

Research on Model Construction and Countermeasures of Knowledge Workers' Work Fatigue from the Perspective of Green Performance Evaluation

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ABSTRACT

Objective: Against the background of green development, the research on knowledge workers' work fatigue is helpful to improve their physical and mental health and work efficiency, so as to improve enterprises' green performance and strengthen their market competitiveness. **Methods:** With reference to the General Burnout Scale (BMI -GS), the scale was constructed from six dimensions: working environment, organizational system, interpersonal communication, self-cognition, emotional exhaustion and personality characteristics. 559 valid questionnaires were distributed to employees of different enterprises, and the scale structure was obtained by factor analysis. The AMOS structural equation model verified the structural validity, and Cronbach's alpha coefficient was used to evaluate the internal consistency of the scale. Through difference analysis, the work fatigue status of knowledge workers of different ages, genders, working years and job categories was further explored. **Results:** The alpha coefficient of Cronbach's scale is 0.785, which has good internal consistency and accords with the scale standard. Exploratory factor analysis has extracted 6 factors, and confirmatory factor analysis shows that the fitting indexes are good, all of which have good structural validity. There are significant differences in organizational system and emotional exhaustion between different types of knowledge workers.

Keywords: Work fatigue, Knowledge workers, Analysis, Green development.

1. INTRODUCTION

From the blueprint of "promoting green development, circular development, low-carbon development" and "building a beautiful China" put forward by the 18th Party Congress for the first time, to the long-term goal of "promoting comprehensive green transformation of economy and society" put forward in the 14th Five-Year Plan, faced with the expanding demand of green market and the requirements of enterprise development, enterprises, as the main microcosmic carriers to promote social and economic development [1], should keep pace with the times and establish the concept of green management. Scientific development put forward by the 17th National Congress of the Communist Party of China is a development strategy based on people-oriented, overall consideration, and comprehensive, coordinated and sustainable development as its basic

requirement and goal. Its key lies in handling the direct relationship between resources, environment and people. Therefore, against the background of "Green New Deal", it is time and necessary for enterprises to implement green management. Green performance is to evaluate the economic and environmental benefits of enterprises in the process of green development and its impact on a country or region on the basis of considering resource input and environmental cost. Knowledge workers, as a special working group of talents, often bear great responsibility pressure and mental and ideological burden [2]. Work fatigue will lead to the decrease of employees' work and study efficiency [3] and performance level [4], which will have a negative effect on daily life, reduce employees' sense of identity with the enterprise, and even affect their career direction [5]. In severe cases, it will even cause illness or even death [6]. This is not in line with

the connotation of the concept of sustainable development and the basic concept of enterprise green management, which hinders the promotion of enterprise green performance and is a "non-green" phenomenon. Maslach's three-dimensional theory of job burnout focuses on emotional exhaustion to study the impact of work fatigue, which tends to study the psychological impact of employees, ignoring the complexity of fatigue and other dimensional factors, and can't systematically analyze the impact of work fatigue. In the aspect of human capital investment in labor economics theory, fatigue impact is defined as the fact that individual efficiency can't keep high efficiency for a long time, and there is a fluctuation. However, it is found that in practice, this theory can't comprehensively summarize the influence of work fatigue on knowledge workers. Therefore, this study aims to explore the work fatigue of knowledge workers through systematic research, explore the mechanism of fatigue from multiple dimensions, and form a suitable fatigue research tool. In theory, it enriches the theoretical space and logical framework of fatigue research, and puts forward suggestions for enterprise managers to prevent and improve the mental fatigue of knowledge workers in practice.

2. RESEARCH BASIS

At present, due to the complexity and multifactor of fatigue itself [7], the definition of fatigue has not been unified so far. Fatigue, as a complex physiological and psychological phenomenon [8], can be regarded as a protective reflex [9] or a universal sub-health state [10]. Fatigue can be divided into physiological fatigue and psychological fatigue [11]. Physiological fatigue mainly refers to body fatigue, which means that the human body can't maintain activities due to long-term continuous activities or short-term strenuous exercise, which exceeds people's body load, or can't maintain normal work, study and life due to the time and quality of sleep [12]. Psychological fatigue, also known as psychological fatigue, refers to a high sense of tension and monotony, which is repeated intensively for a long time, resulting in psychological and physical load imbalance and mental and physical disorder [13]. Combined with scholars' views, this study defines work fatigue as the physiological or psychological load caused by work activities that will affect normal work and life.

