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MENTAL WORKLOAD AMONG EMPLOYEES IN INDUSTRIAL GAS COMPANIES IN SOUTHERN ALGERIA

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Abstract

This study explores the level of mental workload among employees in industrial gas companies in Southern Algeria, with a focus on identifying potential differences based on age and job type. Utilizing a descriptive approach, a validated "Cognitive Load Symptoms" questionnaire was administered to a sample of 33 employees to assess physical, psychological, and behavioral manifestations of cognitive load. The findings indicate that workers experience a high level of mental workload regardless of age or job type, reflecting the demanding and hazardous conditions associated with the industrial gas sector. The significance of this study lies in its potential to inform organizational strategies aimed at maintaining employee well-being while ensuring high operational performance, particularly within critical industries that played a strategic role during the COVID-19 pandemic by supplying medical oxygen and other essential gases across Algeria and North Africa. Understanding the determinants of mental workload in such contexts can support targeted interventions to reduce stress and fatigue, enhance occupational safety, and sustain productivity in vital industrial operations. The study underscores the need for practical measures to manage mental workload to maintain a healthy and efficient workforce within the industrial gas sector.

Keywords: Mental Workload, Cognitive Load, Industrial Gas Companies, Occupational Stress, Algeria, Workplace Ergonomics, Employee Well-being.

1. Introduction:

The world today is undergoing a critically important transitional phase imposed by the variables of the twenty-first century, amid transformations and developments that have affected various social, economic, and political systems and impacted all organizations of different types. In the midst of these changes, these organizations strive to achieve the goals for which they were established, whether productive, competitive, or profitable.

The achievement of these goals necessitates periodic implementation of numerous procedures to update their systems and improve their working conditions, and encourages them to adopt certain administrative strategies that affect their work organization methods in order to manage situations and circumstances effectively, efficiently, and optimally, such as adopting "new systems for

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production, work and technological innovations, new policies for human resource management, innovative forms of work organization, and so forth" **(Fournier et al: 2010, p1)**.

Perhaps the rapidity of these changes in the organizational world has led to actual improvement in organizational performance, through "work intensification associated with quality standards that are increasingly translated through procedure standardization and error reduction" **(Rabassa: 2006, p12)**, as well as through "new human resource policies that have become more effective in soliciting effort from employees" **(Green: 2002, p04)**. However, to evaluate the overall performance of these organizations, it is necessary to identify their potential effects on their employees, because "work intensification may constitute a major problem in terms of strain, psychological health, and stress for the worker" **(Kelliher & Anderson: 2010, p85)**.

As is the case in other economic sectors, workers at the National Industrial Gases Company in Ouargla (LIND GAZ) may experience continuous strain as a result of the nature of the activity they practice and the various working conditions associated with it. This company is considered one of the oldest factories in the southeastern region, tasked with meeting the demand for industrial gases in the southern region of the country, and supervises two distribution centers: the Ghardaiacenter and the Touggourtcenter. It is also the sole supplier for petroleum companies in Hassi Messaoud, Ain Salah, Berkaoui, Hassi R'mel, and Ain Amenas, producing and distributing various industrial and medical gases to different economic sectors such as sports, industry, agriculture, and technological research.

The products manufactured by the National Industrial Gases Company are of great importance to the nation from health, educational, and economic perspectives, as its products are used in many sectors. They are used in the hydrocarbon sector, petroleum industries, petrochemical industries, and in the chemical industry sector. Its products are also used in the health sector, where it supplies hospitals with oxygen and other gases used for health services. In the education sector, it provides institutes and universities with industrial gases necessary for education and scientific research. It also serves the agricultural sector and food industries, as well as providing craftsmen with industrial gases necessary for their trades such as repairing household appliances, repairing car refrigerators and units, and more.

