storage files are designed for classified storage, as shown in Table 1.

Table 1. List of web crawler data storage files

Document description	Name	Purpose
Raw data source table	Data.csv	Used to store the downloaded original data
Deduplication data source table	DataSource.xlsx	Save the data after eliminating duplicate recruitment information.
Recruitment company information form	CompanyResult.xlsx	Release recruitment company information
Automatic word cloud statistics	AutoWord.xlsx	Rely on the internal plug-in of the Python program to automatically count the word cloud of post information
Manual word cloud statistics	DesignWord.xlsx	Rely on the designed competency keyword database to count the job information word cloud

3.3. Descriptive statistics

Tableau Desktop software is used to summarize the data. It is summarized from the dimensions of educational level, working years, and required technical knowledge.

From the perspective of working years of software project manager, among the requirements for working years in all cities, 3-4 years of project manager experience is the most, followed by 5-7 years of working experience and 2 years of working experience; At the same time, this group of data can also directly show that the first-tier cities such as Beijing, Shanghai, Guangzhou, and Shenzhen have the largest demand for this post.

From the perspective of the educational level of software project managers, the number of requirements for a bachelor's degree is the largest. Among them, Shanghai has higher requirements for various academic levels than other cities, but among the requirements for a master's degree or above, Beijing ranks first, and there are no obvious requirements for a master's degree or above in other cities except Beijing, Shanghai, Guangzhou, and Shenzhen.

From the perspective of general IT skills, each company's requirements for project manager skills and knowledge include some general IT skills. The relevant skills and knowledge are summarized as follows:

Basic office software: word, Excel, PowerPoint, etc

Software development classes: Java, C ++, PHP, Python, JS, etc

Database classes: MySQL, Oracle, NoSQL, and other relational databases and non-relational databases

Software testing: LoadRunner, etc

Network and server clusters: Spring clouds, Hadoop, Kubernetes, Docker, network access

Agile theory knowledge: ACP

Project management: pfmp, PgMP, soft test, PRINCE2, IPMP, Gantt chart, Zen, Microsoft Project

The demand for the technical knowledge of the project manager ranges from the use of the most basic office software, to the use of programming language, database, flexible use of testing tools, to the idea of agile

development, and finally to the skills related to project management. The process is in line with the track of the learning and growth of the project manager. The use of basic office software is the most basic requirement for the skill factor of a project manager. The development of programming language is the only way for a project manager to grow up. CS/BS architecture programming and big data technology have witnessed the growth history of a project manager. As the last line of defense of product launch, software testing undertakes the most important task. Agile thinking, PMP certificate has become a high-level requirement for project managers.

3.4. Text mining

Based on the data results of a web crawler, aiming at the content of post content and post responsibility field, this study uses Chinese word breaking technology (n-gram) to remove redundant function words and obtains high-frequency words of competency to refine competency indicators.

3.4.1. Chinese word segmentation

Word breaking technology can be divided into the thesaurus method and the non-thesaurus method. This paper uses the word-based method to compare the documents word by word and line by line through the constructed thesaurus in advance and judge the words contained.

3.4.2. Create competency Keyword Thesaurus

Mcclelland (1973) studied the competencies required for more than 200 jobs around the world and finally extracted six groups, namely achievement orientation, personal effectiveness, serviceability, management ability, problem-solving ability, and influence, with a total of 20 general competency elements. However, because software projects are different from other engineering projects, they have their own industry characteristics. Therefore, in addition to the general competency index, it is also necessary to summarize the literature on the competency model of software project manager. the study finally sorted out 35 competency indicators for software project managers, specifically requirements engineering and cost estimation, software development technology, project management knowledge, relevant legal knowledge, psychological knowledge, system thinking ability, communication ability, adaptability, leadership, decision-making ability, risk identification and control ability Interpersonal ability, innovation ability, progress control ability, organization and coordination ability, goal orientation, overall concept, team building, affinity, dare to take responsibility, principle and flexibility, patience, detail, organization, noble morality, project management experience, execution, achievement orientation, initiative, self-confidence, seeking truth from facts, pressure resistance, learning ability, correct view of right and wrong Insight.