Knowledge-based employees are those who create value for enterprises by transmitting, analyzing or collecting information in knowledge-based industries [15]. They have corresponding professional

expertise and high personal quality [16], but they are weak in frustration [17] and difficult to supervise and control their work. The work stress generated by different working environments can lead to different types of fatigue, and the causes of fatigue are related to the characteristics of their occupations [5]. Teachers' psychological fatigue is related to their workload level, social support level and achievement motivation [14]. The degree of students' psychological fatigue is related to their subjects and achievements [18]. Psychological fatigue affects students' learning efficiency and academic achievements, and even their physical and mental health [13]. Some workers engaged in mental work, such as editors, are prone to mental fatigue of knowledge operation; Medical workers, pilots, accountants and other people who have been engaged in high-intensity and high-risk jobs for a long time will also have symptoms of mental fatigue [5]. The above research shows that the mechanism of work fatigue is complex, and it will exert both physiological and psychological load on employees.

The existing research methods of fatigue involve psychology, pedagogy, medicine and other fields. From the psychological point of view, Li Meiling and Zhang Liwei (2019) used TOT (time on task) paradigm of mental fatigue combined with AX-CPT (AX-continuous performance task) to examine the influence of mental fatigue on active control and reactive control [19]. From the medical point of view, the physiological changes before and after fatigue can be objectively reflected by testing the changes of physiological indexes (heart rate variability, pupil aperture, stereoscopic vision, fundus vascular stent, video electronystagmography, obliquity, cognitive ability, etc.), and then the mental fatigue state of personnel can be sensitively evaluated by means of software analysis and data technology processing [20]. From the perspective of pedagogy, the most commonly used method at present is questionnaire survey. Using MBI -GS (Mental Fatigue Questionnaire) to systematically investigate college students, it is found that the occurrence of mental fatigue of college students is highly correlated with their living background and study situation at school [21].

To sum up, in the existing theoretical research and empirical research on fatigue, the research objects are mostly concentrated in specific industries such as teachers, students, doctors, etc., without forming a cross-industry paradigm, and there is little research on employees in enterprises, especially knowledge workers. The measurement of fatigue mainly focuses on physiological indicators and

subjective reports, lacking specific measurement tools. The research on the influencing factors of fatigue is mostly carried out from the external environment and industry characteristics, but there are still some deficiencies in systematically refining the formation mechanism of fatigue. Therefore, based on literature review and factor analysis, this study intends to explore the influencing factors of knowledge workers' work fatigue across industries, and build a research model by adapting the General Burnout Scale (BMI -GS) to link the influencing factors with all dimensions of work fatigue, so as to make the study of knowledge workers' work fatigue more detailed. On the basis of learning and drawing lessons from existing research results, this paper explores the mechanism of work fatigue from multiple dimensions.

3. EMPIRICAL RESEARCH

3.1 Scale Construction

Through the collection and analysis of literature, this paper sums up the common factors that can reflect knowledge workers' work fatigue, such as interpersonal communication, working environment, organizational system and personal factors, etc., selects the General Burnout Scale of Markov (BMI -GS), selects the items, draws lessons from the items related to this study or its sub-scales, and adds or subtracts the items according to the existing theories and the unique investigation situations. In order to verify and supplement the existing research, open interviews were conducted with knowledge workers, and the problems existing in the development of the scale and the actual feelings of employees were exchanged. On the basis of literature review, interview and scale research, a database of knowledge workers' work fatigue items is constructed, which contains 51 items in total.

