

Comparative analysis of psychological safety of shift workers in the South and North of the Russian Federation

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Abstract. The purpose of the study: to identify the features of psychological safety of specialists in shift work organization in the North and South of the Russian Federation. Samples: 1) 68 shift workers of diamond production in the Far North at the age of 26 to 59 years, the experience of the shift method in the North from 1 to 30 years; 2) 82 shift workers employed in the construction of the Crimean bridge, aged 21 to 64 years, the experience of the shift method in the South from 1 to 20 years. Methods of research: 1) psycho-physiological level of psychological safety – a "Complex visual-motor reaction" and "Variation cardiointervalography" made using the device of psychophysiological testing UPFT-1/30 "Physiologist"; 2) psychological level of color test M. lusher with the calculation of interpretation coefficients G. A. Amineva; 3) the image of the object of labour and subject of labour – questionnaire; 4) the image of the subject-object and subject-subject relations – "Express-method" for the study of socio-psychological climate in labor collective O. S. Michaluk and A. Yu. Shalyto. Statistical methods: two-stage cluster analysis, multivariate variance analysis, contingency tables. Statistical data processing was performed using the IBM SPSS Statistics 23.00 statistical package. Comparing with the model of psychological safety of workers of diamond production and builders of the Crimean bridge, such components as psychological and psychophysiological levels of the functional status, the components of the image of the object of labor and the image of the subject of labor, as well as the image of the subject-object and subjective relations coincide. It is established that in the South the emergency adaptation strategy is used to a greater extent (81.9%) than in the Far North (54.2%), which poses the risk of depletion of internal reserves by the end of the shift. There are differences in the psychophysiological level of functional status: in the South, more employees have a reduced level of functional status (62.9%) than in the North (44.4%). This tells us that employees of the Far North have a higher level of functionality than employees of the

South. According to the image of the object of labor there is a positive trend, both in the South (71.8%) and in the Far North (76.1%), workers give low and undifferentiated hazard assessment, this means that workers do not see a special danger of dangerous situations in the shift period. Regarding the image of the subject of labor, it should be noted that in the Far North (63.1%) and in the South (94.8%) give a higher assessment of their professionalism. The component image of subject-object and subject-subject relations, as in the Far North (43.1%) and in the South (41.8%) workers give a positive assessment.

Key words: *psychological safety, South, North, shift work, climatic factors, production factors, social factors.*

I. INTRODUCTION

In researches of many authors it is established that workers at the shift organization of work are influenced by three groups of factors: climate-geographic, connected with features of climate; production due to danger and harmfulness of production; social and domestic, dependent on group isolation conditions [1-6]. On the basis of all these factors are formed requirements for the body shift worker, which often exceed its reserves. This eliminates the possibility of full adaptation of the body to the data conditions and causes the occurrence of occupational health risks. Research in the field of the impact of factors of shift work on workers was carried out mainly in the Far North and the Arctic [1, 4, 7, 8]. It is revealed that professional activity shift method in the Far North contributes to the formation of discomfort in the body and subsequently — the development of destructive personal qualities of employees. All this ultimately leads to a deterioration of the mental status of workers, reduced productivity and efficiency of work [1]. Note that in the South of Russia is also widely used shift method of labor organization. In this regard, it is necessary to determine the difference in the impact of factors of shift labor on workers depending on the location of shift camps: in the North or South of the Russian Federation (Russia). This will allow us to understand what technologies of psychological support of shift personnel, developed for production facilities in

the North of Russia, can be used for enterprises located in the South of the country. Extremity of shift work is caused to a greater extent by methods of the organization of work or difficult climate-geographic conditions. Shift method of labor organization is widespread in the following southern regions of Russia: Astrakhan region, Krasnodar region, Republic of Crimea. Climate-geographic factors are among the key factors in assessing the extreme shift work, so it is important to assess the consequences of their impacts on workers. The climate in these regions is arid, with strong winds and high levels of solar radiation, which significantly affects the results of shift workers [9, 10]. Climate-geographic conditions of the South of Russia can be considered extreme for shift workers. These conditions are evaluated differently by the staff: to some of them employees are adapted, know how to behave and act and how to protect themselves from their influence, and therefore the subjective assessment of their discomfort is often underestimated; the other part it continues to cause some difficulties in the work and requires much more attention from the management of enterprises. The purpose of the study: to identify the features of psychological safety of specialists in shift work organization in the North and South of the Russian Federation..