In Algeria, the industrial gas sector plays a critical role in supporting both the national economy and public health systems. Industrial gases, particularly oxygen and carbon dioxide, are essential for various sectors, including healthcare, petrochemicals, and food industries, making their continuous supply a matter of national security. This sector’s contribution became especially evident during the COVID-19 pandemic, as it ensured the uninterrupted provision of medical oxygen to hospitals and intensive care units across the country and North Africa. The stability and efficiency of this sector directly influence the country’s healthcare resilience and industrial continuity, underlining the need to safeguard the psychological and physical well-being of its workforce to maintain operational readiness and safety standards within these essential industries

It is worth noting that the nature of work performed by Lind Gaz workers is related to their working conditions and the type of activity they practice, which involves dealing with dangerous and combustible materials such as oxygen (O_2) and carbon dioxide (CO_2), which is semi-manufactured and at extremely cold temperatures reaching below minus 185°C. Workers process

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these materials to become moderate and ready for use at normal temperatures reaching 7°C, after which they are transported in cylinders or tanks to the sectors concerned with their use.

Dealing with these extremely dangerous materials and the nature of tasks performed by workers at this institution "may constitute a major problem in terms of strain, psychological health, and stress for the worker" **(Kelliher & Anderson, 2010, p85)**, which may lead to increased levels of pressure and stress resulting from their working conditions. Since workers are the primary axis for this institution's development, the progress and development of this institution may be affected due to the impact of these conditions on their psychological and physical health, because working conditions are characterized by (physical nature such as lighting, noise and heat, as well as psychological and moral nature such as horizontal relationships with other workers, and vertical relationships with the administrative hierarchy, and they are of an organizational nature such as the content of work, its importance and nature" **(Ali Moussa: 2006, p31)**.

Cognitive load is considered an important aspect of working conditions, and it is an integral part of the general workload, which is divided into two parts: physical load and cognitive load **(Djibo et al, 2006, p08)**. The latter is referred to as a part or sample of information about the processing capacity or resources of the worker to meet system demands, where "Szekly" defines it as "a state of comprehensive mobilization of the worker resulting from performing work that requires information processing, thus symbolizing the cost of this type of work for the worker" **(Djibo et al, 2006, p118)**. In the same context, "Leplt" (1977) defines cognitive load as "the cognitive resources mobilized by the worker, where these resources allow him to respond to the requirements of the work he performs; in other words, it represents the degree of his personal mobilization, and the proportion of his capacity at work" **(Martin, 2013, p58)**.

It is observed that these definitions use the concept of "capacity" to designate the maximum information processing limit, and consider cognitive load as a result of interaction between the constraints imposed by the task (processing difficulty, complexity) and the cognitive resources allocated by the worker and their ability to mobilize them in order to meet the requirements of this task. These definitions also use the concept of "mental effort" to explain cognitive load, which represents "the reduced level of mental activity that the individual suffers from, resulting from a decrease in central nervous activity" **(Neuwirth & Eberhardt, 2003, p3)**, leading to psychological and physical effects.

Many studies have been dedicated to examining this multi-faceted problem, and numerous studies have shown that with increasing work demands, workers must change their work procedures **(Leplat, 2004, p45, p106)**, because "after a certain time, chronic fatigue develops into pathological fatigue, and excessive fatigue leads to dysfunction of the organizational and integrative functions of the hypothalamus, which translates into serious organic psychological or psychosomatic disorders leading to loss of physical and mental powers (coordination difficulty, memory loss), mood changes (intolerance, reactivity, lethargy, etc.), sleep disorders, organic disorders (headaches, gastric ulcers, heart attacks)" **(Guelaud et al, 1975, p123)** and others.

It is worth noting that fatigue and mental exhaustion lead to stimulation of the hypothalamus, which receives neural signals from the higher brain centers and secretes hormones that activate the pituitary gland. Among the most important of these hormones is cortisol, which is considered an

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indicator of tension and stress and is known as the stress hormone. Its secretion causes "a series of reactions in the body including weakening of the immune system, tension in large muscles, and elevated blood pressure" **(Muayyad, 2015, p361)** and other physical symptoms.

Therefore, cognitive load was of paramount importance to researchers, which prompted them to study it and its main effects on workers. Among these studies is that of "Charlotte Thellend" (1981), which examined the impact of physical working conditions and certain personal characteristics, in addition to the impact of increasing cognitive demands in mental tasks. The aim of this study was to present a new approach to measuring mental fatigue through eye kinetics, based on a known indicator, the critical visual fusion frequency test. Its most important findings indicate that some groups seem more affected by exhaustion and fatigue resulting from mental tasks, and the results show that certain factors significantly affect mental fatigue, such as age, educational level, individual differences, and working conditions represented in physical environmental conditions such as lighting, sound level, thermal environment, work conditions, and work organization, which constitute factors contributing to increased cognitive load.