Thirty-five knowledge workers were selected in the preliminary scale for preliminary investigation. According to the results of the survey feedback, combined with the feedback problems of knowledge workers in the survey, the items of the scale are adjusted again, mainly in terms of language expression, item placement order, item repetition, fuzzy expression and so on. Finally, a pre-test scale with 49 items was established to investigate and analyze the work fatigue of knowledge workers. Using Likert's 5-grade scoring method, from complete non-conformity to complete conformity is divided into 5 grades, which can be judged by the testees according to their own situation. In order to

prevent the testees from forgetting the 5 grades in the later stage with too many entries, 5 grades are calibrated at the beginning of each dimension, and the 5 grades are calculated from 1 to 5. The higher the score, the higher the degree of work fatigue.

In this study, 567 questionnaires were sent out to the knowledge workers of different enterprises. Eight invalid and obviously tendentious questionnaires were excluded, and 559 valid questionnaires were found, with a recovery rate of 98%.

3.2 Statistical Analysis

Before the exploratory factor analysis of the scale, it is necessary to judge the size of the Kaiser-Meyer Olkin Measure of Sampling Adequacy (KMO) and Bartlett's spherical test value, and then the factor analysis of the items can be carried out. If Bartlett spherical test value is significantly less than 0.05, and KMO value is greater than 0.8, this entry can be used for factor analysis.

Principal component analysis and orthogonal rotation were used to make exploratory factor analysis of the scale. According to whether the characteristic value is greater than 1 or not, combined with the gravel map and the adaptability of the contents among the factor items, the number of factors that should be kept is determined comprehensively. Confirmatory factor analysis (CFA) was carried out on the structural model obtained by exploratory factor analysis by using the maximum likelihood estimation method. According to the fitting index results, the construct validity of the scale was judged, and whether the dimension structure of the scale obtained by exploratory factor analysis was reasonable or not was verified.

The influence of gender, age, working years and job category on the degree of work fatigue of knowledge workers is determined by difference analysis.

3.3 Analysis of Results

3.3.1 Project Analysis

The items of the scale were analyzed, and the correlation coefficient between the scores of each item in each scale and the total score of the scale was greater than 0.5 and the correlation reached a significant level ($P > 0.05$) as the standard, and the unqualified items were deleted, leaving 42 items.

3.3.2 Exploratory Factor Analysis (EFA)

The remaining 42 items of the scale were subjected to exploratory analysis for many times, 18 items with factor load less than 0.5 were deleted, and finally 24 items remained, and a six-factor structure was obtained, with the cumulative variance contribution rate of 66.329%, KMO value of 0.889, Bartlett's spherical test $X^2=6265.776$, degree of freedom of 276, and $p<0.01$. The factor analysis is shown in "Table 1".

According to the rotation matrix and component factors, after fine-tuning, the conclusion is drawn that

the first factor includes six items, namely, 35, 36, 37, 38, 39 and 40, and is named as the working environment. The second factor includes five items, 42, 43, 44, 45 and 49, which are named organizational system. The third factor includes four items, 25, 26, 27 and 28, and is named interpersonal communication. The fourth factor consists of three items, 19, 20 and 23, named self-cognition. The fifth factor includes three items, 9, 10 and 11, and is named emotional exhaustion. The sixth factor consists of three items: 1, 2 and 4, which are named as personality traits.

Table 1. Factor Analysis of Work fatigue Scale

Topic item	Factor load	Topic item	Factor load		
1. Working Environment		2. The Organizational System			
35	My working environment has good air. My working environment is at a suitable temperature.	0.767	42	The performance appraisal of my work unit is reasonable.	0.790
36	My working environment is brightly lit.	0.806	43	The salary system of my work unit is reasonable.	0.848
37	There is no noise in my working environment.	0.782	44	My work unit training system is reasonable.	0.789
38	My working environment is clean and tidy.	0.722	45	My work unit has reasonable promotion channels.	0.757
39	My working facilities are convenient and complete.	0.771	49	I recognize the corporate culture of the work unit.	0.704
40		0.725			
3. Interpersonal Communication		4. Self-cognition			
25	My family is warm and harmonious. I get along well with my colleagues.	0.814	19	My enthusiasm for work is declining. My learning ability is declining.	0.786
26	My love life is stable. I have friends to talk to.	0.762	20	My job is boring.	0.783
27		0.739	23		0.727
28		0.620			
5. Emotional Exhaustion		6. Personality Characteristics			
9	I often need to work overtime in my job. I often receive temporary assignments in my work.	0.798	1	I am used to solving problems independently.	0.705
10	I work with many clients.	0.838	2	I like to meet challenges.	0.784
11		0.673	4	I'm used to careful and meticulous work.	0.712