II. MATERIALS AND METHODS

Methods of research: 1) psycho-physiological level of psychological safety – a "Complex visual-motor reaction" and "Variation cardiotintervalgraphy"(VKG) made using the device of psychophysiological testing UPFT-1/30 "Physiologist"; 2) psychological level of colour test M. Lusher with the calculation of G.A. Aminev's interpretation coefficients; 3) the image of the object of labour and subject of labour – questionnaire; 4) the image of the subject-object and subject-subject relations – "Express-method" for the study of socio-psychological climate in labor collective O.S. Michaluk and A.Yu. Shalyto. Statistical methods: two-stage cluster analysis, multivariate variance analysis, contingency tables. Statistical data processing was performed using the IBM SPSS Statistics 23.00 statistical package.

III. RESEARCH DESIGN

To achieve this goal and objectives, a research was conducted through two expeditions:

1) for diamond mining production in the Far North (in the Arkhangelsk region), which was attended by 68 workers with shift work organization, aged 26 to 59 years (average age 38.56 ± 9.206), work experience in shifts in the North from 1 to 30 years (average experience 8.16 ± 5.781). The study was conducted in July – August 2017, the duration of the shift arrival is 14 days, and the rest period is 14 days.

2) on the construction of the Crimean bridge, which was attended by 82 shift workers, 75 of them men and 7 women, aged 21 to 64 years (average age $41.31 \pm$

11.180); experience of shift work from 3 years to 30 years (average experience 8.021 ± 6.4503); experience of shift method in the South from 1 year to 20 years (average experience 3.543 ± 3.6660). The study was conducted in June - July 2018 (duration of shift arrival 30 days, rest period - 30 days).

IV. PSYCHOLOGICAL SAFETY OF WORKERS OF THE DIAMOND MINING INDUSTRY WITH SHIFT FORMS OF WORK IN THE NORTH OF THE RUSSIAN FEDERATION

In order to study the components of psychological safety of workers of the shift method of the Far North ,five two-stage cluster analyses on variables related to psychophysiological and psychological parameters of functional Statuss, the image of the object and the subject of labor, as well as the image of the subject-object and subject-subject relations.

The first block of the theoretical model of psychological safety is presented by psychophysiological parameters of the functional status, measured with the help of psychophysiological testing UPFT-1/30 "Psychophysiologist". As a result of the two-stage cluster analysis, all subjects were divided into 2 clusters. Statistically significant differences are observed only in the parameter "reaction speed" ($p=0.038$): representatives of the first group more often showed such a reaction, compared with representatives of the second group. In order to assess the differences in the level of functional status of the representatives of the two clusters, we used the contingency tables with Pearson's X^2 criterion; the results are presented in table 1.

Table 1. Distribution of workers in clusters according to the type of functional status (in %)

The cluster number	Type of functional status (VCG) in %			
	maximum	permissible	near optimal	optimal
1 (reduced level)	22,2	20,0	2,2	0
2 (optimal level)	0	0	42,2	13,3

*Note x^2 is 41,152 at $p < 0.0001$

As can be seen from the data in table 1, the first group was made up of specialists with the maximum permissible and permissible level of functional status, i.e. it is possible to consider representatives of this group – with a reduced level of status. Representatives of the second group have a close to optimal and optimal functional status, i.e. this group can be referred to as the optimal status level.

The second block of the theoretical model of psychological safety includes psychological parameters of the functional status, which were studied with the help of the questionnaire "Well-Being. Activity. Mood" and the test of colour preferences of M. Lusher with the use of G.A. Aminev's interpretation coefficients. The results are presented in table 2.

Table 2. Distribution of workers in clusters according to the parameters of the psychological level of functional status as a component of psychological safety

Names	Group 1	Group 2	P
Heterogeneity/ autonomy	-0,8222±3,394	-2,5563±2,343	0,024
Concentricity/ eccentricity	2,7481±2,796	-3,1625±2,083	<0,001
Imbalance/ balance of personal properties	1,3037±4,574	7,0781±2,353	<0,001
Vegetative balance: sympathetic or parasympathetic	-0,2963±3,454	7,2438±1,767	<0,001
Efficiency	15,3704±3,236	20,2219±1,03	<0,006
Stress	14,9296±10,693	5,3625±4,520	<0,001

As a result of two-stage cluster analysis, all subjects were divided into two clusters. We found that the first group is characterized by autonomy, which indicates independence, activity, initiative, independence, and the desire for success and self-assertion.