By manually reading and browsing 100 pieces of data in the recruitment information, add two competency indicators and corresponding descriptive words:customer-oriented and forward-looking. After removing synonyms, 37 competency indicators are finally determined, and the indicators are converted into 59 descriptive key Thesaurus. The finally determined key thesaurus is shown in Table 2.

Table 2. Software project manager competency key Thesaurus

Competency characteristics	Descriptive words - keyword Thesaurus
Demand engineering and cost estimation	Demand research and cost
Software development technology	Software development
Project management knowledge	Project management knowledge
Legal knowledge	Law
Psychological knowledge	Psychology
Decision making ability	Policy decision
communication skills	Communicate
Strain capacity	Flexible and flexible
Leadership	leadership

Interpersonal competence	Interpersonal
Systematic thinking ability	Systematic thinking
Risk identification and control capability	Risk control and risk identification
Innovation ability	Innovate
Schedule control capability	Progress control
Target location	Target
Global views	The overall situation, overall consciousness, and overall view
Organization and coordination ability	Organization, coordination, and organization ability
Team building	Authorization, team building, recruitment, training, cooperation, and incentive
Affinity	Affinity
Dare to take responsibility	Responsibility
Principle and flexibility	Principle
Patience	Patience
Careful	Careful
Organization	Organized
High moral character	Character
Project management experience	Project management experience, working experience, development experience, development experience
Executive power	Executive power
Achievement orientation	Enterprising and achievement motivation
Initiative	Active
Self-confidence	Self-confidence
Seek truth from facts	Seek truth from facts and be sincere
Compressive capacity	Pressure and bearing capacity
The correct view of right and wrong	Values, right and wrong
Learning ability	Understanding and learning
Forward-looking	Forward-looking and strategic thinking
Customer orientation	Customer orientation and customer awareness

3.4.3. Word frequency statistics

The position information field in the data_source.xlsx file is the original data source. Take the descriptive words of the key thesaurus as the input parameters, traverse the data source text and match the keywords. Add one after matching the keywords. Add one after matching the keywords. The statistical results of competency high-frequency words A1, A2... A37 are shown in Table 3. Excluding the competency indicators whose frequency is less than 200, 28 updated features are obtained: organization and coordination, communication ability, progress control, project management experience, team building, software development technical

knowledge, demand engineering and cost estimation, risk identification and control, dare to take responsibility, learning ability, goal orientation, pressure resistance, initiative, systematic thinking ability, project management knowledge Executive ability, innovation ability, adaptability, foresight, correct view of right and wrong, seeking truth from facts, decision-making ability, self-confidence, interpersonal ability, customer orientation, achievement orientation, overall awareness, and leadership.

Table 3. Statistical results of high-frequency words of software project manager competency

Num	Competency characteristics	Frequency	Num	Competency characteristics	Frequency
1	Organization and coordination	23663	21	Seek truth from facts	512
2	Communication skills	18460	22	Decision making ability	509
3	Progress control	14081	23	Self-confidence	375
4	Project management experience	10950	24	Interpersonal competence	326
5	Team building	10773	25	Customer orientation	279
6	Software development technology	9107	26	Achievement orientation	254
7	Demand engineering and cost estimation	5654	27	Global consciousness	243
8	Risk identification and control capability	5260	28	Leadership	214
9	Dare to take responsibility	5041	29	Organization	168
10	Learning ability	2882	30	Affinity	166
11	Target location	2816	31	Patience	141
12	Compressive capacity	2283	32	Principle and flexibility	115
13	Initiative	1977	33	High moral character	92
14	Systematic thinking ability	1692	34	Relevant legal knowledge	80
15	Project management knowledge	946	35	Careful	59
16	Executive power	901	36	Insight	48
17	Innovation ability	695	37	Psychological knowledge	20
18	Strain capacity	679			
19	Forward-looking	672			
20	The correct view of right and wrong	554			

3.5. Optimize competency characteristics

The competency characteristics extracted by big data technology can better meet the needs of the industry. Next, it is necessary to combine with the reality of the enterprise to build a competency model that meets the needs of the enterprise. This stage is divided into two steps. The first step is to optimize the competency characteristics by matching the company's strategic objectives, job responsibilities and key behavior interviews. After the implementation of these measures, six abilities have been added: unity and cooperation, problem analysis and problem-solving ability, professional dedication, information collection ability, quality awareness and industry business knowledge of the company. 34 competency characteristics were obtained. The second step is to compile the competency questionnaire, analyze the survey data, establish the element feature weight, and finally build the competency model of the software project manager.