3.3.3 Reliability of Internal Consistency

According to the analysis of the internal consistency reliability index of the scale, the coefficients of six dimensions of the scale are 0.901, 0.898, 0.762, 0.774, 0.674 and 0.651, respectively, and Cronbach's alpha of the total scale is 0.785. The internal consistency coefficients of the six dimensions are basically within the acceptable range, and the work fatigue scale for knowledge workers has good reliability.

3.3.4 Constructive Validity-Confirmatory Factor Analysis (CFA)

Structural Equation Modeling (SEM) is used as a tool for scale confirmatory factor analysis. The relationship between variables is analyzed by structural equation model. According to the initial theoretical model, the covariance matrix among variables and the covariance matrix of the theoretical model are calculated, and the implied covariance

matrix between the covariance matrix of collected data and the covariance matrix of the theoretical model is compared to evaluate the quality of the model.

Select standard fitting index (NFI), informal fitting index (NNFI), incremental fitting index (IFI) and comparative fitting index (CFI) to measure the improvement degree of data fitting. The overall fitting degree of the model is tested by the ratio of chi-square and its corresponding degrees of freedom (χ^2/df). The absolute fitting indexes such as goodness-of-fit index (GFI), residual mean square root (RMR) and approximate root mean square error (RMSEA) are used to measure the interpretation degree of structural equation model to various relationships found in sample data.

There are different standards about the critical value of fitting index. Researchers usually take the values of GFI, NNFI, NFI, IFI and CFI > 0.90 as acceptable standards. Meanwhile, RMSEA should be less than 0.1. When χ^2/df is less than 3, the model fits well. When some indexes fail to meet the standards, the model can still be regarded as reasonable as long as most indexes meet the standards.

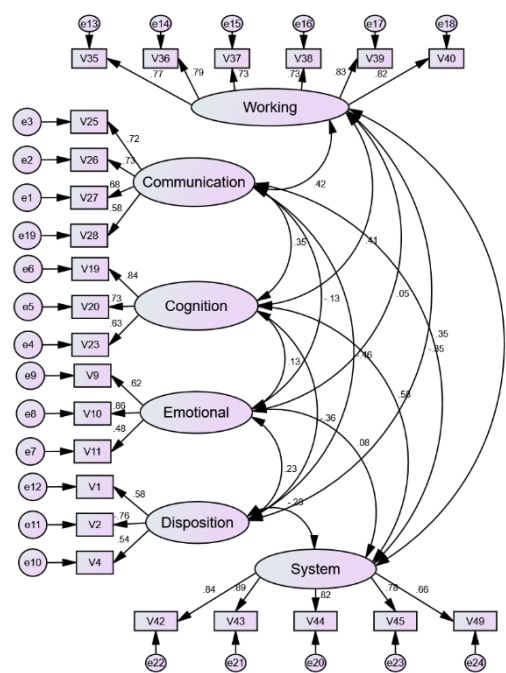


Figure 1 Fitting model.

The scale structure model is shown in “Figure 1”, and the fitting index is shown in “Table 2”. The NFI value of each fitting index of the model is 0.896, which is slightly smaller than the standard value of 0.90, but it is in an acceptable range. The fitting indexes of other subscales are all ideal, indicating that the model fits well. The verification results show that the measurement indexes are in line with the requirements of surveying, and the sample data has a good fit with the theoretical model.

