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The Impact of Workload-related Factors on the Effort-Reward Imbalance in Various Working Groups at a Gas refinery Complex

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ABSTRACT

Background: Workload is defined as the amount of work assigned to employees. The imbalance of efforts and rewards may cause occupational stress. The present study aimed to assess the impact of workload-related factors on the effort-reward imbalance in various working groups at a gas refinery complex.

Methods: This cross-sectional study was conducted on 274 employees in five working groups in 2018. Data were collected using a demographic questionnaire, NASA TLX, need for recovery scale, and effort-reward imbalance (ERI) questionnaire. Data analysis was performed in SPSS version 22.

Results: In total, 97 participants (34.3%) had the ERI score of more than one, and the imbalance was higher in the service workers. The ERI score was significantly correlated with the mental workload in the staff (P= 0.034) and engineering personnel (P= 0.045). A significant association was observed between the need for recovery and ERI score in the staff, engineering personnel, and middle managers (P< 0.05).

Conclusion: The ERI score reduced with the reduction of workload-related factors through improving the workplace conditions, hiring sufficient employees, and proper rewards. Therefore, special attention must be paid to the needs of various working groups in order to enhance their working conditions.

1. Introduction

Stress is defined as the inability to cope with the factors that threaten wellbeing, which causes physiological responses and adaptations [1]. Occupation is considered to be a major source of stress [2], as the workplace is highly demanding [3]. Occupational stress arises from the occupational activities that cause employees to perceive overwhelming responsibilities without sufficient decision-making power or authority [1].

The imposed costs due to occupational stress have been estimated at 200 billion dollars per year in the United States [4]. Occupational stress threatens the health of employees, thereby leading to health issues such as work-related musculoskeletal disorders [5]. Furthermore, long-term stress may lead to job burnout [6], reduced productivity [7], and increased absenteeism rate [8]. Therefore, it is of utmost importance to investigate occupational stress and the influential factors in this regard. The concept of occupational stress could be discussed from various aspects.

TEffort-reward imbalance (ERI) is a work stress model, which has been extensively used in occupational health research [9]. The model has been developed to evaluate stressful work conditions [10], and is highly popular in this research domain. Based on the ERI, perceived work efforts should be conferred by sufficient rewards [11]. These efforts may encompass the physical, psychological, and emotional demands of work, while the rewards may be esteem, money, promotion prospects, and job security. Higher effort/reward ratio shows the higher imbalance, which eventually leads to significant stress levels [12]. Therefore, efforts should be equal to the received rewards as perceived by employees [13].

The perception of ERI may be affected by parameters such as demographics, organizational factors [14], organizational level of employees [15], and job complexity [16]. The ERI level should be assessed in various working groups with different duties. Workload is an important job-related factor that could cause stress, which refers to the amount of work assigned to employees [17].

Workload could be measured through the assessment of the need for recovery, in which recovery is defined as a period that an employee needs to recuperate normal function after finalizing the work [18,19]. The need for recovery is in close correlation with occupations stress [20], the rate of which has been reported to be 55% in miners [21], 33% in firefighters [20], and 33.2% in office workers [22]; evidently, the rate varies depending on the occupation. Mental workload is another feature that could be defined as the mental costs of fulfilling the required tasks [23], which increases in difficult tasks, requiring a balance between the ability and workload of employees in order to prevent occupational stress [24]. Perceived mental workload varies in different occupations with different duties and even among the workforce in the same organization.

In every organization, employees with different job descriptions and duties work alongside each other (e.g., managers, staff, and service workers). These groups have different job characteristics and experience different workload levels, which affects their level of occupational stress and perceived ERI. Therefore, these parameters must be evaluated separately in order to achieve better outcomes.

The present study aimed to assess the impact of workload-related factors on the perceived ERI in various working groups at an office in a gas refinery complex.

2. Materials and Methods

2.1. Study Design and Participants

This cross-sectional study was conducted at the administrative department of a gas refinery complex in the south of Iran in 2018. All the personnel of five sectors (senior managers, middle managers, technical and engineering personnel, staff, and service workers) were invited to participate in the study. The inclusion criteria were the willingness of the personnel to participate and a minimum of one-year of work experience, and the personnel with mental disorders were excluded. Based on the inclusion criteria, 368 out of 402 organizational members were enrolled in the study. From 368 distributed questionnaires, 274 were completed properly (74% participation rate) and analyzed.

2.2. Data Collection Tools

After explaining the objectives of the research, data were collected using four questionnaires.