3.6. Subjective and objective combination weighting

3.6.1. Factor analysis to determine the objective weight

SPSS (Statistical Package for the Social Sciences) software was used to conduct factor analysis on the

preprocessed questionnaire data. Kaiser–Meyer–Olkin (KMO) test and Bartlett test were used to verify the suitability of factor analysis. It can be seen from table 4 that KMO is 0.883, greater than 0.6, indicating that it can be used for factor analysis. $P < 0.05$. Bartlett’s sphericity test showed that it was suitable for factor analysis.

Table 4. KMO value and Bartlett test

	KMO	0.883
Bartlett test	Approximate Chi-square	2358.277
	Degree of freedom DF	561
	P value	0.000

The interpretation degree of the total variance in the results of factor analysis is shown in Table 5: from the information in the table, we can see that there are five factors extracted from factor analysis, and the eigenvalues are greater than 1. The variance interpretation rates of the five factors after rotation are 18.857%, 14.100%, 13.283%, 12.790%, and 11.505%, respectively, and the cumulative variance interpretation rate after rotation is 70.535%, which can cover most of the information of the original variables. So, the common factors are extracted by principal component analysis. The results are shown in Table 6.

Table 5. Interpretation of total variance

Num	Interpretation rate of variance before rotation			Interpretation rate of variance after rotation		
	Total	Percentage variance	Accumulate %	Total	Percentage variance	Accumulate %
1	17.535	51.574	51.574	6.411	18.857	18.857
2	2.661	7.827	59.401	4.794	14.1	32.957
3	1.422	4.183	63.584	4.516	13.283	46.24
4	1.279	3.762	67.346	4.349	12.79	59.03
5	1.084	3.189	70.535	3.912	11.505	70.535

Table 6. Common factor list

Common factor name	Characteristics of competency elements	Common factor name	Characteristics of competency elements
(Common factor 1)	Demand management and cost accounting	(Common factor 3)	Characteristics of competency Elements
Professional ability	Ability to analyze and solve problems	Personal charisma	Aggressiveness
	Project management experience		Executive power
	Technical knowledge of software development		Global views
	Systematic thinking ability		Leadership
	Progress control		Target location
	Decision-making ability		Self-confidence
	Company industry business knowledge	(Common factor 4)	Correct values
	Project management knowledge	Personal characteristics	Honesty and trustworthiness
(Common factor 2)	Interpersonal skills		Sense of responsibility

Self promotion	Development and innovation ability		Team building
	Forward looking		Strain capacity
	Information collection capability		Risk identification and control
Customer orientation	(Common factor 5)		Effective communication skills
Learning and growth	Work practice		Unity and cooperation
Quality consciousness			Organization and coordination
Achievement motivation			Compressive capacity
			Dedication

Objective weight calculation method as the following formula: the first step is to calculate the product (StandW_i) of competency characteristic component coefficient (Z_i) and common factor weight(λ_i). The second step is normalization.

$$W_i = Z_i * \lambda_i$$

$$StandW_i = W_i / \sum_{j=1}^{34} W_j, (i = 1, 2, \dots, 5)$$

Finally, the objective weight is calculated, and the results are shown in Table 7 and Table 8.