Table 2. Main fitting indexes of table scale

Fitting index	χ^2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI	IFI
Criterion	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9	>0.9
Inventory	2.800	0.908	0.057	0.047	0.930	0.896	0.919	0.931

3.4 Variance Analysis

3.4.1 Gender Differences

It can be seen from the following “Table 3” that there are significant differences between genders in three dimensions: organizational system, emotional exhaustion and personality characteristics. Comparing the specific differences, in the organizational system, the average value of men is 3.26 higher than that of women's 3.11, and the fatigue degree of men is higher. In the dimensions of emotional exhaustion and personality characteristics, the scores of men are also higher than those of

women. Because of the gender differences between men and women, compared with men, women's ability to socialize in the workplace or maintain the relationship between colleagues is stronger than men's, which is one of the reasons that lead to higher fatigue scores of men.

Table 3. T test of Gender difference

	Organizational System		Working Environment		Interpersonal Communication		Self-cognition		Emotional Exhaustion		Personality Characteristics	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Man	3.26	0.91	3.45	0.89	3.84	0.70	3.00	0.73	3.49	0.82	3.95	0.65
Woman	3.11	0.80	3.57	0.71	3.94	0.63	3.05	0.70	3.27	0.82	3.76	0.62
T	2.085*		1.757		1.650		0.661		3.173**		3.626**	

Table 4. Position Category difference F test

	Organizational System		Working Environment		Interpersonal Communication		Self-cognition		Emotional Exhaustion		Personality Characteristics	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Management	3.30	0.84	3.63	0.74	3.94	0.67	3.04	0.65	3.54	0.74	3.94	0.58
Professional	3.16	0.87	3.48	0.87	3.81	0.65	2.95	0.71	3.41	0.87	3.85	0.67
Labour	2.90	0.88	3.08	0.82	3.86	0.63	3.15	0.88	3.04	0.81	3.79	0.60
Other	3.18	0.90	3.44	0.85	3.90	0.72	3.05	0.78	3.23	0.85	3.80	0.72
Variance ratio	2.553		5.493**		1.448		1.095		6.316**		1.614	

a *p<0.05 ; **p<0.01

3.4.2 Age Differences

Age variables are not significant in organizational system, working environment, interpersonal communication, self-cognition, emotional exhaustion and personality traits ($p>0.05$). It means that different age groups are consistent, and there is no significant difference.

3.4.3 Position Category

There are no significant differences in four categories of job samples: organizational system, interpersonal communication, self-cognition, and personality characteristics, but there are significant differences in two categories of job samples: working environment and emotional exhaustion. Different jobs are faced with different working environments and different requirements for employees, which also leads to significant differences in job categories in these two dimensions. From the data ("Table 4"), it can be seen that management posts scored the highest in five dimensions: organizational system, working environment, interpersonal communication, emotional exhaustion and personality characteristics, while workers' skills posts scored the lowest in four dimensions: organizational system, working environment, emotional exhaustion and personality characteristics, and the overall scores of professional skills posts were also low. Management positions face the risk of being

replaced due to their own lack of ability, and score high in all dimensions. According to this study, the degree of work fatigue faced by professional posts that cannot be easily replaced is lower than that of other posts.

3.4.4 Working Years

The sample of working years does not show significant differences in working environment, interpersonal communication, self-cognition, and personality characteristics, but shows significant differences in organizational system and emotional exhaustion. At the level of organizational system and emotional exhaustion, there are differences in the performance of employees with different length of service on work fatigue. At the organizational system level, the degree of fatigue is the highest when the length of service is within one year. The reason is that there is the risk of distrust of new employees, and the benefits of new employees are often lower than those of other working years; In terms of emotional exhaustion, it basically shows the trend of increasing fatigue with the increase of working years. ("Table 5")

