

Impact of total quality management on the ergonomics of the work environment system

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ABSTRACT

Total Quality Management (TQM) is a management philosophy increasingly recognized as an effective approach to enhancing organizational quality and productivity. Improvement in working conditions constitutes a fundamental driver of enterprise growth, and applying systemic TQM principles facilitates both the identification of required changes and their successful implementation. Within this framework, emphasis must be placed on employees, the target domains of improvement, and the beneficiaries of these measures. To establish appropriate working conditions, ergonomic requirements should be addressed, and their integration with TQM principles is essential to ensure long-term effectiveness. The present study employed a questionnaire-based survey to evaluate ergonomic arrangements in a sample of Egyptian companies. Findings revealed that approximately 80% of employees perceive training and education as critical to improving work performance. Moreover, factories implementing structured quality systems and maintaining stable work

environments achieved customer satisfaction levels exceeding 60%. The study pursued two primary objectives: (a) to examine the impact of workplace ergonomics on quality through the interaction of human and environmental factors, and (b) to analyze the integration of ergonomics with TQM. The questionnaire incorporated elements of both TQM and ergonomics, with responses analyzed using SPSS. Results demonstrate that adopting TQM has become indispensable across industrial sectors in Egypt. High-performing factories exhibit strong integration of TQM and ergonomic practices, contributing to enhanced competitiveness and the ability to export products internationally. The study confirms a significant relationship between TQM implementation and workplace ergonomics, underscoring their combined role in advancing quality outcomes and employee well-being.

Keywords: TQM; ergonomics; work environment; questionnaire.

1. INTRODUCTION

Total quality management (TQM) is essentially a management philosophy, and it has become the preferred approach for improving quality and productivity in organizations. Various terminologies have been used to describe the general concept of TQM. These include “total quality control”, “total quality leadership”, “total quality improvement program”, “continuous quality improvement”, and “total quality service”. However, whatever terminology is used, the three basic ingredients of TQM are constant: (1) quality; (2) customer satisfaction; and (3) continuous improvement.

Luthans et al. [1] summarized TQM as being a participative system that empowers all employees to take responsibility for improving quality within the organization. The nature of TQM is reflected in the criteria as follow: The nature of TQM is reflected in

the criteria as follow: policy on quality management; quality control circle (QCC); training; quality audit; other quality improvement programs; top leadership involvement; management data and information; human resource management; customer satisfaction; handling customers; complaints to increase productivity; support services and vendor programs; and quality and operational results. Ergonomics and quality interact in manufacturing. Many authors agree that while good ergonomics results in higher quality performance, existing quality systems facilitate ergonomic improvements such as better work conditions or enhanced occupational safety [2]. Many authors point out that experimental studies demonstrating quantified, concrete effects of ergonomics on quality are needed [3]. Since 1991, much more comprehensive literature has been developed to evaluate several areas of overlap between ergonomics and quality initiatives. This has focused on interfaces between quality techniques and safety [4], between Japanese work organization techniques and modern theories of work design [5], and between quality management prescriptions and broader human aspects such as management theory and human resource management [6]. Both ergonomists and management theorists have been somewhat slow to acknowledge the quality-driven changes that are taking place around us. Indeed, argue that the reason why one technique, Total Quality Management (TQM), was shunned for so long by management schools was its lack of a coherent theoretical base. They characterize Deming' s famous fourteen points of TQM [7] as an ad hoc mixture of common-sense principles of management and folksy, yet quirky, maxims.

Ergonomics is often most successful when carried out as an integral part of the TQM program to improve the organization's effectiveness, which already has strong management support. This will result in reduced lost time accidents and injuries, greater

employee satisfaction, and improvements in additional quality measures, as indicated by the previous researchers [8]. Understanding the linkages between ergonomics and TQM is crucial. Drury [9] lists several interactions between ergonomics and TQM. They are: To improve the performance of quality control inspectors through ergonomics. Safety aspects of ergonomics linked with application of TQM; Relationship between TQM and socio-technical systems; Strategic issues of open systems; Organization design and leadership through systems approaches; Operations based on measurement; Use of technology in an appropriate way; Individuals, teams, and the change process.

The disciplines of ergonomics and quality should thus be complementary, and together able to achieve performance levels they cannot attain separately. Drury [9] provides prescriptions for a joint discipline comprising the shared and complementary features of quality and ergonomics. Interesting research has been conducted to examine the links between ergonomics stress and how quality of performance. Eklund [10] showed a significant linkage between quality bottlenecks and ergonomics deficiencies in his project. Other studies on quality and ergonomics by Rooney et al. [8] are of interest.

There is little argument that management's influence on an organization's decision-making structure is critical to the success of its ergonomic program. There is a growing trend for integrating management's decision structure across an organization's functions and operations to improve quality and safety. Hence, the intervention of an ergonomic program in TQM results in many benefits, which may be associated with personnel, materials, equipment, product design, increased sales, or health, safety, and fitness of employees.