Table 7. Common factor objective weight

Common factor name	Variance interpretation rate after rotation(%)	Cumulative(%)	Weight(%)
Professional ability	18.857		26.73
Self promotion	14.1		20
Personal charisma	13.283	70.535	18.83
Personal characteristics	12.79		18.13
Work practice	11.505		16.31

Characteristics of competency elements	Objective weight coefficient	Objective weight	Characteristics of competency elements	Objective weight coefficient	Objective weight
Project management experience	0.068	0.047	Team building	0.042	0.029
Compressive capacity	0.065	0.045	Company industry business knowledge	0.04	0.027
Aggressiveness	0.064	0.044	Sense of responsibility	0.039	0.027
Forward-looking	0.061	0.042	Dedication	0.039	0.027

Technical knowledge of software development	0.06	0.041	Effective communication skills	0.038	0.027
Interpersonal skills	0.06	0.041	Leadership	0.038	0.026
Demand management and cost accounting	0.06	0.041	Target location	0.036	0.025
Honesty and trustworthiness	0.057	0.039	Strain capacity	0.035	0.024
Executive power	0.057	0.039	progress control	0.032	0.022
Self-confidence	0.055	0.038	Information collection capability	0.032	0.022
Correct values	0.052	0.036	Customer orientation	0.027	0.018
Organization and coordination	0.052	0.036	Risk identification and control	0.025	0.017

Table 8. Objective weight of competency element characteristics

3.6.2. Analytic hierarchy process and determination of subjective weight

According to the system established by factor analysis above, the analytic hierarchy process is used to give weight to the characteristics of each element. Software project manager post competency A is the goal of decision-making, the highest level of the hierarchy. As the second layer, the public factor layer includes professional ability, personal improvement, personal charm, personal characteristics, and work practice. Take 34 specific features as the third layer and draw the hierarchical structure diagram. The expert judgment matrix is established, and the subjective weight of the competency index is determined on the premise of passing the consistency test. Pass C_i and C_r verification. The final weight results are shown in the following table 9.

Table 9. Objective weight of competency element characteristics

Common factor	Characteristics of competency elements	Subjective weight
Professional ability	C11 demand management and cost accounting	0.022
	C12 problem analysis and problem-solving ability	0.057
	C13 project management experience	0.024
	C14 technical knowledge of software development	0.011
	C15 system thinking ability	0.106
	C16 progress control	0.017
	C17 decision making ability	0.012
	C18 company industry business knowledge	0.038
	C19 project management knowledge	0.017
Self promotion	C21 interpersonal relationship handling	0.022
	C22 development and innovation ability	0.013
	C23 forward looking	0.040
	C24 information collection capability	0.007
	C25 customer orientation	0.012
	C26 learning and growth	0.005
	C27 quality awareness	0.008

	C28 achievement motivation	0.006
personal charisma	C31 proactive	0.013
	C32 executive force	0.042
	C33 overall concept	0.020
	C34 leadership	0.008
	C35 target positioning	0.057
Personal characteristics	C41 confidence	0.015
	C42 correct values	0.061
	C43 honesty and trustworthiness	0.022
	C44 sense of responsibility	0.033
	C45 strain capacity	0.010
	C46 team building	0.007
	C47 risk identification and control	0.014
Work practice	C51 dedication	0.031
	C52 effective communication skills	0.039
	C53 solidarity and cooperation	0.065
	C54 organization and coordination	0.122
	C55 compressive capacity	0.023

3.6.3. Subjective and objective combination weighting

In this paper, the mean method is used for subjective and objective combination weighting. Comprehensive weight, including subjective weight and objective weight. Firstly, normalize the to obtain a unified measurement standard, and then calculate the arithmetic mean. The calculation formula is as follows. The calculation results are shown in Table 10.

$$w_i = \alpha_i / \sum_{i=1}^{34} \alpha_i$$

$$w_j = \alpha_j / \sum_{j=1}^{34} \alpha_j$$

$$AvgW_{ij} = (w_i + w_j) / 2$$

Table10. Comprehensive weight of competency element characteristics

Common factor	Characteristics of competency elements	Subjective weight	Objective weight	Comprehensive weight
Professional ability	C11 demand management and cost accounting	0.022	0.041	0.032
	C12 problem analysis and problem-solving ability	0.057	0.036	0.046
	C13 project management experience	0.024	0.047	0.035
	C14 technical knowledge of software development	0.011	0.041	0.026
	C15 system thinking ability	0.106	0.034	0.07