In the same context, we find the study of "Sylvi Hamon-Cholt" and "Catherine Rougerie" (2000), which aimed to investigate working conditions, and most of its results were as follows: workers suffer from a general increase in mental and psychological load factors during the performance of their tasks; workers suffer from a general increase in physical load factors during the performance of their tasks; mental load factors result from pressures during task performance due to the limited time for task execution and the standards to be respected regarding product quality or anything related to the customer **(Hamon-Cholt&Rougerie, 2000)**.

The study of "Caroline Martin" (2013) aimed to measure cognitive load among air traffic controllers in various work situations. Its findings revealed that air traffic controllers suffer from cognitive load resulting from increasing cognitive demands and tiring air transport conditions. Additionally, the characteristics of air traffic controllers such as age, years of experience, and training have an impact on the cognitive resource management methods they use. The study concluded that training reduces the level of resources, which helps in reducing the cognitive load that sample individuals may suffer from **(Martin, 2013)**.

As for Arab studies, we find that the term cognitive load has not received significant attention from Arab researchers due to its novelty. Despite the scarcity of these studies, this does not mean they are non-existent. We find the study of "Khadija Abadou" (2018), which aimed to study the prevailing work characteristics among 320 physicians in Ouargla city hospitals and their relationship to cognitive load. It addressed some psychosocial factors affecting cognitive load such as autonomy and some organizational factors such as length of service. Its results found that the level of cognitive load among physicians in hospitals is low, in addition to the existence of a statistically significant negative relationship between (job importance, verification of job identity, autonomy, and feedback) and cognitive load among physicians in hospitals, and the existence of statistically significant differences in the level of cognitive load according to length of service and employing entity (public, private). The interaction of training nature, employing entity, and length of service does not affect cognitive load **(Abadou, 2018)**.

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The importance of the current study emerges from previous studies as it addresses the same variable, namely cognitive load, while differing in samples. As for cognitive load measurement methods, the study of "Khadija Abadou" (2018) and the study of "Sylvi Hamon-Cholt" and "Catherine Rougerie" (2000) agreed in using subjective measures—questionnaires—while other studies differed from the current study by using physiological measures (eye flickers) such as the study of "Caroline Martin" (2013) and the study of "Charlotte Thellend" (1981).

Hence, the importance of the current study is reflected in its attempt to reveal the level of cognitive load among workers at the National Industrial Gases Company in Ouargla, a workforce that may experience cognitive load through dealing with dangerous and combustible materials, in addition to significant professional demands related to time pressure, and their ability to reconcile the demands of employers and demands related to meeting their increasing requests in light of the challenges imposed by administrative strategies and modern techniques, which may increase their level of cognitive load. This is done through a scientific study based on methodological foundations, taking the National Industrial Gases Company in Ouargla (LIND GAZ) as a field model, and thus the following questions were posed:

1. What is the level of cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ)?
2. Are there statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the age variable?
3. Are there statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the job type variable?

2. Importance of the Study:

1. The current study derives its importance through its targeting of a workforce that is responsible for providing critical services to many health, educational, agricultural, and industrial sectors, namely the workers at the National Industrial Gases Company in Ouargla (LIND GAZ).
2. The importance of the current study is manifested in being one of the few Arab studies that addressed the concept of cognitive load.
3. Enriching an important aspect of psychological and ergonomic studies with a new variable, namely the cognitive load variable.
4. The importance of this study for LIND GAZ lies in its potential to inform organizational strategies aimed at preserving employee well-being while maintaining high operational performance under demanding conditions. Given LIND GAZ’s critical role as a primary supplier of industrial and medical gases—particularly medical oxygen during the COVID-19 pandemic across Algeria and North Africa—the company’s workforce operates under high cognitive and psychological demands. Understanding the levels and determinants of mental workload among its employees can support targeted interventions to reduce stress and fatigue, enhance occupational safety, and improve productivity and service reliability in critical industrial operations. This is particularly vital for LIND GAZ, as maintaining a

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healthy workforce directly influences its ability to continue serving essential sectors, including healthcare, under normal and crisis conditions.