Thus, the representatives of the first group have a greater concentration (concentration) on their own problems, and they are dominated by the tone of the parasympathetic nervous system, i.e. they are focused on rest, recuperation, saving resources (using an economical adaptive strategy); there is a low efficiency and stress level in representatives of this group. Thus, we can call the first group as applying "economical strategy". An economical adaptation strategy is that workers gradually spend their resources during the shift, they need small breaks for rest, during which they recover.

As a result of the analysis of M. Lusher's color preferences; it was found out that the first group is characterized by heteronomicity, which indicates the passivity of the tendency to the dependent position from others, sensitivity. Representatives of the second group, on the contrary, have autonomy, which indicates independence, activity, initiative, independence, and the desire for success and self-assertion. Considering the parameter "concentricity - eccentricity", it was found that the first group has a greater concentration (concentration) on their own problems, the representatives of the second group have eccentricity, i.e. are interested in the environment as a source of assistance.

The representatives of the second group there is a balance of personal properties, and the representatives of the first group to a greater extent manifest unstable personality. Considering the vegetative balance, it can be noted that in the first and second group there is a predominance of the tone of the sympathetic nervous system, i.e., workers are mobilizing all functions, preparing for active protection.

In the third block of the model of psychological safety is considered such a component relating to the mental structure of regulation as the image of the object of labor, studied by subjective assessment of workers adverse climatic conditions, production and social factors, as well as the assessment of dangerous situations arising during work on shift

According to estimates of climatic features, workers are allocated as the most uncomfortable: wind high humidity ($2,31 \pm 0,002$) Lack of ultraviolet radiation; low temperature ($2,81 \pm 0,000$); and radiation conditions ($2,25 \pm 0,000$)

The most unfavorable social factors for the employee on a shift basis are: social isolation of the team ($2,44 \pm 0,00$), lack or shortage of food ($2,88 \pm 0,00$) and lack of infrastructure ($2,38 \pm 0,00$)

The most unfavorable for the evaluation by workers of the production factors are: noise ($3,63 \pm 0,000$), vibration ($3,63 \pm 0,000$), chemical factors ($2,69 \pm 0,000$), noise ($2,48 \pm 0,000$), high and low temperature work zone ($3,06 \pm 0,00$), the inability to leave the premises during slave time ($2,88 \pm 0,00$) neuro-psychological overload ($3,00 \pm 0,000$) enhanced monitoring of compliance with safety regulations ($3,19 \pm 0,000$), strengthened enforcement of corporate governance rules ($2,81 \pm 0,000$).

Subjective assessment of the impact of adverse factors and the risk of situations arising during shift work, the group of specialists of the first group have higher values and are differentiated, in contrast to the estimates of employees who were assigned to the second group.

The fourth block of the theoretical model of psychological safety is to determine the image of the subject of labor as a mental structure of regulation of professional activity. In the study of this component, a subjective assessment of the professionalism of workers in shifts was used. The results of the cluster analysis are presented in table 3.

Table 3. Distribution of workers in clusters in accordance with the subjective assessment of the professionalism of workers as a component of psychological safety

Name	1 cluster	2 cluster	P
Professional skills	7,46	9,51	<0,001
Personal qualities for my position	7,50	9,32	<0,001
Personal qualities to work as a shift	7,13	9,54	<0,001
Knowledge of workplace safety	7,71	9,44	<0,001
Compliance with safety in the workplace	7,75	9,66	<0,001
Job satisfaction	7,29	9,05	<0,001
Satisfaction with the work schedule	7,75	9,20	0,002
The performance of the	7,71	9,68	<0,001

work			
Work efficiency	6,92	9,54	<0,001
Forces spent on professional tasks	7,33	9,17	<0,001
The name of the component of psychological safety – the image of the subject of labor	giving a high assessment of the professionalism	giving a high assessment of the professionalism	

It should be noted that the first group of respondents consisted of employees who give a higher rating on the criteria of personal professionalism than the specialists of the second cluster group, who assess themselves differentially, choosing a moderately high rating

The component of psychological safety of one more block is represented by the image of subject-object and subject-subject relations, which was measured with the help of "Express methods for the study of socio-psychological climate in the workforce" (O. S. mikhalyuk and A. Yu. Shalyto). As a result of the two-stage cluster analysis, all the surveyed were divided into five groups, the results of descriptive statistics on the parameters of the socio-psychological climate are presented in table 4. To correlate the data of our study and the model of psychological safety, five clusters were combined into three clusters (table 4).