Eklund J.[11] evaluated the relationships between a number of ergonomic conditions and product quality in car assembly. An increased risk of quality deficiencies was seen for all three categories of ergonomics problems investigated. The results also showed that an important factor for job satisfaction was the possibility for the workers to perform their tasks with high quality. The study therefore confirms close relationships between ergonomics and quality, thereby pointing to the possibility of conducting integrated change programs to simultaneously improve work quality and work conditions. Ismail A. R. et al. [12] performed a survey to investigate the relationship between environmental factors, job satisfaction, and the influence of workers' discomfort in four automotive manufacturing plants in Malaysia. Discomfort level of the operator in the workstation was often associated with workstation design, posture comfort of the operator at work, activity which involved work, and the influence of the environment, such as heat, noise, and lighting. Jazani R. K. and Mousavi S.[13] examined different areas of ergonomic research on their impact on quality; it was important to show how the ergonomic aspects influence the improvement of job satisfaction, safety and health, work conditions, and organization productivity, ultimately improving quality. Finally, it was suggested that, according to this issue, information about the relationship between ergonomics and quality was rare. Therefore, further research in this area was necessary to be done by ergonomists to convince managers that ergonomic principles are vital for organizations to achieve desirable quality. M.Asjad and Z.Mallick [14] evaluated and investigated the hidden relation between TQM and ergonomics, with their effect on the organizational performance. The study concluded that considering ergonomics in TQM may affect the workplace design,

which may increase productivity with safety. Thus, ergonomics can be considered an integral part of TQM activities.

The importance of Quality systems and ergonomics work environment has increased as a means of competitive advantage in the market, and since the industrial sector is considered one of the major contributors to the Egyptian economy. The study will determine the degree to which industrial companies in Egypt adopt TQM and identify the relationship between TQM and the work environment. The study will draw attention to the factories and authorities and emphasize the importance of integrating the TQM with the work environment to increase productivity, human performance during working time, and income. The objectives of the present study can be summarized as follows: To demonstrate the importance of work environment ergonomics on quality, from the perspective of the interaction between human and work environment. To understand the integration of ergonomics and TQM. To understand the concept of TQM as applicable to the service system.

2. Experimental work

A total of questionnaires were administered to staff, and the respondents who were drawn spanned various job levels, with the majority of the respondents being junior and middle-level staff. The prepared questionnaire with all types of questions and assessment grades exists in Annex A at the end of the paper.

2.1 Population and sample

The population of this work comprises 200 administrative, technical, and auxiliary personnel.

2.2 Data collection technique

The questionnaire technique is used to collect data regarding the determination of ergonomic arrangements (see annex A, Supplementary materials). In this work, the researcher used both qualitative and quantitative approaches. The diagnostic features of the quantitative work are that the techniques used will generate numerical data, which will then be analyzed mathematically.

2.3 Research instruments

The study used primary data using a structured questionnaire, which has advantages as the responses were gathered in a standardized way. It was relatively quick to collect information using a questionnaire. An Ex tech sound level meter was used to measure the noise levels inside factories, and a HIOKI lux meter was used to measure the lux.

2.4 Data analysis

The completed questionnaires were coded, and entries were made into the statistical package for the social sciences (SPSS version 21). The study used descriptive analysis techniques to analyze the data. Descriptive statistics were computed using frequencies and percentages. The study also used measures of central tendency, which include means and standard deviation, to measure the extent to which the variables are practiced.

2.5 Characteristics of samples

The target population of this study is the list of select Egyptian companies. The list provides the names of service companies, complete addresses, and persons to contact. It also mentions telephone number(s), e-mail addresses, as well as the website of the company. The four service industries mainly included in this study are food, steel, construction, and information and communication technology and devices. The

personnel interview was performed with a 200-person age range of 20-60 years, most of whom were men. A small number of women participated in the survey. Most of the participants were of middle education, which may exceed 40% of personnel, 40% of high education, and 20% of workers with no education.

3. Results and discussion

A total of questionnaires were administered to staff, the respondents who were drawn spanned the various job levels, with the majority of the respondents being junior and middle level staff, accounting for 92.0 percent of the total respondents. Senior management accounted for only 8 percent of the respondents. The respondents were drawn from the various divisions, departments, and units to ensure adequate and fair representation of employees' views on the subject.

The workplace environment is considered a vital part of enhancing productivity. Applying TQM inside the working factories at this time is very important to manage all the working tasks. Here, we will show the importance of ergonomics and the application of a well-defined TQM system for increasing worker performance and productivity. It will be clear to the readers through the selected questionnaires and responses collected from the employees. The reader can deduce the percentage of importance for both ergonomics and TQM inside the facility.