3. Objectives of the Study:

1. Revealing the level of cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ).
2. Identifying differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) according to the age variable.
3. Identifying differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) according to the job type variable.

4. Operational Definition of Cognitive Load:

4.1. Cognitive Load: The strain experienced by workers at the National Industrial Gases Company in Ouargla (LIND GAZ), resulting from the interaction between the cognitive demands they need to accomplish their tasks and the work requirements, and the consequent physical, psychological, and behavioral symptoms that impede their performance and threaten their psychological and physical health.

The score obtained by the worker at the National Industrial Gases Company in Ouargla (LIND GAZ) on the scale prepared and designed for this purpose with its three dimensions (symptoms: physical - psychological - behavioral) expresses the level of their cognitive load.

5. Limitations of the Study: This study is defined by the following human, spatial, and temporal parameters:

5/1 - Human Limitations: This study is humanly limited to workers at the National Industrial Gases Company in Ouargla.

5/2 - Spatial Limitations: This study is spatially limited to the National Industrial Gases Company in Ouargla (LIND GAZ).

5/3 - Temporal Limitations: This study is temporally limited to the academic year (2021/2022).

6. Field Study Procedures:

6-1 - Study Methodology: The descriptive approach was used, which is often associated with social and human sciences studies where it has been used since its inception and emergence. It involves accurate monitoring and tracking of a specific phenomenon or event in a quantitative or qualitative manner in a specific period or several periods, in order to identify the phenomenon or event in terms of content and substance, and to reach results and generalizations that help in understanding and developing reality. The descriptive approach is defined as the approach in which the researcher describes the phenomenon as it exists in reality, both quantitatively and qualitatively. **(Zarwati, 2007, p257)**.

6-2 - Study Sample:

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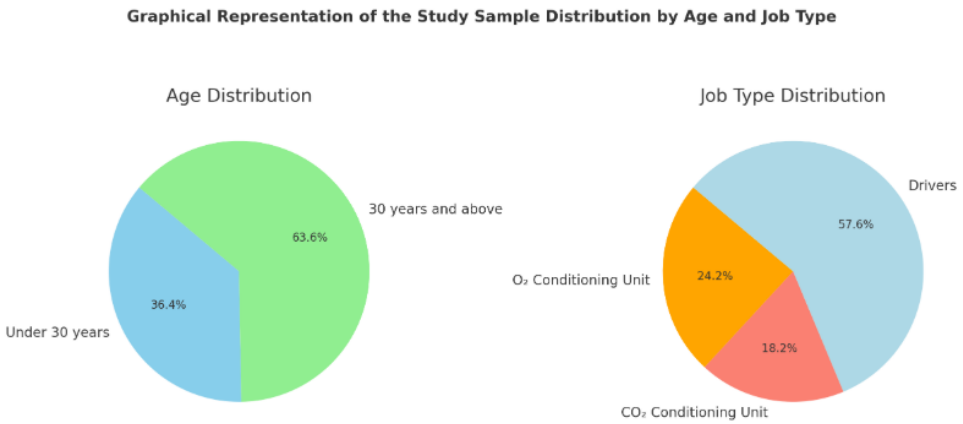
The current study sample consisted of (33) workers at the National Industrial Gases Company in Ouargla (LIND GAZ), who were selected by simple random sampling. They were classified according to age and job type, as illustrated in the following table:

Table (01) shows: Distribution of the study sample according to the variables of age and job type

Variables		Count	Total	Percentage	Overall Total
Age	Under 30 years	12	33	36.36%	100%
	30 years and above	21		63.63%	
Job Type	Oxygen Conditioning Unit (O_2)	8	33	24.24%	100%
	Carbon Dioxide Conditioning Unit (CO_2)	6		18.18%	
	Drivers	19		57.57%	

From Table (01), we observe that the number of workers aged less than 30 years reached (12) workers, representing 36.36%, which is less than the number of workers aged 30 years and above, estimated at (21) workers, representing 63.63%. Meanwhile, the number of driver workers reached (19), representing 57.57%, which is greater than the number of workers in the oxygen conditioning unit, estimated at (8), representing 24.24%, and greater than the number of workers in the carbon dioxide conditioning unit, totaling (6), representing 18.18%.