1. Questionnaires of demographic data and background factors consisting of data on the age, gender, work experience, education level, and marital status were completed. In addition, these scales included items on working conditions, such as working in consecutive shifts, working hours, shiftwork, the sufficiency of employees, having a second job, and overall satisfaction with the current position.

2.3. The Need for Recovery (NFR) Scale

NFR is the main scale used for the assessment of workload [21], fatigue, and the quality of recovery in working populations [25], as well as work stress, prolonged fatigue, and workload indicators. The questionnaire consists of 11 items, which are responded with Yes/No options, with the maximum score of 100. The NFR scale could also be applied to evaluate fatigue and workload, with the Yes responses graded 9.09; if the Yes responses are scored more than four (scores of $\geq$45.45), the need for recovery is considered to be high. The validity and reliability of the Persian version of the NFR scale have been confirmed in a previous study in this regard [21].

2.4. The NASA Task Load Index (NASA TLX)

In the present study, the NASA TLX was used to assess the mental workload of the participants. The questionnaire contains six items regarding various aspects of workload, including physical demand, mental demand, temporal demand, effort, performance, and frustration. The items are scored within the range of 0-100, and the total score is calculated by summing up the scales of the six mentioned domains [26]. It is also notable that the tool has been used in various fields in Iran with confirmed validity and reliability.

2.5. The Effort-Reward Imbalance (ERI) Questionnaire

The ERI questionnaire consists of 18 items, with eight items on effort and 10 items on reward. The items that are focused on effort are scored based on a five-point scale (Never = 1, Always = 5) to assess the demanding aspects of occupations, including working hard, working on time pressure, job complexity, and strenuous work. Moreover, the items regarding salary, esteem, security, and composite rewards are scored based on a four-point scale (Certainly Not=1, Most Certainly = 4). The effort-to-reward ratio could be obtained by dividing the scores of the items on effort to the score of the items on reward. Scores higher than one indicate negative imbalance [27]. The Persian version of the ERI questionnaire has been confirmed in terms of reliability and validity [28].

2.6. Data Collection Process

The current research was conducted upon the request of the company managers. Initially, the researchers introduced themselves to the participants and explained

the objectives of the study. After asking for their consent, the questionnaires were distributed, and the participants were asked to complete them in proper time, so that they could respond carefully. Following that, written informed consent was obtained from all the participants, and they were assured of confidentiality terms regarding their information. The questionnaires were collected after two weeks, and the required permit to perform the study was obtained from the top manager of the organization. The ethical approval of the study was also confirmed by the managerial office.

2.7. Statistical Analysis

Data analysis was performed in SPSS version 22 using descriptive statistics (mean and standard deviation), Chi-square, Kruskal-Wallis test, and independent-samples t-test. In all the statistical analyses, the significance level was considered to be 0.05.

3. Result and Discussion

3.1. Demographic Characteristics and Work-related Factors

The mean age and work experience of the participants were 34.85 ± 7.04 and 7.82 ± 6.10 years, respectively. Among the participants, 257 were male, and 17 were female. Tables 1 and 2 show the demographic characteristics of the sample population.

Among the participants, 35% of the staff, 58% of the middle managers, 40% of the service workers, 28% of the top managers, and 70% of the engineering personnel were shift workers. The service workers had the longest working hours per month (mean: 237.83 ± 14.21 hours), while the staff had the shortest working hours per month (mean: 210.51 ± 25.76 hours). Table 3 shows the work characteristics of the participants.

3.2. ERI, NFR, and Workload Domains

Based on the calculated ERI scores, 97 participants (34.3%) achieved higher scores than one, which indicated that their perceived effort was higher than their perceived reward. In addition, the overall mental workload score in the subjects was 69.7918.82 out of 100.

According to the findings, the performance domain of the NASA TLX questionnaire had the highest mean score compared to the other domains (mean: 79.95 ± 18.01). The total mean score of the NFR was 60.11 ± 23.66, and 218 participants (79%) had significant need for recovery.

Table 4 shows the scores of The ERI, workload domains, and NFR in the sample population.

3.3. ERI-related Variables

3.3.1. Demographic Variables

The results of the Kruskal- Wallis test indicated no significant correlations between ERI, age, and work experience in sample population. However, the female participants in the staff and engineering personnel reported significantly lower ERI scores (P = 0.018 and P = 0.001, respectively). Furthermore, the married staff, middle managers, and engineering personnel reported higher ERI scores (P= 0.010, P= 0.001, and P= 0.003, respectively). A significant association was also observed between the academic degree and ERI scores in all the working groups, with the exception of the top managers

3.3.2. Work-related Factors

The results of Chi-square demonstrated that among the staff, service workers, and engineering personnel, the employees with temporal working contracts had higher ERI scores ($P < 0.05$). In addition, the independent-samples t-test indicated a significant association between working hours and ERI score in the service workers (P= 0.018). In the middle managers, staff, and engineering personnel, the ERI score had a significant correlation with overtime work, second job, and the opinion about the sufficiency of employees ($P < 0.05$). In all the studied employees, job satisfaction was significantly associated with the ERI score, and the shift worker staff and engineers reported significantly higher ERI scores (P = 0.019 and P=0.002, respectively).