3.1 TQM

3.1.1. General TQM opinions

Table 1 shows that the total number of employees who record their opinion is 200, and the mean degree of agreement for each question is presented. In addition, the standard deviation, minimum, and maximum values for each question appeared clearly. One

observes that the degree of agreement ranges from 3 (neutral) up to 5 (strongly agree) for all the questions here. The standard deviation does not exceed 0.44, which means the opinion deviation was not far.

Table 1 represents the overall questions results of the questions related to general TQM opinions.

	TQM is a management philosophy and practice to ensure the effective and efficient use of all available resources	TQM aims to make customer satisfaction the focus of business.	Teamwork and participation are important for achieving a continuous improvement	Training and education are vital elements of TQM implementation.	Statistical techniques (such as Statistical Process Control, Design of Experiments, etc.) are important to ensure product and process quality consistency.	Supplier involvement is vital in supporting quality improvement	Management leadership, commitment, and support determine the success of new change initiatives	Management must provide adequate resources in every aspect of the business	A work environment, which is conducive to improvement, is created through management-worker	Initiatives such as Kaizen, suggestion schemes, quality circles, etc., will motivate employees to participate in quality improvement
N valid	200	200	200	200	200	200	200	200	200	0
Missing	0	0	0	0	0	0	0	0	0	200
Mean	4.0050	4.0200	4.0050	4.7850	3.0800	4.0600	3.9750	4.9000	4.8950	
Std.	0.02506	0.02122	0.01503	0.03160	0.01923	0.01683	0.01653	0.02127	0.02173	
Error of Mean	0.35441	0.30008	0.21261	0.44696	0.27197	0.23808	0.23377	0.30075	0.30732	
Median	0.126	0.090	0.045	0.200	0.074	0.057	0.055	0.090	0.094	
	2.00	2.00	2.00	2.00	1.00	1.00	2.00	1.00	1.00	

Std.	3.00	3.00	3.00	3.00	3.00	2.00	3.00	4.00	4.00	
Deviati	5.00	5.00	5.00	5.00	4.00	3.00	5.00	5.00	5.00	
on	801.00	804.00	801.00	957.00	616.00	412.00	795.00	980.00	979.00	
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Table 2(a-h): Represents general TQM opinion questions (see the head of tables).

Training and education are vital elements with respect to TQM implementation.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid Neutral	3	1.5	1.5	1.5	(a)
Agree	37	18.5	18.5	20.0	
Strongly agree	160	80.0	80.0	100.0	
Total	200	100.0	100.0		

TQM is a management philosophy and practice to ensure the effective and efficient use of all available resources

	Frequency	Percent	Valid percent	Cumulative percent	
Valid Neutral	12	6.0	60	6.0	

Agree	175	87.5	87.5	93.5	(b)
Strongly agree	13	6.5	6.5	100.0	
Total	200	100.0	100.0		

Teamwork and participation are essential for achieving continuous improvement.

	Frequency	Percent	Valid percent	Cumulative percent	(c)
Valid Neutral	4	2	2.0	2.0	
Agree	191	95.5	95.5	97.5	
Strongly agree	5	2.5	2.5	100.0	
Total	200	100.0	100.0		

Statistical techniques (such as statistical process control, design of experiments, etc.) are essential to ensure product consistency and process quality.

	Frequency	Percent	Valid percent	Cumulative percent	(d)
Valid	184	92.0	92.0	92.0	
Neutral	16	8.0	8.0	100.0	
Agree	200	100.0	100.0		
Total					

Management must provide adequate resources in every aspect of the business.

	Frequency	Percent	Valid percent	Cumulative percent
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Valid	20	10.0	10.0	10.0	(e)
Agree	180	90.0	90.0	100.0	
Strongly	200	100.0	100.0		
agree					
Total					

Management leadership, commitment, and support determine the success of new change initiatives.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid					(f)
Neutral	8	4.0	4.0	4.0	
Agree	189	94.5	94.5	98.5	
Strongly	3	1.5	1.5	100.0	
agree	200	100.0	100.0		
Total					

Supplier involvement is vital in supporting quality improvement.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	188	94.0	94.0	94.0	(g)
Disagree	12	6.0	6.0	100.0	

Neutral	200	100.0	100.0	
Total				

A work environment, which is conducive to improvement, is created through management-worker.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid Agree	21	10.5	10.5	10.5	(h)
Strongly agree	179	89.5	89.5	100.0	
agree	200	100.0	100.0		
Total					