	C16 progress control	0.017	0.022	0.02
	C17 decision making ability	0.012	0.013	0.012
	C18 company industry business knowledge	0.038	0.027	0.033
	C19 project management knowledge	0.017	0.006	0.012
Self promotion	C21 interpersonal relationship handling	0.022	0.041	0.032
	C22 development and innovation ability	0.013	0.036	0.024
	C23 forward looking	0.04	0.042	0.041
	C24 information collection capability	0.007	0.022	0.014
	C25 customer orientation	0.012	0.018	0.015
	C26 learning and growth	0.005	0.011	0.008
	C27 quality awareness	0.008	0.012	0.01
	C28 achievement motivation	0.006	0.011	0.008
Personal charisma	C31 proactive	0.013	0.044	0.028
	C32 executive force	0.042	0.039	0.041
	C33 overall concept	0.02	0.029	0.024
	C34 leadership	0.008	0.026	0.017
	C35 target positioning	0.057	0.025	0.041
Personal characteristics	C41 confidence	0.015	0.038	0.026
	C42 correct values	0.061	0.036	0.048
	C43 honesty and trustworthiness	0.022	0.039	0.031
	C44 sense of responsibility	0.033	0.027	0.03
	C45 strain capacity	0.01	0.024	0.017
	C46 team building	0.007	0.029	0.018
	C47 risk identification and control	0.014	0.017	0.016
Work practice	C51 dedication	0.031	0.027	0.029
	C52 effective communication skills	0.039	0.027	0.033
	C53 solidarity and cooperation	0.065	0.031	0.048
	C54 organization and coordination	0.122	0.036	0.079
	C55 compressive capacity	0.023	0.045	0.034

Finally, the competency model of the company's software project manager is obtained. The model includes specific competency characteristics and weights: it includes five dimensions: professional ability,

self-improvement, personal charm, personal characteristics, and work practice. The weights account for 28.59%, 15.36%, 15.17%, 18.58% and 22.31% respectively. It can be seen that professional ability and work practice ability are the most important for the project manager position of the target company. The five dimensions contain 34 indicators, among which the top ones are organization and coordination ability of 7.9%, systematic thinking ability of 6.99%, problem analysis and problem-solving ability of 4.65%, correct values of 4.84%, unity and cooperation of 4.81%, and forward-looking ability of 4.13%. See Table 11.

Table 11. Competency model of software project manager

Primary index	Specific indicators	Weight
Professional ability 28.59%	Demand management and cost accounting	3.20%
	Problem analysis and problem-solving ability	4.60%
	Project management experience	3.50%
	Technical knowledge of software development	2.60%
	System thinking ability	7.00%
	Progress control	2.00%
	Decision making ability	1.20%
	Company industry business knowledge	3.30%
	Project management knowledge	1.20%
	Self promotion 15.36%	Interpersonal relationship handling
Development and innovation ability		2.40%
Forward looking		4.10%
Information collection capability		1.40%
Customer orientation		1.50%
Learning and growth		0.80%
Quality awareness		1.00%
Achievement motivation		0.80%
personal charisma 15.17%	Proactive	2.80%
	Executive force	4.10%
	Overall concept	2.40%
	Leadership	1.70%
	Target positioning	4.10%
Personal characteristics 18.58%	Confidence	2.60%
	Correct values	4.80%
	Honesty and trustworthiness	3.10%
	Sense of responsibility	3.00%
	Strain capacity	1.70%
	Team building	1.80%

	Risk identification and control	1.60%
	Dedication	2.90%
	Effective communication skills	3.30%
	Solidarity and cooperation	4.80%
	Organization and coordination	7.90%
Work practice 23.31%	Compressive capacity	3.40%

3.6.4. K-means clustering verification

In order to verify the feasibility of the competency model, the K-means cluster analysis method is used to verify the model. The clustering results are shown in Table 12.