3.3.3. NFR and Mental Workload

According to the results of independent-samples t-test, the ERI and NFR scores were significantly correlated in the middle managers, staff, and engineering personnel (P= 0.041, P= 0.010, and P< 0.001, respectively). Moreover, the total workload was significantly associated with the ERI in the engineering personnel and staff. Among the staff, The ERI was significantly correlated with mental demand (P= 0.032), effort (P< 0.001), and frustration (P= 0.002).

The ERI score of the top managers was not significantly correlated with the workload domains, while in the service workers, the score had significant associations with temporal demand and frustration (P= 0.036 and P= 0.002, respectively).

Table 1: Demographic Characteristics of Sample Population

Working group	Frequency	Age (years)	Work experience (years)	Gender		Marital status	
				Male	Female	Single	Married
Staff	117	33.90 ± 6.52	7.7 ± 5.81	112	15	23	94
Middle manager	24	38.87 ± 7.15	13.12 ± 8.7	24	-	4	20
Services	59	34.54 ± 7.55	6.78 ± 3.80	59	-	11	48
Top manager	7	46.25 ± 8.65	13.71 ± 11.90	7	-	-	7
Engineering and technical	67	34.16 ± 5.81	6.43 ± 5.31	65	2	17	50
Total	274	34.85 ± 7.04	7.82 ± 6.10	257	17	55	219

Table 2: Education Level of Participants

Working group	Lower than diploma	Diploma	Associate´s degree	Bachelor´s degree	Master´s degree	PhD
Staff	-	11	20	60	23	3
Middle manager	-	0	0	13	8	3
Service	24	28	3	4	0	0
Top manager	-	-	-	5	2	0
Engineering and technical	-	3	8	31	21	4
Total	24	42	31	113	54	10

In the engineering personnel, the ERI score was significantly correlated with mental workload (P = 0.045), physical demand (P = 0.026), effort (P = 0.002), and frustration (P = 0.044). In addition, the ERI score of the middle managers had a significant association with the mental demand of workload (P= 0.007).

According to the obtained results, the NFR level and mental workload demands were significantly correlated. Such correlation was also observed in the staff with frustration, service workers with total workload, mental and temporal demands, and frustration, in the top managers with the total and mental workload domains, and in the engineering personnel with total workload, mental domain, effort, and frustration level.

The present study aimed to evaluate the impact of work-related and background factors and workload-related domains on various working groups at a gas refinery complex. According to the findings, the perceived ERI could be influenced by various work-related factors in different working groups of an organization. The service workers had more significant imbalance (47.5%), which is consistent with the notion that the level of imbalance increases with the extension of service duties [29].

In the present study, the male staff and engineering personnel reported higher ERI levels compared to women. This is in line with the study by Mortezapour et al. (2017) [14], while in contrast with the study by De Jonge et al. (2000) [30], which could be due to the large sample population. The similarity of the findings could also be attributed to the lower expectations of women compared to men in the workplace or lower expectations from women in some occupations in general. Another reason could be the smaller number of the female employees compared to men (17 versus 257). According to the findings of the current research, the ERI score had no significant correlations with age and work experience, which is consistent with some studies in this regard on firefighters and industrial workers [14,20]. Therefore, it could be inferred that the employees with lower or higher job experience may be affected by occupational stress; in the case of elderly employees, this is mainly due to their inability to adapt to new technologies, while in the case of younger employees, it is due to unfamiliarity with the work system.

However, contrary findings have been proposed in some of the studies in this regard [31], suggesting that elderly and more experienced workers could better adapt to new working conditions compared to younger employees.

In all the working populations in the current research, a significant association was observed between the academic degree and ERI score, so that the workers with higher academic degrees perceived higher imbalance and had higher ERI scored than one. This is consistent with the previous studies in this regard [14, 32]. It seems that work and duties are not proportionate for employees with higher academic levels, and the assigned duties appear monotonous to these individuals. Therefore, work design must address the abilities of the potential workers with high academic degrees. Higher academic degrees could moderate the stress level and reduce ERI, while it could be more generalizable to the situations where work fits the abilities and education level of employees.