Training and education are vital elements with respect to TQM implementation

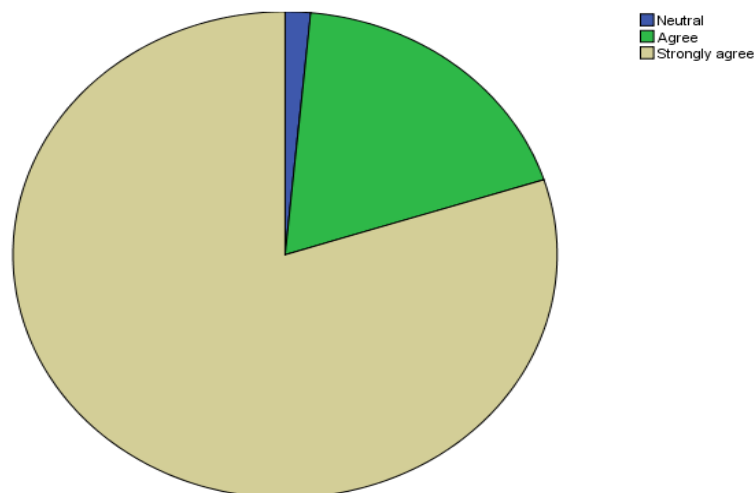


Figure 1: Represents the questionnaire results for training and education and their importance.

Table 2 (a) shows that the definition of TQM was agreed by approximately 87.5% of all employees. They recorded the agreed choice by 175 persons, while only 12 persons recorded neutral. In the case of the question relating to training and education, approximately 80% strongly agree that it is vital for TQM implementation to be well-trained. Teamwork and participation were considered very important; the agreement percentage reached 95.5%. The percentage of neutrals reached 92% when they were asked about the statistical process for controlling the process, which means a little awareness of the statistical methods and numbers. When they asked about management's role in providing resources, most people strongly agree that in business, the management must save the resources. The leadership of management and their support were considered important in the opinion of most persons, where approximately 94.5% agree. The supplier's involvement is vital in supporting the improvement, but most of the persons disagree with the opinion by 94%. The work condition for improvement is considered very important, and most of the persons strongly agree by 89.5%. From Figure 1, one can find a high percentage strongly agree on the vital role of training and education.

Table (3): Represents resource management Statistics

	Human resource ability is considered in improvement activities	Employees are given the information and training	Employees are given tools They need to do the job	Sufficient financial resources provided to support improvement	The company manages its material resources
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		they need to do the job	effectively	activities	effectively
N valid	200	200	200	200	200
Missing	1	1	1	1	1
Mean	3.9450	3.9200	3.7000	3.5650	3.0300
Std. Error of Mean	0.03264	0.3841	0.04702	0.05189	0.04004
Median	4.0000	4.0000	4.0000	3.0000	3.0000
Std. Deviation	0.46156	0.54321	0.66499	0.73380	0.56631
Minimum	2.00	2.00	2.00	3.00	2.00
Maximum	5.00	5.00	5.00	5.00	5.00

3.1.2. Resource management

Table 3 shows that the standard deviation, minimum, and maximum values for each question are clear. One can observe that the mean values for the response of employees range between 3.0 and 3.9, which means that most responses said that it is important. Below, we can find the details for each question value response.

Table 4(a-d): Represents questionnaire statistics (see table head)

Human resource ability is considered in the improvement activities

	Frequency	Percent	Valid percent	Cumulative percent	
Valid					(a)
Disagree	3	1.5	1.5	1.5	
Neutral	18	9	9.0	10.5	
Agree	166	82.6	83.0	93.5	
Strongly	13	6.5	6.5	100.0	
agree	200	99.5	100.0		
Total	1	0.5			
Missing	201	100.0			
System					
Total					

Employees are given the information and training they need to do the job effectively.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	1	0.5	.5	.5	(b)
Disagree	35	17.4	17.5	18.0	
Neutral	143	71.1	71.5	89.5	
Agree	21	10.4	10.5	100.0	
Strongly	200	99.5	100.0		
agree	1	0.5			



Total	201	100.0		
Missing				
System				
Total				

Employees are given the tools they need to do their job effectively.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid					(c)
Disagree	6	3.0	3.0	3.0	
Neutral	65	32.3	32.5	35.5	
Agree	112	55.7	56.0	91.5	
Strongly agree	17	8.5	8.5	100.0	
Total	200	99.5	100.0		
Missing	1	0.5			
System	201	100.0			
Total					

Sufficient financial resources provided to support improvement activities

	Frequency	Percent	Valid percent	Cumulative percent	
Valid Neutral	116	57.7	58.0	58	

Agree	55	27.4	27.5	85.5	(d)
Strongly	29	14.4	14.5	100	
agree	200	99.5	100.0		
Total	1	0.5			
Missing	201	100.0			
System					
Total					

The company manages its material resources effectively.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid					(e)
Disagree	23	11.4	11.5	11.5	
Neutral	154	76.6	77.0	88.5	
Agree	17	8.5	8.5	97.0	
Strongly	6	3.0	3.0	100.0	
agree	200	99.5	100.0		
Total	1	0.5			
Missing	201	100.0			
System					
Total					