Table 4. The content of the components of the socio-psychological climate as a component of psychological safety in five clusters

№ cluster's	Components of socio-psychological climate			The final group
	Emotional	Behavioral	Cognitive	
1	+	+	+	+
2	+	neutral	+	+
3	+	neutral	neutral	neutral
4	+	-	neutral	neutral
5	-	neutral	neutral	-

*Note: + positive; - negative.

According to the data of table 4, the representatives of the first cluster have positive indicators for all components of the socio-psychological component. The representatives of the second cluster also note the positive socio-psychological climate to a greater extent, the third and fourth clusters have a neutral socio-psychological climate, and the fifth cluster has a negative one.

In General, all interviewed employees gave a positive assessment of the emotional component of the socio-psychological climate, which indicates a good relationship between colleagues in the team.

The cognitive component of the socio-psychological climate of the surveyed team is neutral, which is characterized by the presence of the exchange of labor experience, knowledge in the field of activity between colleagues.

The behavioral component of the socio-psychological climate of the surveyed team is neutral, which is expressed in the presence of ideas about the behavior of each other's colleagues in the group.

V. DETERMINATION OF COMPONENTS OF PSYCHOLOGICAL SAFETY OF SHIFT WORKERS IN THE SOUTH OF THE RUSSIAN FEDERATION

In order to study the components of psychological safety, five two-stage cluster analyses were carried out on the variables related to the psycho-physiological and psychological parameters of functional Status, the image of the object and the subject of labor, as well as the image of the subject-object and subject-subject relations.

The first block of the theoretical model of psychological safety includes psychological parameters of the functional status, which were studied with the help of the questionnaire "well-Being. Activity. Mood" and the test of colour preferences of M. Lusher with the use of G.A. Aminev's interpretation coefficients. The results are presented in table 5. The parameters of the questionnaire "Health. Activity. Mood" do not have statistically significant differences and are within the norm for employees of the first and second groups.

Table 5. Distribution of workers in clusters according to the parameters of the psychological level of functional status as a component of psychological safety

Names	1 cluster	2 cluster	P
Status of health	4,0169±2,04679	4,5385±2,06621	0,409
Activity	3,8814±2,05178	4,8462±2,15430	0,133
Mood	5,0339±1,92950	5,5385±2,47034	0,421
Heterogeneity/ autonomy	-0,7373±2,552	1,0769±2,78752	0,026
Concentricity/ eccentricity	-2,0254±3,583	4,5923±2,3563	<0,001
Imbalance/ balance of personal properties	6,5711±2,629	-2,7462±3,2348	<0,001
Vegetative balance: sympathetic or parasympathetic	6,2710±2,58673	-4,9153±2,9714	<0,001
Efficiency	19,347±1,5204	13,3846±2,302	<0,001
Stress	6,0220±5,1668	19,953±9,1232	<0,001
Name of the group according to the psychological level of functional status	Emergency adaptation strategy	Economical adaptation strategy	

As a result of two-stage cluster analysis, all subjects were divided into two clusters. The representatives of the first cluster are characterized by autonomy, independence, activity, initiative, independence, tendency to dominate, desire for success and self-assertion. Workers of the first cluster have a high concentration (concentration) on their own problems, as well as the predominance of the tone of the sympathetic nervous system, i.e. the mobilization of all body functions. There is a high efficiency and a tendency to

stress. Thus, we can name the representatives of the first cluster as using an emergency adaptation strategy.

For members of the second cluster characteristic heteronomy, passivity, a tendency to the dependent position from others, sensitivity. Also, these workers are characterized by concentricity, i.e. focus on their own problems and the predominance of the parasympathetic nervous system, which is expressed in the focus on rest, recuperation and resource conservation (the use of an economical adaptive strategy). These workers have low efficiency and manifestations of stress. Representatives of the second cluster are more prone to fatigue, tension, there is a predominance of negative and asthenic experiences. In the first cluster of respondents there is a predominance of tone of the sympathetic nervous system, ie, employees are mobilizing all functions, preparing for active protection (ie, the use of emergency adaptive strategy).

