Statistical Methods for Controlling the Quality of Crude Oil Products in Iraq

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Abstract

   The purpose of this study is to measure the levels of quality control for some crude oil products in Iraqi refineries, and how they are close to the international standards, through the application of statistical methods in quality control of oil products in Iraqi refineries. Where the answers of the study sample were applied to a group of Iraqi refinery employees (Al-Dora refinery, Al-Nasiriyah refinery, and Al-Basra refinery) on the principles of quality management control, and according to the different personal characteristics (gender, age, academic qualification, number of years of experience, job level). In order to achieve the objectives of the study, a questionnaire that included (12) items, in order to collect preliminary information about the study sample was designed. The data was analyzed statistically and hypotheses were tested using the SPSS statistical package. The study relied on a random sample of 225 individuals, of which 205 were valid. The most important results obtained are: The degree of applying control over quality management in the refineries under study was: 68.8% for the principle of senior management's commitment to quality, 65.2% for the principle of planning for the application of quality standards and 65.% for the principle of strengthening the culture of quality among workers. The level of quality of some crude oil products in the refineries under study was estimated at 45%. In addition to the existence of a statistically significant correlation between the application of the principles of control over quality management and the quality of some oil products.

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1. Introduction

Today, the world is witnessing a great interest in quality and control over it, and in providing requirements and specifications that make quality at its highest levels. Quality control is one of the main pillars of success in production and service organizations, due to the intensity of competition and the emergence of differentiation between products. Therefore, quality is extremely important to meet Consumer desire due to mass production, free economies, and open markets, and control over them has become more important to meet consumer requirements and to meet the challenges that almost afflict the industry, represented by freedom of trade and strictness in conforming products to specifications and standards. Due to these challenges, the process of producing goods and services with the required specifications became one of the important things that producers rely on to market their products. This matter included all final and intermediate products, the most important of which is oil, which is the origin of any industry and the main mover of any economic activity. Everywhere as a main mover of development and as a activator for the economies of countries, many types of oil appeared, including: heavy oil, light oil, and other types, so it became necessary to search for means and tools to control oil products, and thus specific specifications for the quality of oil products appeared in order to preserve the machines and equipment on the one hand, and the production of oil products that do not harm the environment and human health on the other hand.

Statistical methods in quality control are the appropriate tool and the optimal method to achieve product quality, especially after the availability of computers and statistical programs that facilitate dealing with production data in a large and more comprehensive way, which made quality control using statistical methods easier and an essential step during the production process.

1.1 Literature Review

There are many studies contributed to the development of quality control approaches (Hammoud, 2016):

Demin in 1939 considered as the father in the leadership of statistical control, he made meaningful contributions in the application of Statistical Process Control maps, where Edward focused on the need to reduce the deviations that occur in the production process, as he indicated in his writings about His philosophy of quality control through fourteen standards are:

i. Establishing the purpose of improving the product or service.
ii. Adopting a new philosophy and adapting to it.
iii. Adopting examination and inspection using statistical methods to eliminate failures in productive performance.
iv. Stop looking at the project through prices as a basic indicator of product quality.
v. Continuous improvement of the production process and interest in using statistical methods.
vi. Adopting modern methods and their integration with education at work.
vii. Achieving coordination between supervision and management.
viii. Removing fear from workers and directing them towards diagnosing problems in performance and informing management.
ix. The removal of barriers between departments.
x. Reducing slogans, digital goals and other methods that distance the organization from achieving the basic goals of the production process.
xi. Reducing the procedures that create the appropriate atmosphere for committing mistakes.
xii. Removing obstacles to communication.
xiii. Develop development programs.
xiv. Constantly adopting new methods by encouraging employees to keep pace with improvement and development.

Juran in 1951 developed of the qualitative revolution during World War II, as he focused on defects or errors during operational processes, and reducing wasted time, which is one of the most quality-related errors. He also focused on quality control without focusing On how to manage quality, he believes that quality is concerned with product specifications that satisfy the consumer's needs and work to satisfy him, and he believes that quality control is a necessary process to achieve the goals of the production process and reduce defects and errors and avoid their occurrence. According to Juran, quality control is carried out through the following steps:

a- Evaluation of the actual work performance.

b- A comparison between the actual performance and the set goals.

C - Addressing differences and deviations by taking corrective action.

Crosby in 1979 defined the concept of zero defects in the framework of the productive process in the organization. He believes that quality control is a reflection of the extents of leadership standards and other tools that reflect quality standards. He believes that the application of quality control stems from continuous development due to the following factors:

A- The consumer is aware of the importance of the quality of products and services.

b- Developing tools that help to develop quality control, which leads to an increase in the market share of the organization.