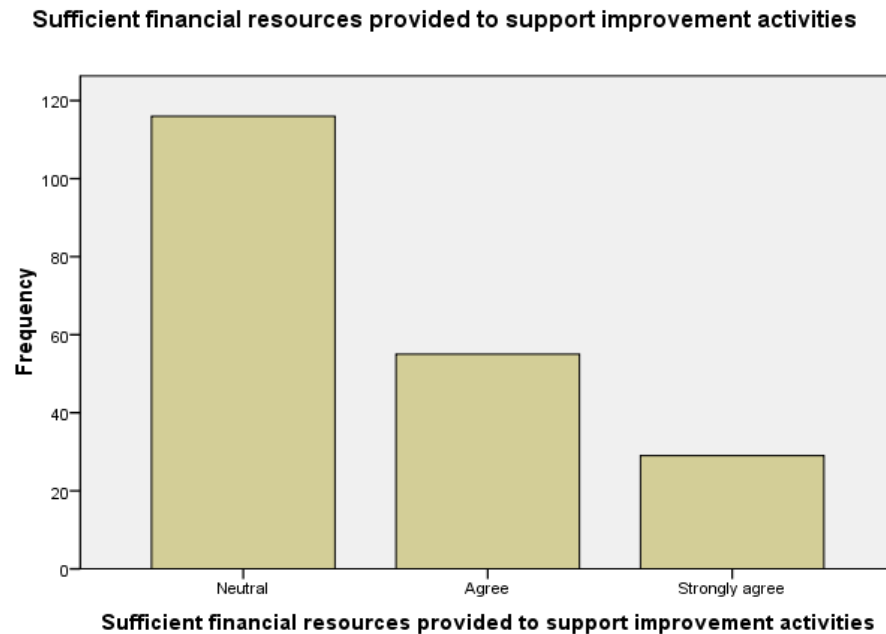


Figure 2: Represents the financial resources to support improvement activities.

Table (4a) shows that most employees agree on 82% the human resource ability. In Table (4b), one can find that approximately 71% agree that the employees are given the training and information needed for the job, and this is a positive point. From Table (4c), one can find that 55.7% agree that employees are given the tools needed for the job, which means that sometimes the tools may not exist. Table (4d) shows that the higher parentage has a 57.7% response to neutral for sufficient financial resources to support improvement. Table (4e) shows that high parentage neutral 76.6% of the material resource effectively. Figure 2 shows the importance of financial resources, and the results prove that personnel are not included or do not understand the situation.

3.1.3 Education and training

Table 5: Represents the education and training questionnaires' overall statistics.

	Top	Employees are	Employees are	Continuous
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	management always updates its knowledge.	trained for job- related skills.	trained on total quality concepts.	learning is provided through education and training.
N Valid	200	200	200	200
Missing	2	2	2	2
Mean	3.7500	3.5950	3.8400	3.7350
Median	4.0000	4.0000	4.0000	4.0000
Std.	0.63996	0.65813	0.64535	0.77962
Deviation	0.410	0.433	0.416	0.608
Variance	2.00	2.00	2.00	2.00
Minimum	5.00	5.00	5.00	5.00
Maximum				

Table 5 shows that the standard deviation, minimum, and maximum values for each question are clear. One can observe that the mean values for the response of employees range between 3.5 and 3.84, which means that most responses said that it is important and very important. Below, we can find the details for each question value response.

Table 6 (a-d): Represents questionnaire statistics (see Table head).

Table (6) (a-d): Represents questionnaire Statistics.

Employees are trained for job-related skills.

	Top management always updates its knowledge.	Employees are trained for job-related skills.	Employees are trained on total quality concepts	Continuous learning is provided through education and training	
Valid					(a)
Disagree	11	5.4	5.5	5.5	
Neutral	67	33.2	33.5	39.0	
Agree	114	56.4	57.0	96.0	
Strongly agree	8	4.0	4.0	100.0	
Total	200	99.0	100.0		
Missing	2	1.0			
system					
Total	202	100.0			

Top management always updates its knowledge.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	9	4.5	4.5	4.5	(b)
Disagree	45	22.3	22.5	27.0	

Neutral	133	65.8	66.5	93.5
Agree	13	6.4	6.5	100.0
Strongly agree	200	99.0	100.5	
Total	202	100.0		
Missing system				
Total				

Employees are training on total quality concepts.

Continuous learning is provided through education and training.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	6	3.0	3.0	3.0	(d)
Disagree	76	37.6	38.0	41.0	
Neutral	83	41.1	41.5	82.5	
Agree	35	17.3	17.5	100.0	
Strongly agree	200	99.0	100.0		
Total	2	1.0			
Missing	202	100.0			
System					
Total					