6-3 - Study Tool: Based on the nature of the data to be collected and the methodology adopted in the study, we determined that the most appropriate tool to achieve the objectives of this study is

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the questionnaire. Accordingly, the "Cognitive Load Symptoms" questionnaire was constructed. The scale in its initial form consisted of (34) items distributed across three dimensions:

A - Physical Symptoms: Measured by the following statements (1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, 34).

B - Psychological Symptoms: Measured by the following statements (2, 5, 8, 11, 14, 17, 20, 23, 26, 29, 32).

C - Behavioral Symptoms: Measured by the following statements (3, 6, 9, 12, 15, 18, 21, 24, 27, 30, 33).

The questionnaire statements were formulated in a declarative manner, i.e., in line with the trait direction, and scored according to a five-point scale of alternatives, as follows: (Always / Often / Sometimes / Rarely / Never), with the **scoring key:** (5/4/3/2/1).

6-4 - Assessment of Some Psychometric Characteristics of the Study Tool: After conducting a pilot study consisting of (30) workers at the National Industrial Gases Company in Ouargla (LIND GAZ), and after applying and correcting the tool, terminal comparison validity and internal consistency validity, Cronbach's alpha reliability, and split-half reliability were relied upon. The following is a detailed explanation of their application.

6-4-1 - Terminal Comparison Validity: Validity was calculated using the terminal comparison method to test the tool's ability to distinguish between the upper and lower groups in the trait being measured in the pilot sample. The scores were arranged from highest to lowest, and a percentage (33% highest) and a percentage (33% lowest) were taken. The arithmetic mean and standard deviation for the upper and lower groups were calculated, then the (t) ratio for the two samples was calculated using SPSS version 25, where (n_1 = 10) and (n_2 = 10), as shown in the following table:

Table No. (02): Shows the Validity of Extreme Comparison for the Cognitive Load Symptoms Questionnaire

Group	Sample Size	Arithmetic Mean	Standard Deviation	Calculated T-Value	Degrees of Freedom	Significance Value (sig)	Significance Level
High	10	110.70	5.498	-12.298	18	0.000	0.05
Low	10	159.20	11.193				

From the results shown in Table (02), we observe that the t-value was estimated at (-12.298), which is significant at the degree of freedom (18), and the value of (sig = 0.000) is less than the significance level (0.05), indicating the existence of differences between the upper and lower

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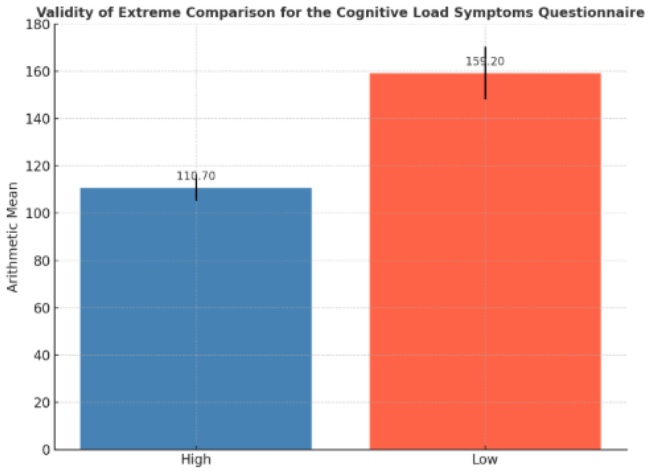
groups. Therefore, the Cognitive Load Symptoms questionnaire is distinctive and has an acceptable level of validity, thus it can be applied in the main study.



6-4-2 - Internal Consistency Validity:

Internal consistency validity was calculated to determine that the items of each scale are interrelated, by calculating the correlation coefficients between the score of each item and the total score of the dimension, and between the score of each dimension and the total score of the tool.