C - Developing a culture related to quality control in accordance with the environmental and circumstantial changes surrounding the organization.

Abdulghafour et al (2017) considered that improving quality is one of the most important requirements to enhance the competitive position in our markets today. So improving quality will reduce variations and shrinkage and thus production costs and thus customers will get the right products and services to use.

Dawood and Kareem (2017) developed models for the consumption of major petroleum products; Fuel oil, gas oil and gasoline for a period of five years (2016-2020) based on two statistics; moving average integrated regression (ARIMA) and multiple linear regression (MLR). To control the transition to production capacity in the production of fuel and gas oil) and the production of fuel or the import of these types of fuel, or the decision to implement a new refinery.

Abbas and Aneed (2021) studied the possibility of determining the effect of total quality as an independent variable through it (support of senior management, customer focus, operations management, training and learning, management of relations with giving, continuous improvement) on the quality of life in its dimensions (work environment, growth and development in the work environment, growth and development in stress, social support, compensation and reward, job characteristics) in the Missan Oil Company.

Jawad and Al-Rabia'I (2021) Studied if there is existence of relationships between product innovation and the reputation of the organization. The study problem is that the State Organization for Marketing of Oil (SOMO) system is inflexible in terms of marketing procedures and needs innovative, unconventional methods in innovating its products and improving.

Mohammed (2022) studied methods of controlling the occurrence of corrosion in the crude oil refining unit in the Najaf refinery for four types of crude oil - API (28, 28.2, 29.2, and 30.2) were studied. This practical study showed the importance of adding chemicals in different quantities, as well as electrical and thermal treatment in controlling and preventing corrosion of oil equipment in the crude oil refining unit.

The main objectives of this study are as follows:

1- Studying the levels of quality control in Iraqi refineries.

2- Studying the quality of oil products in Iraqi refineries, and how close they are to applying international standards.

3- Applying statistical methods in quality control of oil products in Iraqi refineries.

Study hypotheses: The following main hypothesis can be put forward:

"There is a weak implementation of monitoring the quality of oil products in Iraqi refineries, and statistical methods are the most appropriate tool for measuring that."

The current research has dealt with one of the main and important pillars of the Iraqi economy through a field study on some products of oil products produced by refineries, and in order to identify the extent to which statistical methods can be applied in controlling the quality of oil products, as a step to contribute to the service of oil production in Iraq.

The purpose of the study: Because oil is a source of energy and mover for development, and its contact with human life as consumers of oil products, this study came to show the quality of oil products as well as statistical methods for controlling them.

The importance of the study comes from the fact that quality control has become an intellectual and applied field, so the production and service organizations are interested in the quality of their products through developing and improving them at various stages in order to achieve competition in general, and to meet specific requirements in particular. Oil products are also the mainstay in the daily industrial work, due to the many factors that result from it, as they are play main role in all production processes and in various fields. The importance of the study also lies in the fact that it deals with a subject that has not been paid attention to before, as well as to clarify the statistical methods and techniques for quality control.

2. Materials and Methods
2.1 Hypotheses
The following sub-hypotheses fall under this main hypothesis:

The first null hypothesis, H01, which states: "Iraqi refineries do not apply quality control standards to a high degree, and the level of quality of some oil products is not high."

The second null hypothesis H02, which states that "there is no statistically significant relationship at the level of significance 0.05 between the commitment of senior management to the quality of some oil products in Iraqi refineries."

The third null hypothesis, H03, which states, "There is no statistically significant relationship at the level of significance 0.05 between planning for the application of quality standards and the quality of some oil products in Iraqi refineries."

The fourth null hypothesis, H04, which states, "There is no statistically significant relationship at the level of significance 0.05 between planning for the application of quality standards and the quality of some oil products in Iraqi refineries."

2.2 The Concept of quality
In the past, quality meant accuracy and perfection in the manufacture of historical and religious monuments, including statues and castles, for the purpose of demonstrating them. At the present time, the concept of quality has changed after the emergence of the industrial revolution, the development of administrative and accounting sciences, as well as after the expansion of commodity production and the emergence of large companies and the intensification of competition between them, as the concept of quality has new and complex dimensions, as quality has become one of the main factors for the failure of companies and its success, by providing products and services of high quality so that the company can achieve competition and customer satisfaction. Thus, quality is achieving the appropriate use of the company's resources, in order for seeking to achieve satisfaction for the product or service to meet the needs of the market and the consumer, through the technical and engineering specifications of the product (Al-Khatib, 2008; Muhammad et al, 2017).