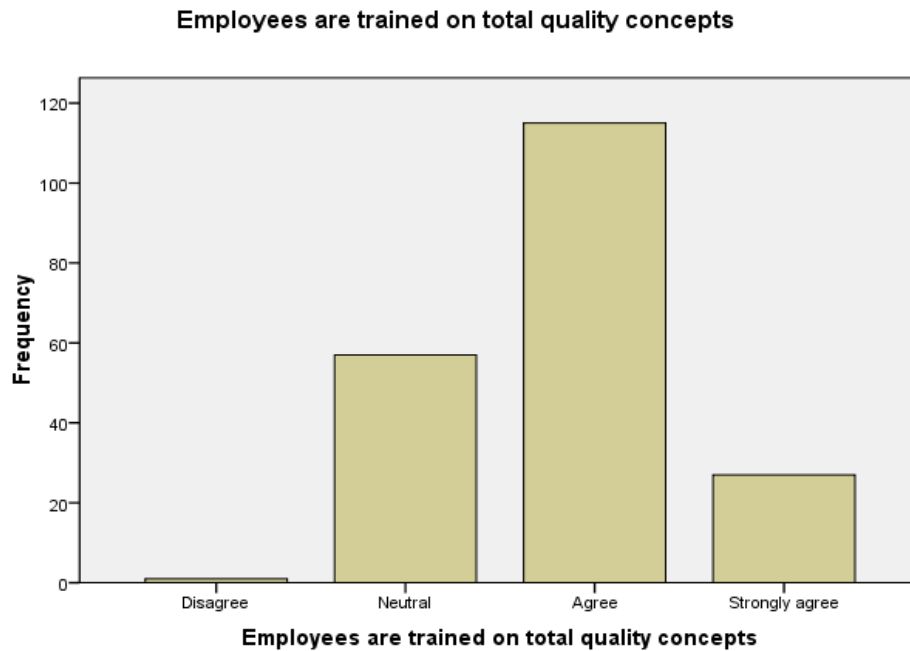


Figure 3: The employees are trained on the TQM concept.

From Table (6a), one can find that approximately 56.4% agree that the employee being trained is very important. From Table (6 b), one can find that roughly the percentage of agreement is high, 65.8 %, meaning top management continually renews its knowledge. From Table (6c), one can find that 56.9 % agree, which means that most of the employees are trained on quality systems and applications, which is required in most companies. From Table (6d), one can find that the percentage of neutral responses is 37.6%, 41.1% neutral, and agree, which means that the training and trials from workers may be a way for continuous learning. Figure 4 shows the importance of employees being trained on the quality concept, and a high percentage agree.

3.2 Ergonomics

3.2.1 Work environment

Table 7 represents the overall statistics of the work environment and culture questionnaires.

Statistics

	A pleasant environment exists in all working areas	Positive values such as trust, honesty, hardworking, are fostered by management	Teamwork and involvement are normal practices in the company	The company adopts employee satisfaction initiatives (such as suggestion schemes, profit sharing, etc.)
N Valid	200	200	200	200
Missing	2	2	2	2
Mean	2.7000	2.6750	2.7050	2.9500
Median	2.0000	3.0000	3.0000	3.0000
Std. Deviation	0.84473	0.75645	0.70031	0.67063
Variance	0.714	0.572	0.490	0.450
Minimum	2.00	2.00	2.00	2.00
Maximum	5.00	5.00	5.00	5.00

Table 7 shows that the standard deviation, minimum, and maximum values for each question are clear. One can observe that the mean values for the response of employees range between 2.6 and 2.95, which means that most responses said it was of neutral importance. Below, we can find the details for each question value response.

From Table (8a), one can find that approximately 51.5% disagree that all the work has a pleasant environment, which means the hard style. From Table (8b), one can find that approximately the percentage of agreement is as high as 47%, which means that the management fosters little trust and honesty. From Table (8c), one can find that 63.4 % neutral, which means that some companies make employee satisfaction by profile sharing, for example. From Table (8d), one can find that the percentage of neutral responses is 49.5%, and 40.6% are neutral and disagree, which means that no teamwork practice exists in most companies. Figure 4 shows the importance of a pleasant working environment for effective work by employees. A high percentage did not find pleasant working conditions.

Table 8(a-d). Questionnaire statistics (see Table head).

A pleasant environment exists in all working areas.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	104	51.5	52.0	52.0	(a)
Disagree	58	28.7	29.0	81.0	
Neutral	32	15.8	16.0	97.0	
Agree	6	3.0	3.0	100.0	
Strongly	200	99.0	100.0		

agree	2	1.0		
Total	202	100.0		
Missing				
System				
Total				

Positive values such as trust, honesty, and hard work are fostered by management.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	95			47.5	(b)
Disagree	80	47	47.5	87.5	
Neutral	20	39.6	40	97.5	
Agree	5	9.9	10	100.0	
Strongly	200	2.5	2.5		
agree	2	99.0	100.0		
Total	202	1.0			
Missing		100.0			
System					
Total					

The company adopts “Employee satisfaction” initiatives (such as suggestion schemes, profit sharing, etc.).