The second block of the theoretical model of psychological safety is represented by psychophysiological parameters of the functional status, measured with the help of psychophysiological testing UPFT-1/30 "Psychophysiologist". As a result of two-stage cluster analysis, all subjects were divided into two clusters. The parameters of the psychophysiological level of the functional status, which revealed statistically significant differences, are presented in table 6.

Table 6. Parameters of psychophysiological level of functional status of shift workers in the South of the Russian Federation

Group	1 cluster (the optimum level)	2 cluster (reduced level)	P
Integral indicator of reliability of IPN	42,35 ±23,220	55,90±15,341	0,007
The speed of the reaction (M) - SZRM	556,95±128,221	486,20 ±69,060	0,006
To assess the stability of responses (SD) for SZRM	135,78 ±56,445	111,41±40,123	0,052
Gaps in SZRM	0,26 ±0,540	0,05 ±0,223	0,036
The speed of the reaction (M) VCG	1,65±0,822	2,05±0,723	0,053
Heart rate (HR) by VCG	76,47±6,126	82,92±10,556	0,010
To assess the stability of responses (SD) for SZRM	784,69±63,201	732,89±109,506	0,043

The first cluster included workers with an optimal level of functional status, that is, a higher rate of speed and stability of the visual-motor reaction, a high level of speed and stability of the reaction according to the variation cardiointervalometry. The second cluster

consisted of specialists with lower indicators of psychophysiological level of functional status.

Table 7. The level of functional capabilities of the representatives of the first and second cluster on the psychophysiological level of functional status

The cluster number	The level of functionality (for the VCG) to %		
	Low	Medium	High
1 cluster (the optimum level)	4,3	21,7	73,9
2 cluster (reduced level)	46,2	33,3	20,5

As can be seen from table 7, the representatives of the first cluster – with the optimal level of functional status - have a higher level of functionality than the representatives of the second cluster.

Table 8. The level of operator performance of the representatives of the first and second cluster on the psychophysiological level of functional status

The cluster number	The level of the operator's performance (on the VCR) to %		
	Low	Medium	High
1 cluster (the optimum level)	65,2	34,8	0,0
2 cluster (reduced level)	48,7	38,5	12,8

As can be seen from table 8, the representatives of the first cluster have a lower level of operational efficiency than the representatives of the second cluster.

In order to assess the differences in the level of functional status of the representatives of the two clusters, we used contingency tables with Pearson's χ^2 criterion, the results are presented in table 9.

Table 9. Distribution of workers in clusters according to the type of functional status (in %)

The cluster number	Distribution of workers in clusters according to the type of functional status (in %)			
	maximum	permissible	near optimal	optimal
1 cluster (the optimum level)	8,7	4,3	69,6	17,4
2 cluster (reduced level)	43,6	48,7	2,6	0,0

*Note χ^2 is 46.227 at $p < 0.0001$

As can be seen from the data of table 9 , the representatives of the first cluster have a close to optimal and optimal functional status, i.e. this group can be called as having an optimal psychophysiological level of functional status. The representatives of the second cluster were specialists with the maximum permissible and permissible level of functional status, i.e. it is possible to consider the representatives of this group – with a reduced psychophysiological level of functional status. This criterion of division into clusters according to the psychophysiological level of functional status as a

component of psychological safety is correlated with the previously developed model of psychological safety for employees of oil and gas production and diamond production.

In the third block of the model of psychological safety the image of the object of work, studied by means of subjective assessment of unfavourable climatic features, production and social factors, is considered. According to the results of cluster analysis, we have two clusters. The specialists of the first cluster give lower and undifferentiated subjective estimates of the impact of adverse production factors, in contrast to the estimates of employees who were assigned to the second group. The most unfavourable factors according to the workers' assessment are the following: noise (2.54 ± 0.078), chemical factors (2.02 ± 0.000), increased surface temperature of the equipment (2.02 ± 0.009) and increased and reduced temperature of the working area (2.00 ± 0.004).