2.3 The Importance of statistical quality control

The process of statistical quality control is one of the branches of monitoring the quality of a product or service. It is the process of collecting, analyzing and interpreting data, in order to use it in quality control (Hegazy, 2002). Quality control occupies the attention of specialists, scholars, and organizations working in the industrial sector, because quality control works to achieve a certain degree of quality for the product and works to satisfy the consumer and satisfy his needs of goods, and this is done using descriptive and quantitative means by relying on statistical methods in order to expand the circle of practical application To maintain the quality of products and maintain their established level, and this is done according to international or local controls and standards for quality control standards.(Mahgoub and Al-Tamimi, 2003)

Statistical control is used in the measurement process when the source of the difference is identified and controlled. Therefore, consumers' expectations and the objective of the quality control system process can be met by providing statistical methods for the reasons for this difference (Heizer and Render, 1996). When collecting and recording data related to products, we obtain a huge amount of information, and for the purpose of summarizing and analyzing this data and facilitating

Dealing with it, we resort to statistical methods through which a large group of data can be presented in a condensed form that is understood at first sight. Therefore, the importance of statistical control over quality comes not in Measuring only, but also in inspection because of the effort, time and cost reduction provided by sampling and examination methods using samples, in addition to announcing the position on quality quickly during the process and not after its completion.(Manar, 2017)

The importance of statistical quality control is summarized in the following (Idris, 2014; Qasim, 2017):

1- Statistical control of quality controls the application of standards that the organization wants to maintain its products, where quality standards are formulated at the level of the organization as a whole using standards and requirements related to the distinctive specifications of products.

2- Statistical quality control improves product specifications, which are mostly limited to reducing errors and developing products of goods and services to satisfy customers more effectively.

3- Statistical quality control helps to detect the presence of production problems and then work to correct them, which leads to a tangible improvement in the quality of products and a reduction in spoilage:

1- Statistical control serves to inform us of the necessity of continuing the production process, or the need to correct the mistakes of this process, or to leave it.

2- Statistical control gives confidence in the quality of products and an assurance of good quality that reduces cost. Statistical tools help to understand the changes that occur in the production process and the possibility of solving problems facing the organization in order to increase its effectiveness and efficiency.

3- The presence of statistical control of quality creates the necessary awareness in the organization, which has high value importance in the long term.

4- Statistical control reduces the wasted time and materials to the minimum limits, by giving early warning of the occurrence of malfunctions, which works to reduce the production cost to increase the profits of the organization.

2.4 Statistical Methods for Quality Control

Among the most important methods used in statistics, through which the level of quality control can be diagnosed (Al-Hadithi, 2002).

A- Descriptive statistics method: represented by (frequencies, percentages, arithmetic mean, standard deviation).

B- Inferential statistics method: represented by Cronbach's Alpha coefficient for testing the stability of the study tool, and Pearson's correlation coefficient for testing the relationship between the independent variables and the dependent variable.

These methods require:

1- The study tool: The questionnaire is a tool for collecting the necessary data for the study, and it is one of the appropriate scientific research tools that achieve the research objectives in a descriptive manner, and to obtain information and facts related to a specific reality,(Mansour and Sabri, 2000) Therefore, the questionnaire was designed according to what was studied of previous questionnaires related to the subject of the study, so that the questionnaire would come out in its final form as shown in Appendix (1). The questionnaire was designed in two parts: Educational attainment, number of years of experience, and job position in the refinery. As for the second part, it included the main data of the research, as it was formulated in the form of axes with the number of hypotheses of the study. Each axis included a number of paragraphs, as it came in the form of 12 paragraph phrases divided into three axes related to the quality of crude oil products (dependent variable) in the Iraqi refineries.