According to the current research, the ERI and marital status were significantly correlated in the staff, middle managers, and engineering personnel. Moreover, perceived stress increased when the employees were not able to handle their family responsibilities and make the equilibrium in this regard [33]. On the other hand, the single employees had fewer responsibilities and difficulties in the family, which in turn resulted in their lower stress levels.

In the present study, the type of employment was significantly correlated with the ERI in the staff, engineering personnel, and service workers, while the workers with temporary contracts experienced higher imbalance. This is consistent with another research conducted on industrial workers [14]. Therefore, it could be concluded that workers with higher job security and longer contract durations experienced lower stress levels. However, such finding was not observed in the managers, as the majority of them had permanent contracts, which could be attributed to their higher authority and job control in the organization.

In the current research, the correlation between the working hours and ERI was significant only in the service workers, who had the longest working hours (237 hours per month) compared to the other groups (210-220 hours per month). Therefore, it seems that service workers expected more rewards considering their longer working hours.

Table 3: Work Characteristics of Sample Population

Working group	Overtime work		Employment status			Sufficient number of employees		Overall job satisfaction			Second job	
	Yes	No	Permanent	Treaty	Temporal	Yes	No	High	Neutral	Low	Yes	No
Staff	20	97	42	60	15	57	60	64	23	30	11	106
Middle manager	3	21	20	3	1	6	18	12	4	8	4	20
Service	10	49	1	56	2	19	40	35	6	18	2	57
Top manager	1	6	4	3	0	3	4	2	4	1	0	7
Engineering and technical	10	57	17	43	7	40	27	32	18	17	6	61
Total	44	230	84	165	25	125	149	145	55	74	23	251

Table 4: Scores of ERI, Workload Domains, and NFR in Sample Population

Working group		Staff	Middle manager	Service	Top manager	Engineering and technical	All participants
Mental demand		75.49 ± 20.39	82.39 ± 15.70	67.46 ± 27.33	66.41 ± 22.86	77.84 ± 19.40	74.72 ± 21.90
Physical demand		61.43 ± 23.17	60.87 ± 19.19	76.88 ± 18.86	45 ± 20.30	53.21 ± 25.50	62.13 ± 24.12
Temporal demand		71.92 ± 19.82	72.61 ± 17.09	75.95 ± 18.84	68.57 ± 22.86	70.30 ± 21.68	72.75 ± 19.32
Performance		80.04 ± 15.42	76.26 ± 13.70	72.71 ± 14.30	78.57 ± 14.92	77.54 ± 17.53	83.38 ± 15.12
Effort		74.55 ± 20.65	78.10 ± 16.45	72.14 ± 26.27	71.43 ± 18.86	73.51 ± 23.35	73.74 ± 21.68
Frustration		52.12 ± 31.04	53.54 ± 30.12	55.25 ± 31.05	40.09 ± 27.86	50.37 ± 27.66	52.18 ± 29.27
Total workload		69.29 ± 28.46	70.27 ± 20.20	74.52 ± 16.06	61.06 ± 30.12	61.21 ± 31.01	69.70 ± 25.46
NFR (%)		62.01 ± 30.21	57.95 ± 28.11	58.80 ± 34.81	45.45 ± 28.12	61.05 ± 31.87	60.11 ± 21.89
NFR	low	28 (24%)	6 (25%)	14 (23.7%)	3 (42.8%)	15 (21.7%)	66 (24%)
	high	89 (76%)	18 (75%)	45 (76.3%)	4 (87.2%)	52 (78.3%)	208 (76%)
ERI	low	72 (61.5%)	19 (79.1%)	31 (52.5%)	5 (71.4%)	51 (73.9%)	178 (65%)
	high	45 (38.5%)	5 (20.9%)	28 (47.5%)	2 (28.6%)	16 (26.1%)	96 (35%)

Interestingly, they were the subgroup who perceived higher temporal workload, which was significantly associated with the ERI as they work longer hours and perceive higher time pressure. Heavy workload, time constraints, and long working hours are among the main stressors in the workplace [13], and the service workers in the present study had staff shortage as 66% perceived low service practitioners in the organization.