The fourth block of the theoretical model of psychological safety is to determine the image of the subject of labor as a mental structure of regulation of professional activity. The study of this component used a subjective assessment of the professionalism of workers in shifts in the South of the Russian Federation. The results of the cluster analysis are presented in table 10.

Table 10. Distribution of shift workers in the South of the Russian Federation in clusters in accordance with the subjective assessment of the professionalism of workers as a component of psychological safety

Names	1 cluster	2 cluster	P
Work efficiency	7,89	2,25	<0,001
Professional skills	8,37	2,00	<0,001
Personal qualities for my position	8,22	1,75	<0,001
Personal qualities to work as a shift	8,71	1,75	<0,001
Knowledge Of workplace safety	8,74	1,50	<0,001
Prevention of accidents compliance in the workplace	8,10	1,50	<0,001
Job satisfaction	7,82	1,75	<0,001
Satisfaction with the work schedule	7,47	1,50	<0,001
The performance of the work	8,52	1,78	<0,001
Wages	5,01	3,50	0,301
Forces spent on professional tasks	7,36	6,00	0,308
The image of the subject of labor	higher assessments of their professionalism	lower estimates of their professionalism	

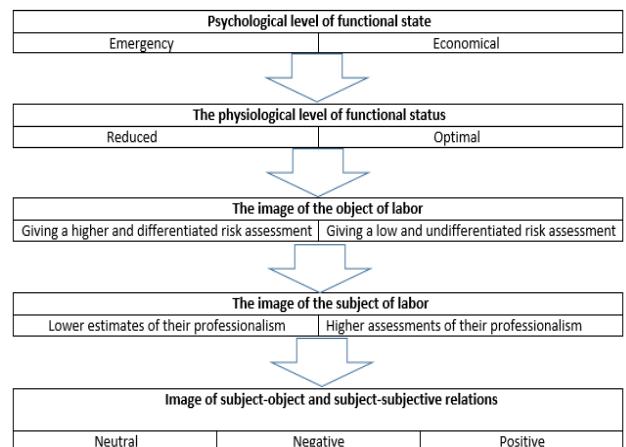
The first cluster includes employees who give a higher rating on the criteria of personal professionalism than the specialists of the second cluster, who assess themselves differentially, choosing a moderately high rating.

The component of psychological safety of the fifth block is represented by the image of subject-object and

subject-subject relations, which was measured using the "Express methodology" for the study of the socio-psychological climate in the workforce (O. S. Mikhalyuk and A.Yu. Shalyto). For the convenience of the analysis, we have created an additional variable – an integral indicator of the socio-psychological climate, which is represented by three values: positive, negative or neutral. As a result of the data obtained, a greater number of interviewed employees give a positive assessment according to the component of psychological safety in the image of subject-object and subject-subject relations, as a result, according to the data, 42% , a slightly smaller number of respondents gave a neutral assessment of 37%, and only 21% of respondents gave a negative assessment, i.e. this indicates that there are good relations between colleagues in the team.

The model of psychological safety of workers of construction of the "Crimean bridge" and diamond mining industry in this work is presented as follows Fig. 1.

Figure 1. The model of psychological safety of workers of construction of the "Crimean bridge" and diamond mining industry



VI. CONCLUSIONS

Comparing with the model of psychological safety of workers of diamond production and builders of the Crimean bridge, such components as psychological and psychophysiological levels of the functional status, the components of the image of the object of labor and the image of the subject of labor, as well as the image of the subject-object and subjective relations coincide. It is established that in the South the emergency adaptation strategy is used to a greater extent (81.9%) than in the Far North (54.2%), which poses the risk of depletion of internal reserves by the end of the shift. There are differences in the psychophysiological level of functional status: in the South, more employees have a reduced level of functional status (62.9%) than in the North (44.4%). this tells us that employees of the Far North have a higher level of functionality than employees of the South. According to the image of the object of labor there is a positive trend, both in the South (71.8%) and in the Far North (76.1%), workers give low

and undifferentiated hazard assessment, this means that workers do not see a special danger of dangerous situations in the shift period. Regarding the image of the subject of labor, it should be noted that in the Far North (63.1%) and in the South (94.8%) give a higher assessment of their professionalism. The component image of subject-object and subject-subject relations, as in the Far North (43.1%) and in the South (41.8%) workers give a positive assessment.

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