2- Measurement scale: A scale is adopted to measure the level of discrimination for the strength of the word's compatibility with the phrase, paragraph, or choice subject for the purpose of scientific research, in order to determine the levels from a strong positive (positive) relationship to a strong negative (reverse) relationship.(Sabri, 2006) The scale of measurement relied upon in the current study is the five-point Likert scale, in which the weights of the answers to the questionnaire can be clarified in the following table:

Table (1) Five-point Likert scale scores

Weights	The choice
1	Strongly Disagree
2	Not Agree
3	Neutral
4	Agree
5	Strongly Agree

The answers are analyzed for the study sample items through the arithmetic mean, which can be located for the five-point Likert scale in one of the score areas referred to in Table (1)

So the answers are as shown in the following table:

Table (2): The length of the categories according to the five-point Likert scale

SMA	Direction of the answer
1 to less than 1.80	Strongly disagree very low
1.8 to less than 2.60	disagree low
2.6 to less than 3.40	Neutral - mid-trend
3.40 to less than 4.20	OK high
4.20 to less than 5	Agree very high

3- The stability of the study tool: The stability is the extent of accuracy and consistency of the results of the scale, as it gives the same results when applied twice in two different times for the same individuals, and the stability is calculated using the Cronbach's Alpha coefficient method,

which provides the study with a good estimate for most situations, as the coefficient depends on the consistency of the performance of the individual from one item to another, and the value of the coefficient is acceptable if it is 0.6 and less than that is low(Sekaran, 2003).

3. Discussion of Results
3.1 The Iraqi refineries and their crude oil products

Iraq is considered one of the first countries in the region to own refineries for the production of crude oil products. In 1927, the first refinery was built in Iraq for export purposes, which is the Al-Wand refinery. Its oil products were directed towards covering the local demand, then several refineries were established, as follows (Jasim and Ali, 2020):

1- South refineries: it includes the following refineries:

A- Muftiyeh Refinery: It was established in 1953 in the north of the city of Basra on the Shatt al-Arab River. It was established in order to produce gasoline, naphthalene, kerosene, fuel oil and gas oil.

B - Maysan Refinery: It was established in 1999 with a production capacity of 10 thousand barrels per day, and it produces a number of crude oil products, including: gasoline, kerosene and gas oil.

C - Nasiriyah Refinery: It was established in 1980 in Nasiriyah. It contains units for oil distillation, a unit for processing kerosene, and a kerosene sweetening unit.

D - Al-Shuaiba Refinery: It was built in 1969 in Basra, and it produces crude oil products to cover the local demand for gasoline and gas oil.

2- Medium refineries: These include the following:

A- Dora Refinery: It is the largest refinery in Iraq, built in 1953. It is located in the capital, Baghdad. The refinery produces automobile gasoline, kerosene , diesel oil, gas oil, fuel oil, asphalt, wax, and other petroleum products.

B - Samawa Refinery: located in Al-Muthanna Governorate, production began in 1978. It is a small refinery where it oil distillation and sweetens kerosene.

C- Najaf Refinery: Production started in 2005, and it contains a naphthalene refinement unit and a crude oil distillation unit.

D - Karbala Refinery: It is located 40 km from the city of Karbala. Its construction began in 2014, and its actual operation began in 2019. It contains 20 units for refining crude oil.

3- North Refineries: It includes the following refineries:

A- Baiji Refinery: It is the largest oil refinery in Iraq, with a production capacity of 310,000 barrels per day. It contains processing units and a hydrogen cracking unit. It was closed in 2015 due to military operations against terrorist organizations.

B - Haditha Refinery: located in Anbar Governorate, it was established in 1949. The purpose of its establishment is the needs of the central and northern regions of oil products that are used for the purposes of operating diesel machines and K3 pumping stations.

C- Kirkuk Refinery: It is located in the Kirkuk Governorate and was established in 1973. It is one of the small refineries.

D - Qayyarah Refinery: It is located in Mousel Governorate and began operating in 1956. It was established for the purpose of producing asphalt using heavy oil with a high sulfur content.

C- Al-Jazeera Refinery: It was established in 1985 in Salah Al-Din Governorate, with a production capacity of 20,000 barrels per day.

There are also refineries in Kurdistan in Erbil and Sulaymaniyah, which produce naphthalene and supply cities with kerosene.

3.2 Measuring of the quality of some oil products

The quality for some oil products (dependent variable) produced by Iraqi refineries (Dora refinery, Nasiriyah refinery, Basra refinery) is measured, as the process of verifying the quality of oil products is a difficult process, as it conforms to international specifications from the refinery's point of view, and is subject to the judgment of the consumer in that it satisfies his needs, so the extent of conformity of the oil product to the world was adopted, so reliance was made on the statements of the refineries under study related to the Iraqi and international specifications to determine the specifications of the product, so the Iraqi specifications depend on the application of international standards and for OPEC countries, through cooperation with the experts of the International Organization for Standardization ISO and benefiting from the work of the United Nations Industrial Development Organization in order to develop Iraqi standards and infrastructure for the quality of the Iraqi product.(Iraqi Ministry of Planning,2015) Determining the quality of crude oil products in the refineries under study depends on the relative deviation between Iraqi specifications and international standards, as this percentage is determined as follows(Badis,2016)