	Frequency	Percent	Valid percent	Cumulative	
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				percent	
Valid	44			22.0	(c)
Disagree	128	21.8	22.0	86.0	
Neutral	22	63.4	64.0	97.0	
Agree	6	10.9	11.0	100.0	
Strongly	200	3.0	3.0		
agree	2	99.0	100.0		
Total	202	1.0			
Missing		100.0			
System					
Total					

Teamwork and involvement are normal practices in the company.

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	82	40.6	41.0	41.0	(d)
Disagree	100	49.5	50.0	91.0	
Neutral	13	6.4	6.5	97.5	
Agree	5	2.5	2.5	100.0	
Strongly	200	99.0	100.0		
agree	2	1.0			
Total	202	100.0			
Missing					

System				
Total				

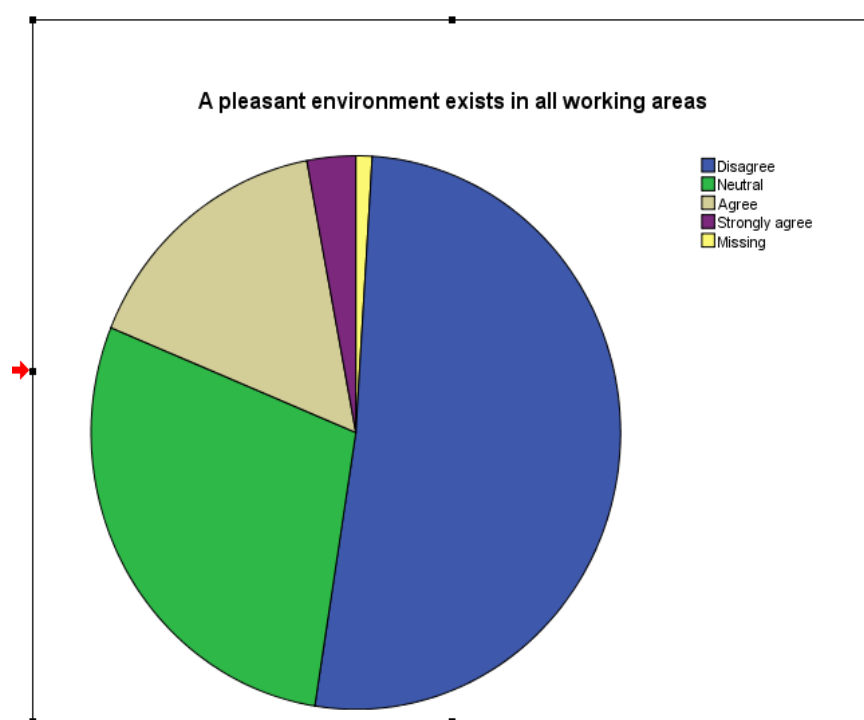


Figure 4: Represents the importance of working in pleasant conditions.

From Table 9, one can find that the standard deviation, minimum, and maximum values for each question are clear. One can observe that the mean values for the response of employees range between 3.6 and 4.1, which means that most responses said that they agree strongly. Below, we can find the details for each question value response. **Table 9** represents the overall statistics of the Ergonomics questionnaire.

Table (9): Represents the ergonomics questionnaire overall Statistics (see table head)

	Noise dB	Light	The number of customer complaints	Our financial results have been	Our quality program has improved our business	Our quality program has improved our business	Our quality program has improved our business	Our quality program has improved our business	Our quality program has improved our business	Our quality program has improved our business	Our quality program has improved our business
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			has decreased	improving	performance in general.	performance in general.	performance in general.	performance in general.	performance in general.	performance in general.	performance in general.
N Valid	200	200	200	200	200	200	200	200	200	200	200
Missing	2	2	2	2	2	2	2	2	2	2	2
Mean	4.0950	3.9850	3.8750	3.5100	3.6900	3.7250	4.1100	4.0800	3.8950	3.9700	3.6800
Median	4.0000	4.0000	4.0000	3.5000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000	4.0000
Std.	0.54540	0.7399	0.60098	0.97707	0.86466	0.85618	0.87276	0.64473	0.81072	0.85013	0.83130
Deviation	0.297	4	0.361	0.955	0.748	0.733	0.762	0.416	0.657	0.723	0.691
Variance	2.00	0.548	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Minimum	5.00	3.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Maximum		5.00									

From Table (10a), one can find that approximately 45 % agree that the light affects working performance. From Table (10b), one can find that approximately the percentage of agreement is as high as 70 %, which means that noise is very effective on the performance of workers if it is raised. A poorly designed workplace often causes health complaints at work, but these shortcomings are closely connected with indoor climate conditions (bad microclimate, excessive noise, insufficient lighting). Sometimes the psychosocial factors also take place as poor relations between the employers and employees, stress coming from home or street with the workers to the workplace, etc.). Therefore, these three components were investigated thoroughly. The results of indoor climate investigations (considering the exposure limits) are given in the following Table (11a,b)

Table 10 (a, b): Represents questionnaire statistics related to light (a) and noise (b).