Table No. (03): Shows the Internal Consistency Validity of the Study Instrument

Table 1. Item–Total Correlations for the Mental-Workload Symptoms Scale

Behavioural Symptoms			Psychological Symptoms			Physical (Somatic) Symptoms		
Sig.	**r**	**Item**	**Sig.**	**r**	**Item**	**Sig.**	**r**	**Item**
.000	0.622 **	3	.000	0.630 **	2	.001	0.572 **	1
.000	0.648 **	6	.000	0.802 **	5	.000	0.743 **	4
.000	0.798 **	9	.007	0.464 **	8	.000	0.648 **	7
.000	0.657 **	12	.000	0.739 **	11	.054	0.339	10
.000	0.672 **	15	.000	0.730 **	14	.066	0.324	13
.054	0.338	18	.000	0.660 **	17	.000	0.741 **	16

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.012	0.433 *	21	.000	0.868 **	20	.000	0.776 **	19
.023	0.393 *	24	.000	0.612 **	23	.000	0.639 **	22
.004	0.485 **	27	.000	0.680 **	26	.000	0.598 **	25
.045	0.352 *	30	.000	0.734 **	29	.000	0.651 **	28
.000	0.714 **	33	.001	0.543 **	32	.006	0.482 **	31
						.005	0.482 **	34
000.	0.832	Total	000.	0.862	Total	000.	0.667	Total

The results shown in Table (03) clearly demonstrate a correlation between each item and the total score of the dimensions. The correlation coefficient values for the relationship between dimensions and their representative items range between (0.324 — 0.868) at significance levels (0.05 — 0.01). The correlation coefficients between dimensions and the total questionnaire score were estimated between (0.667 — 0.862) at significance level (0.01). The strength of correlation serves as a statistical indicator of internal consistency validity. Consequently, items that were significant at these levels were retained, while items numbers (10 - 13) from the physical symptoms dimension and item number (21) from the behavioral symptoms dimension were eliminated. This resulted in an instrument consisting of 31 items measuring symptoms of cognitive load.

6 - 4 - 3 — Reliability: Reliability procedures were conducted on the same pilot sample using split-half method (Guttman coefficient) and Cronbach's alpha, as shown in the following table

Table 4: Reliability Coefficients of the Study Instrument

Variable	Number of Items	Cronbach's α	Guttman Split-Half Coefficient	
			r (before adjustment)	***r***(after adjustment)
Mental workload	**31**	**0.884**	**0.669**	**0.798**

From Table (04), we observe that the reliability coefficient values using Cronbach's alpha equaled (0.884), while the reliability coefficients using split-half method showed an increase in the "r" value after correction with Guttman coefficient from (R=0.669) to (R=0.789). This indicates that

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the cognitive load symptoms questionnaire demonstrates a high degree of reliability, thus enabling its application in the main study.

7. Presentation, Discussion, and Interpretation of Study Results: In this section, we address the presentation of the main study results as produced by the statistical processing of data obtained after applying the instrument to a sample of (33) workers. The field study results will be presented according to the proposed research questions, as generated by statistical processing using SPSS V25 program, followed by analysis and discussion.

7-1 Presentation, Discussion, and Interpretation of the First Research Question Results: The first research question states the following:

1. What is the level of cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ)?

To verify this question, the arithmetic mean and standard deviation were calculated for the workers' response scores on the cognitive load symptoms questionnaire, noting that the theoretical mean of the scale adopted in this study is (93). The results obtained are shown in the following table:

- Theoretical mean = (Maximum score + Minimum score)/2
- Theoretical mean = (31×5)+(31×1)/2 = 93

Table 5: Results of the One-Sample T-Test for Examining the Significance of Differences Between the Theoretical Mean and the Arithmetic Mean of the Study Sample's Scores on the Research Instrument

Variable	Theoretical Mean	Arithmetic Mean	Standard Deviation	DF	Calculated *t*	p-value
Mental workload	93	132.636	21.187	32	10.746	.000

From Table (05), it is evident that the arithmetic mean of the sample scores, consisting of (33) workers, reached (132.636), with a standard deviation of (21.187). The hypothetical mean for the study instrument was calculated at (93). The difference between the two means was tested and found to favor the arithmetic mean using the t-test for a single sample. The t-value reached (10.746), while the probability value (sig) was (0.000), which is less than the significance level of (0.05) at degree of freedom (32) and is statistically significant. This indicates that the level of cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) is high.