Relative deviation = {(the value of the item in the international standards - the value of the item in the national standards) ÷ the value of the item in the international standards} × 100

The results of these specifications were as shown in the following table (3):

Table (3) Relative deviations between the values of international and Iraqi specifications for some crude oil products produced by the refineries under study

N O.	Product name	Density			Distillation			sulfur percentage			mean deviati on %
		Internatio nal Standard	Iraqi Standa rd	Deviati on %	Internatio nal Standard	Iraqi Standa rd	Deviati on %	Internatio nal Standard	Iraqi Standa rd	Deviati on %	
1	liquefi ed gas	min 0.69 max 0.74	0.67 min 0.72 max	2.9 2.7	max 175	174 max	0.5	max 50	max 50	0	1.1
2	fuel oil	min 0.82 max 0.84	0.81 min 0.85 max	1 1	max 370	350 max	20	max 0.25	0.25 max	0	7
3	Kerose ne	min 0.77 max 0.84	0.77 min 0.84 max	0 0	max 300	300 max	0	max 0.3	0.3 max	0	0
4	Gasoli ne	min 0.73 max 0.78	0.71 min 0.76 max	2.7 2.5	max 215	215 max	0	max 0.01	0.01 max	0	0.9

Then, the unweight arithmetic mean of levels close to the Iraqi specifications with the measurements of the international specifications for each national product of crude oil was calculated in order to determine the quality of the product using the five-point Likert scale. The closer the average relative deviation of the Iraqi standard to the international standard, the better the quality of the Iraqi oil product, as shown in the following table:

Table (4) The quality of crude oil products according to their level of proximity to the international specifications standard

Quality values	quality level	Proximity to the international standard
5	Excellent	0
4	High	0 - 3
3	Good	3–6
2	Middle	6–9
1	Bad	9 and over

The reference: From the researcher's work based on Table (3).

From Table (4), we conclude that the quality of the specifications of some crude oil products in Iraqi refineries, according to the crude oil products quality scale, was in the following order:

Table (5) values of the quality of some crude oil products in Iraqi refineries

type of petroleum products	Quality values	quality level
Liquefied gas	2	high
Fuel oil	7	middle
Kerosen	0	Excellent
Gasoline	0	Excellent

The reference: The researcher's work based on tables (3 and 4).

3.3 Statistical analysis of the study population and sample

This will be done through the following:

1- Choosing the study population and sample: Based on the research objectives, the study population was targeted from all workers at the levels of middle management and workers in the refineries under study, as the size of the study sample was 225 workers, and this size of the sample corresponds to the tables of Uma Sekran(Sekran,1993), Where the questionnaires were distributed to the random sample in a proportional manner distributed to the Iraqi refineries under study, as shown in the following table (6):

Table (6) The size of the sample according to each of the Iraqi refineries under study

refineries	The number of distributed questionnaires
AL-dora	115
AL-Nazareth	48
AL-Basra	62
Sum	225

Table (7) The number and percentage of questionnaires distributed and retrieved from the study sample

Refineries	The number of distributed questionnaires	The number of valid retrieved questionnaires	Payback percentage%
AL-dora	115	105	91.3
AL-Nazareth	48	44	91.7
AL-Basra	62	56	90.3
Sum	225	205	91.1

2- Statistical analysis: In order to achieve the objectives of the research and analyze its obtained data, the descriptive statistics method and the inferential statistics method were used based on the Statistical Package for Social Science (SPSS) version 20, and the statistical analysis was carried out according to the following:

A- Characteristics of the study sample: it means the personal data related to those who responded to the study, and their data was analyzed according to the descriptive statistics method, as follows:

Distribution by gender: This was explained in the following table:

Table (8) Distribution of respondents by gender

Sex	the number	percentage
Male	166	80.98
female	39	19.02
Total	205	100

It is clear from Table (8) that the percentage of workers in the Iraqi refineries under study amounted to 80.98% of males, and 19.02% of females.

Table (9) Distribution of respondents by age

Age	the number	percentage
25 years or younger	4	1.95
26 to 35 years	71	34.63
36 to 45 years	102	49.76
46 to 60 years	28	13.66
the total	205	100

It is clear from Table (9) that the workers in the Iraqi refineries under study, aged 25 years or less, amounted to 1.95% of the respondents, which is the lowest percentage. As for the workers between the ages of 26 and 35, their percentage was 34.63% of the respondents, while the workers aged 36 to 45 The highest percentage of respondents was 49.76%, meaning that the workers are mostly young, and the rest of the workers were between the ages of 46 to 60 years and their percentage reached 13.66%. Their percentage decreased due to their age approaching the retirement age.