Table 12. Comparison results of variance analysis of cluster categories (mean ± standard deviation)

Name	Cluster_1(n=10)	Cluster_2(n=57)	Cluster_3(n=23)	p
Self promotion	25.31±0.81	23.48±0.41	24.08±0.57	0.000*
Personal charisma	14.80±0.43	9.74±0.27	13.48±0.24	0.000*
Personal Characteristics	16.62±0.39	11.42±0.36	12.00±0.44	0.000*
Self promotion	17.01±0.55	12.19±0.45	11.29±0.74	0.000*

It can be seen from table 2 that: $P < 0.01$, three groups are obtained by cluster analysis, and their characteristics in the research items are obviously different. As can be seen from the figure, all items are clustered into three categories, cluster_1, all indicators are relatively high, among which the personal charm and personal characteristics are significantly higher than the other two categories, which can be defined as senior project managers. Cluster_2 all indicators are relatively low and can be defined as junior project managers—cluster_3. Cluster is higher than junior project manager in self-improvement and work practice_3. Have better learning ability and practical ability, which can be defined as intermediate project manager. From this classification, it is obvious that the project managers of various categories are not very different in terms of professional ability, and senior project managers have strong advantages in personal charm and personal characteristics. Intermediate project managers have better self-improvement and work practice abilities than junior project managers. Overall, the results of the analysis are consistent with the reality, and it can be preliminarily concluded that the competency model is feasible.

To sum up, the K-means cluster analysis method preliminarily verifies that this model is feasible.

4. Conclusion

This paper did some research on how to build a competency model based on big data technology put forward a construction method. Wrote python program to capture the data of Internet recruitment websites through web crawler .then used text mining to analyze the high-frequency words of post competency, so as to expect the competency characteristics of the target post to meet the characteristics of the current industry. On this basis, taking a software company as an example, combined with the actual situation of the enterprise, comprehensively considering the company’s strategy and post responsibilities, using key behavior event

interviews and questionnaires to obtain first-hand data, and constructing a competency model in line with the actual situation of the enterprise through factor analysis, analytic hierarchy process, subjective and objective combination weighting method.

The limitation of this article is that the role of big data in the competency model is still at the exploratory stage, has not been widely used in management practice, and there are still many problems that need to be further solved. First, in the early stage of big data construction, organizations need to invest a lot of experience. At the same time, the introduction of advanced technology requires a large amount of financial support, which will impose a considerable burden on the capital chain of enterprises. At present, big data lacks the knowledge of the research results of cognitive science, psychology and other disciplines on competency models. How to apply AI, big data, emotion recognition and other technologies to competency models still needs further exploration.

Second, which positions are applicable to the competency model built by big data in the actual management process of the enterprise. How to maximize the input-output benefits. What capabilities do managers need to have when using this tool. In the process of data mining and analysis, how to master an appropriate "degree" to effectively collect data and avoid personal privacy information needs scholars to think deeply (Cao & Dong, 2021).

Third, according to the quantitative level model of data big data job competency, further improve and clarify the job responsibilities and qualifications of talents in data enterprises (Daouk-Öyry et al., 2021). On the basis of traditional data mining, data collection and data editing, add knowledge and basic skills such as big data processing, visual interaction design, etc. Based on the competency model, gradually improve the training methods of enterprise employees.

The significance of this study is that big data is one of the key measures to build a job competency model. It is of great significance to the construction of enterprise talent team and the formation of an effective human resources supply chain. It can not only promote the transformation of traditional post competency model, but also better communicate and cooperate with computer, interactive design and other talents, and improve the enterprise's data capability through team big data. Therefore, it is necessary to improve the training content of enterprises according to the quantitative level model of post talents' competency, especially to increase the training of basic computer knowledge and skills, so as to improve their ability to use computers skillfully; Increase the training of basic data knowledge and skills, and improve their ability to acquire, process, analyze and integrate data; Increase the training of basic knowledge and skills of human-computer interaction, and improve their interaction and visual design capabilities.

The inadequacy of this study is manifested in the subjective and objective combination of empowerment. At present, the method of taking the mean value after normalization is adopted. In the subsequent research, the combination of weighting can be combined with game theory. The concept of game theory is to find a balance between different methods, keep the advantages of each method, make the inconsistency tend to be unified, and minimize the deviation. The trade-off between subjective and objective weights is in line with the idea of game theory and should be improved in the follow-up study. In addition, in the follow-up study, we can explore the use of neural network BP algorithm to collect all samples of the company and make an overall evaluation and prediction of the position competency of DW company based on the competency model, and put forward suggestions for the current talent structure and talent matching level of DW company.

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Conflict of Interest

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