This result aligns with the findings of studies by Charlotte Thellend (1981), Caroline Martin (2013), and Sylvi Hamon-Cholt and Catherine Rougerie (2000), which found that their sample subjects suffered from high levels of cognitive load while performing their tasks.

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However, this study's results differ from those of "Abadou Khadija" (2018), which found that doctors in Ouargla province hospitals experience low levels of cognitive load.

This result can be attributed to the nature of the tasks performed by workers at the National Industrial Gases Company in Ouargla (LIND GAZ), which imposes numerous constraints. Their work is intellectually demanding, requiring high mental effort to operate machinery and equipment that process and condition gases. This mental effort contributes to decreased cognitive activity due to the high mental demands placed on them, such as heightened vigilance and attention, as well as precision and concentration in executing their tasks. "Cognitive demands are one of the main sources of mental workload, which negatively affects perception and leads to harmful effects on both workers' health and the achievement of organizational objectives" (Abadou, 2018, p. 241). In this task, workers deal with industrial gases obtained from natural sources such as atmospheric air and natural gas through quantitative and qualitative analysis processes across several workshops.

Additionally, the Linde Gas facility in Ouargla operates on a continuous work system (3×8), whereby the maximum annual production capacity for the workshops producing the studied products is calculated. With increasing pressures due to the repetitive and routine nature of the work system, while maintaining quality performance from this workforce category, mental workload levels increase because continuing "repetitive mental activity in the same pattern will necessarily lead to cognitive load" (Sperandio, 1988, p108). This is compounded by time pressure and limited rest periods, with only 15 minutes of break for each hour of work.

Furthermore, handling oxygen (O2) and carbon dioxide (CO2), which are semi-manufactured and at extremely cold temperatures reaching below (-185°C), presents dangerous and combustible materials that threaten the lives of this sample population. This danger may increase the level of cognitive load resulting from fear of harm.

7-2 Presentation, Discussion, and Interpretation of the Second Research Question Results: The second question states:

- Are there statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the age variable?

After statistically analyzing the results of this hypothesis using the t-test to estimate differences between the mean age of workers under 30 years and workers 30 years and older in cognitive load, the results were presented in the following table:

Table 6: Results of the Independent Samples T-Test for Examining the Significance of Differences in Mental Workload Based on the Age Variable

Variable	Age Group	N	Mean ($\bar{X}$)	SD (S)	df	t	p-value (Sig)	α
Mental	< 30 years	12	131.916	21.529	31	–0.145	.885	0.05

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workload	≥ 30 years	21	133.047	21.513				

Table (06) shows that the calculated t-value reached (-0.145) at degree of freedom (31), with the significance value (sig) estimated at (0.885), which is greater than the significance level (0.05). This indicates that there are no statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the age variable.

These results differ from those of Caroline Martin's study (2013), which found that age, among other characteristics of air traffic controllers, has an effect on the cognitive resource management methods they use. They also differ from Charlotte Thellend's study (1981), which found that age is among the factors that increase cognitive load.

The absence of statistically significant differences according to the age variable in the level of cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) can be attributed to the fact that cognitive load is not affected by the age stage of this worker category. They experience the same high level of cognitive load, and cognitive load is not affected by the workers' age. This leads us to conclude that age is not a fundamental factor among the study sample and does not differentiate between workers under 30 years of age and workers 30 years and older.

The absence of differences between the study sample in cognitive load according to the age variable can also be attributed to the fact that the study sample members experience the same professional conditions. The conditions at the National Industrial Gases Company in Ouargla (LIND GAZ) encompass a wide range of different types of machines, equipment, and tools that pose a risk to workers regardless of their age. Working with industrial gases is considered among the most severe hazards threatening the lives of workers in this sector and may lead to varying damages and occupational diseases such as respiratory, digestive, skin, eye, and other occupational diseases.

Additionally, the environment in which this task is performed adds constraints to those imposed by the task itself. This environment should have certain characteristics that allow workers to be comfortable while performing their work. The antiquity of equipment, machines, and devices responsible for conditioning oxygen and carbon dioxide may hinder their performance on one hand and pose a danger to workers in this sector on the other, thereby increasing their level of cognitive load.

7-3 Presentation, Discussion, and Interpretation of the Third Research Question Results: The third question states:

- Are there statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the job type variable?