Table (10) (a, b): Represents questionnaire Statistics related to light (a) and revised Light (b)

	Frequency	Percent	Valid percent	Cumulative percent
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Valid	56			28.0	(a)
Neutral	91			73.5	
Agree	53	27.7	28.0	100.0	
Strongly	200	45.0	45.5		
agree	2	26.2	26.5		
Total	202	99.0	100.0		
Missing		1.0			
System		100.0			
Total					

Noise dB

	Frequency	Percent	Valid percent	Cumulative percent	
Valid	1	0.5		0.5	(b)
Disagree	18	8.9		9.5	
Neutral	142	70.3	0.5	80.5	
Agree	39	19.3	9.0	100.0	
Strongly	200	99.0	71.0		
agree	2	1.0	19.5		
Total	202	100.0	100.0		
Missing					
System					
Total					

Table 11 (a, b): results of measurement temperature, humidity, noise, and lightning.

factor	Results
Temperature °C	18-35
Humidity %	30 – 75
Average value for Risk level risk level ≤ 4 temperature 18-25: 2 25-30:3 30-35:4 Humidity 30-50:2 50-70:3 70-90:4	

factor	Results
Noise dB	41-90
Lightening Lux	230-500
Average value for Risk level risk level ≤ 4 Noise Below 40dB:1 40-60:2	

60-80:3

80-90:4

Lightening

400-500:2

300-400:3

-300:4

4. Conclusions

This study sought to discover the integration between ergonomics work environment and total quality management in the occupational place in Egypt, as well as its effect on productivity, during the study analysis performed for the collected questionnaires, depending on the employee's assessment. The data was analyzed quantitatively using SPSS, and the results were presented through frequency distribution in tables.

From the results, we can conclude the following:

- 1- Applying the TQM system has become essential throughout all industrial sectors in Egypt
- 2- Many industrial places concentrate on the quality system and its implementation.
- 3- The industrial places that concentrate on export concentrate on TQM and training for employees to perform it.
- 4- The industrial place that is multinational in Egypt has a high standard level in applying TQM and pays attention to human, especially the work environment, and can spend a lot of money on that.
- 5- The small factories that have low investment did their work without taking care of TQM or the work environment.

- 6- Many factories did not give all the personnel the training on the quality system and its implementation.
- 7- A small number of employees in the middle investment factories have experience in quality systems.
- 8- The work environment, such as temperature, has a significant effect on productivity, which can be the reason for an increase if care is taken.
- 9- An ergonomic checklist is a useful tool for analyzing essential working conditions and gathering information on forest workmanship.
- 10- The factories that concentrate on applying TQM have higher productivity than the others.
- 11- Most employees (approximately 80%) agree that training and education are vital for work.
- 12- Further research is needed into the contradiction between the two fields in terms of their views on concepts such as standardization, copying of best practices, development of proactive change processes, and development of common documents/methods for implementing TQM and ergonomics work environment.
- 13- It is recommended that the noise level of the workplace be controlled and decreased to a standard level (less than 85 dB) to increase comfort and human productivity. Nevertheless, lighting, as another environmental factor, has a negligible effect on human productivity and may affect it.

It is highly recommended that the country encourage factories to apply the QM system to be more organized. In addition, the country may save consultants at a low cost for these companies. Training and education for employees on the implementation of the quality system are necessary and critical. Understanding the

linkages between ergonomics and TQM is crucial. The disciplines of ergonomics and quality should thus be complementary, and together able to achieve performance levels they cannot attain separately.

References:

1. F. Luthans, Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior, 2002, 23, 695-706.
2. A. D. Taveira, C. A. James, B.-T. Karsh, and F. Sainfort, Applied ergonomics, 2003, 34, 281-91.
3. G. M. Hägg, Applied ergonomics, 2003, 34, 3-15.
4. M. Rahimi, International Journal of Industrial Ergonomics, 1995, 16, 83-94.
5. D. A. Waldman, Academy of Management Review, 1994, 19, 510-36.
6. R. D. Costigan, Quality Management Journal, 1995, 2, 7-23.
7. W. E. Deming, Massachusetts Institute of Technology, Cambridge, MA, 1986, 367-88.
8. E. Rooney, R. Morency, and D. Herrick, Advances in industrial ergonomics and safety V, 1993, 493-8.
9. C. G. DRURY, Ergonomics, 1991, 34, 825-19.
10. J. Eklund, Applied ergonomics, 2000, 31, 641-8.
11. J. A. Eklund, Applied ergonomics, 1995, 26, 15-20.
12. A. Ismail, M. Haniff, C. Kim, B. Deros, and N. Makhtar, 2010.
13. R. K. Jazani and S. Mousavi, Open Journal of Safety Science and Technology, 2014, 2014.
14. M. Asjad and Z. Mallick, International Journal of Industrial and Systems Engineering, 2017, 27, 272-94.