Table 5. Working Years difference F test

	Organizational System		Working Environment		Interpersonal Communication		Self-cognition		Emotional Exhaustion		Personality Characteristics	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
1 year	3.54	0.78	3.66	0.86	4.11	0.70	2.79	0.67	3.01	0.76	3.66	0.66
1-5 years	3.26	0.91	3.37	0.94	3.98	0.70	3.04	0.77	3.37	0.85	3.91	0.67
6-10 years	2.98	0.86	3.46	0.75	3.85	0.62	3.08	0.77	3.25	0.69	3.81	0.67
1-15 years	3.24	0.86	3.56	0.80	3.80	0.72	3.06	0.74	3.55	0.83	3.93	0.57
More than 16 years	3.18	0.87	3.50	0.82	3.86	0.66	3.02	0.69	3.44	0.84	3.89	0.65
Variance ratio	2.670*		0.887		1.783		1.147		3.577**		1.408	

a *p<0.05 ; **p<0.01

4. CONCLUSIONS, COUNTERMEASURES AND DISCUSSIONS

4.1 Conclusions

In this study, by adapting the General Burnout Scale (BMS -GS) and using factor analysis method, a knowledge worker's work fatigue scale is constructed, which includes six dimensions: working environment, organizational system, interpersonal communication, self-cognition, emotional exhaustion and personality characteristics. Confirmatory factor analysis shows that the fitting index is good and the scale has good structural validity. Through difference analysis, it is found that knowledge workers in different industries show significant differences in organizational system and emotional exhaustion.

4.2 Countermeasures

Against the background of vigorously promoting green economy, enterprises must attach great importance to the necessity and importance of implementing green management. To improve the green performance of enterprises, it is necessary to focus on the problem of knowledge workers' work fatigue, enrich the connotation of green management, strive to overcome the difficulties in implementing green management, constantly improve the green management system, and actively promote the advocacy of low-carbon economy and society and the realization of sustainable development strategy. Based on the research background, the following suggestions are put forward:

4.2.1 Improving the Organizational System and Building a Green Culture of Enterprises

Enterprises should realize that financial performance and green performance are neither contradictory nor mutually reinforcing, but both conflicting and complementary [22]. Jinlian et al. (2010), based on Kane's stress coping hierarchy theory [23], thinks that building a harmonious corporate culture is helpful to relieve employees' work stress [24]. Therefore, it is necessary to shape the green culture of enterprises, relieve the work fatigue of knowledge workers, indirectly promote enterprises to build a new management mode, improve the strategic performance of enterprises by breaking the traditional path [25], and positively regulate the relationship between environmental performance and economic performance of enterprises [26].

4.2.2 Paying Attention to Employee Awareness Training and Encouraging Employees To Participate in Green Management

A comprehensive and green human resource management system transmits the organization's environmental protection concept and motivation to employees through recruitment, training, resource allocation, assessment, salary, performance and other links, and encourages employees to participate in the environmental management process, thus facilitating the implementation of future green development measures of enterprises [27]. In addition, the improvement of employees' green awareness can stimulate their demand for green products and promote the upgrading of consumption structure, thus expanding the green

market demand and improving the green performance of enterprises [28].

4.2.3 *Employees' Personal Level Can Relieve Fatigue*

Employees should insist on physical exercise, keep regular work and rest, and face the work with healthy physique and abundant energy; they can cultivate their own hobbies after work, so as to achieve a balance between life and work. At the same time, employees should strengthen communication, take the initiative to ask for advice from others, know fairly well about job responsibilities and reward and punishment system, improve work ability and interpersonal skills, and constantly learn new knowledge and master new skills. Better coping with work fatigue will help to improve the green performance of enterprises and realize green life.

4.3 *Discussions*

Against the background of sustainable development strategy, the research on the management of knowledge workers, a specific group, is still in the initial stage, but with the improvement of enterprise or organization management and the in-depth study of work fatigue, it can finally effectively monitor the work fatigue of knowledge workers. This study verified that the knowledge workers' work fatigue scale can be used as a preliminary assessment tool for knowledge workers' work fatigue, and it also verified six dimensions: work environment, organizational system, interpersonal communication, self-cognition, emotional exhaustion, personality characteristics and work environment. However, it is not clear how the six dimensions of work fatigue affect each other, which is the next research direction.

AUTHORS' CONTRIBUTIONS

Lilu Sun is responsible for the conception of the whole paper. Jing Zou is responsible for experimental design and wrote the manuscript. Yu Feng analysed data.

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