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To verify the validity of the third question, One-Way ANOVA was used, and the following table illustrates this:

Table 7: Arithmetic Mean and Standard Deviation for Each Category of the Job Type Variable

Variable	Category	Frequency (N)	Mean ($\bar{X}$)	Standard Deviation (SD)
Job type	O_2 conditioning unit	8	132.00	22.00
	CO_2 conditioning unit	6	144.50	27.061
	Drivers	19	129.15	18.61

Table 7 shows that the arithmetic means for each job type (oxygen conditioning unit, carbon dioxide conditioning unit, drivers) were different.

Table 8: Results of the Analysis of Variance (ANOVA) for Examining the Significance of Differences in Mental Workload Among Study Sample Members Based on the Job Type Variable

Variable	Source of Variance	Sum of Squares	df	Mean Square	F	Sig. (p-value)	α
Mental workload	Between groups	1 077.610	5	538.805	1.216	.310	0.05
	Within groups	13 288.026	30	442.934			
	Total	14 365.636	32				

From Table (08), it is clear that the sum of squares was estimated at (1077.610) and the mean square was estimated at (538.805) at degree of freedom (5) between groups. Within groups, the sum of squares was estimated at (13288.026) and the mean square was estimated at (442.934) at degree of freedom (30). Thus, the total sum of squares is (14365.636) with degree of freedom (32). The F-value was calculated at (1.216), which is not statistically significant. This indicates that there are no statistically significant differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) attributable to the job type variable. This leads us to conclude that job type is an additional factor and has no effect on increasing or decreasing the level of cognitive load among sample members. The professional environment at LIND GAZ does not differentiate between drivers, workers in the carbon dioxide conditioning unit, and workers in the oxygen conditioning unit; they all suffer from the same high cognitive load.

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This sector is among the industrial sectors where workers suffer from accidents and health disorders. The occupational hazards to which workers are exposed are numerous and varied, including risks arising from handling combustible materials. The danger for workers in the oxygen conditioning unit lies in handling oxygen that is semi-manufactured at extremely cold temperatures reaching below (-185°C), which is then heated to moderate temperatures reaching (7°C). Empty cylinders are then connected to several internal pipes in unit "A" to be filled with oxygen intended for hospitals or other industrial sectors. The danger in this process lies in the disconnection of pipes and leakage of this material, which could pose a significant risk to sample members, thereby increasing the feeling of cognitive load. As for the carbon dioxide conditioning unit, the working principle is the same as in the oxygen conditioning unit, which is why we did not find differences between these samples in cognitive load.

The pressures and stresses experienced by drivers are no less than those experienced by workers in the previously mentioned units. These stresses include constant anxiety in transporting these materials in designated tanks and cylinders. Sometimes, transporting them requires long distances, in addition to the burdens of driving that require continuous vigilance and attention to avoid traffic accidents that could lead to severe consequences as they carry flammable materials.

Therefore, we conclude that all worker categories at the National Industrial Gases Company in Ouargla (LIND GAZ) endure various stresses and pressures, which is why we did not find differences between them in cognitive load.

8. General Conclusion:

- Workers at the National Industrial Gases Company in Ouargla (LIND GAZ) suffer from a high level of cognitive load.
- There are no differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) according to the age variable.
- There are no differences in cognitive load among workers at the National Industrial Gases Company in Ouargla (LIND GAZ) according to the job type variable.

9. Recommendations:

- Given the high level of cognitive load, we see the necessity of providing a qualified career counselor to assist workers in this sector, who would organize educational lectures and training courses to enlighten this workforce category about scientific and psychological methods that reduce the level of cognitive load they experience.
- The need to review work times and rest hours for this workforce category.
- Intensification of industrial safety measures to protect workers and reduce accidents in this sector, which helps reduce the cost of caring for those injured in these accidents.

10. Suggestions:

- Conduct further studies on cognitive load involving other dimensions not addressed in the current study in industrial sectors, as well as studies and research on cognitive load and its relationship with some psychological and social variables.

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- Conduct more field studies and research covering the effects of cognitive load on psychological, physical, behavioral, and other effects.
- The necessity of conducting more field studies and research to identify the nature of this phenomenon and the factors governing it in industrial sectors.

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