According to the results of the present study, the ERI was significantly correlated with overtime work, having a second job, shift working, and opinions about the sufficiency of the staff, middle managers, and engineering personnel. In a study conducted on industrial workers, shift workers were reported to perceive higher ERI [34]. Working extra hours may cause conflicts between professional and familial responsibilities, thereby increasing occupational stress. As such, overtime work should be rewarded properly, so that workers would not become exhausted or experience adverse health consequences. This also applies to having a second job as working in two or more jobs could increase the need for recovery in workers, causing higher perceived stress due to diminished mental or physical resources. Furthermore, guaranteed job security prevents the intention of workers to seek more professions. In a research in this regard, the perception employees regarding the sufficiency of workforce was confirmed [14]. With inadequate workforce, workers are more likely to become overwhelmed, which in turn leads to their increased effort as opposed to their reward, thereby increasing their stress levels.

In the current research, all the participants claimed that job satisfaction was significantly correlated with the ERI. Therefore, it could be assumed that balance between professional efforts and rewards increases the satisfaction of employees and reduces job burnout rates. A workplace could be developed and nourished to increase the satisfaction of the employees, which in turn results in higher organizational productivity. Factors such as workplace design and environmental factors could be largely influential in this regard [35].

According to the current research, the ERI score was significantly correlated with the need for recovery in the staff, middle managers, and engineering personnel. This is consistent with the results obtained by Takaki et al. (2006) [36]; if employees feel exhausted and are not able to recover from fatigue, they perceive higher imbalance. In another study, fatigue was reported to be an adverse consequence of the ERI [37]. Therefore, these variables are interconnected, and the control of one leads to the reduction of the other. Stress is strongly associated with work fatigue and may jeopardize the mental health of organizational employees [38]. Occupational stress and its determinants should be meticulously assessed in order to improve health in the workforce.

In the present study, mental workload and some of its domains were significantly correlated with the ERI in the middle managers, staff, service workers, and engineering personnel. This is in congruence with the study by Gonzalez et al. (2007) who observed significant associations between occupational stress and the mental workload, temporal demand, and frustration domains of workload [39]. As observed in the current research, the engineering personnel had numerous physical duties, and their ERI score was significantly correlated with physical demand, as well as the domains of frustration, effort, and mental workload. Therefore, it could be concluded that the engineering personnel had heavy workload in these domains, which could be due to their job description and position in the organization. In addition, the frustration domain was associated with the ERI in all the employees, with the exception of the managers, which indicated that lower-level workers were highly stressed as they felt neglected. Similarly, stress was significantly correlated with frustration, effort, and mental and total workload. It seems that despite the optimal efforts of these workers, they are frustrated due to negligence and experience high mental workload, which may lead to other health issues, such as work-related musculoskeletal disorders [40], thereby adversely affecting the workforce; as such, this issues requires further monitoring. In the current research, various working groups had problems in different domains of workload, which should be analyzed separately.

The results of the present study may be generalizable to different working groups. Each of the studied demographic, background, and work-related factors could affect occupational stress in employees, and implications for improvement could be made separately. Using employees with proper education levels in all organizational working groups and maintaining their satisfaction by their recognition, rewards, and engagement in technical decisions could reduce the ERI and frustration, especially in lower-level employees. Furthermore, these solutions could decrease the intention of employees to seek a second job, which is associated with the increased need for recovery and ERI. Long-term contracts and higher job security in lower-level employees may also contribute to the reduction of such imbalance. Some other recommended measures in

this regard include the reduction of working hours in service workers and paying more attention to them through promotion opportunities, reducing the time pressure in their work, increasing the number of employees and, and reducing overtime work in middle managers, engineering personnel, and staff. In addition, decreasing the need for recovery could diminish the perceived imbalance, and some of the solutions in this regard are the provision of proper work-rest cycles, sufficient rest time before starting the next work shift, and decreased physical workload in engineering personnel. Special attention should also be paid to staff as a more significant correlation was observed between the workload and ERI in this population, and the reduction of workload by the mentioned recommendations seems essential.

One of the limitations of this research was the study design as we could not determine the cause-and-effect and analyze behaviors during the study period.

4. Conclusion

According to the results, employees with various duties and job descriptions had different background and perceptions of work-related factors regarding the ERI, and further investigation is required in this regard. In addition, specific recommendations should be proposed for each working group separately. Special attention must be paid to service workers in order to decrease their frustration, while the need for recovery should decrease in the staff, engineering personnel, and middle managers. On the other hand, the reduction of mental workload and the need for recovery, as well as attention to work-related and background factors could effectively diminish the ERI in organizational employees.

Authors' Contributions

R.K., and A.M., conducted the study design, M.S., F.R., and R.M., conducted the data collection, A.Z., and E.B., conducted the data analysis, R.K., A.M., and E.B., drafted the manuscript. All the authors confirmed final version of the manuscript.

Conflict of Interest

The Authors declare that there is no conflict of interest.

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