Distribution according to academic qualification: This is explained in the following table:

Table (10) Distribution of respondents according to educational qualification

Qualification	NO.	percentage
Primary	13	6.34
high school	47	22.93
undergraduate	134	65.37
Postgraduate	11	5.36
the total	205	100

It is clear from Table (10) that most of the workers in the Iraqi refineries under study hold a university degree with a rate of 65.37% of the respondents, and the lowest percentage was for workers with primary certificates as their rate was 6.34% of the respondents, while the workers who have a high school certificate amounted to 22.93 %, and holders of postgraduate degrees from Masters and Ph.D., their percentage was 5.36%.

Distribution according to years of experience: This is explained in the following table:

Table (11) Distribution of respondents by years of experience

Years of Experience	NO.	percentage
5 years or less	54	26.34
6 to 15 years	122	59.52
16 to 25 years	7	3.41
More than 25 years	22	10.73
the total	205	100

It is clear from Table (11) that the percentage of workers with experience of five years or less was 26.34%, and those with experience between 6 to 15 years was 59.52%, and the percentage of workers with experience between 16 and 25 years was 3.41%. More than 25 years of experience, with a percentage of 10.73%.

Distribution according to job position: This is explained in the following table:

Table (12) Distribution of respondents by job location

Job site	NO.	percentage
Manager	1	0.49
Deputy Director	4	1.95
Authority manager	8	3.90
Head of the Department	11	5.37
Officer	181	88.29
Total	205	100

It is clear from table (12) that the percentage of workers with the rank of manager and deputy manager amounted to 0.49% and 1.95%, respectively, and those with the rank of Authority manager and head of department amounted to 3.9% and 5.37%, respectively, and the percentage of workers with the rank of employee amounted to 88.29%.

B- The stability of the study tool: The consistency between the paragraphs of each axis of the questionnaire was calculated using Cronbach's Alpha, and the results were as follows:

Table (13) Cronbach alpha test results for the questionnaire axes

NO.	the hub	the number	α value %	scale level
1	The principle of senior management's commitment to quality	4	89	High
2	The principle of planning for the application of quality standards	4	85	High
3	The principle of consolidating a culture of quality among employees	4	62.3	above average
—	General Average	12	92.2	High

It is clear from Table (13) that the value of Cronbach's alpha coefficient for the axes of the questionnaire is sufficient for the purpose of applying the study tool, so the general average for all data was 92.2%, which is a high stability coefficient, although all stability coefficients were high for all items of the questionnaire except for the axis of the principle of strengthening the culture of quality Among the workers, whose coefficient reached 62.3%, which is a level higher than the average in acceptance as long as it is above 60%.

C- An analysis of the results of the statements related to the degree of management's application of quality control:

The first axis: the principle of senior management's commitment to quality: it was measured in four terms according to the results of arithmetic means and standard deviations, and as shown in the following table:

Table (14) Results of the arithmetic means and standard deviations for the first axis

Sequencing	Ferries	Mean	standard deviation	arrangement	degree of application
1	The clear commitment of the senior management in the refinery to provide quality application requirements	3.38	1.03	3	High
2	The support of the senior management by eliminating restrictions between the refinery departments	3.31	0.92	4	High
3	Senior management commitment to achieving quality programs	3.46	0.96	2	High
4	Control the senior management to apply the approved standards in the quality of its products	3.60	0.95	1	High
—	General Average	3.44	0.74	—	High

It is clear from Table (14) that the degree of application of the principle of senior management's commitment to quality in the Iraqi refineries under study is high, as the general average of the arithmetic mean value was 3.44, with a standard deviation of 0.74. The highest degree of application of the approved standards in the quality of its products", where the arithmetic average of the phrase was 3.60, with a standard deviation of 0.74, and this shows the extent of the senior management's commitment to adjusting the approved standards to achieve quality for the refinery's products of crude oil, and the lowest degree of application was phrase No. (2) that states On "the support of the senior management to get rid of restrictions between the refinery's departments", where the arithmetic average of the phrase was 3.31, with a standard deviation of 0.92, indicating that there are restrictions between the departments in the refinery under study, which impedes the application of quality on oil products in each of the refinery's departments.

The second axis: the axis of the principle of planning for the application of quality standards: it was measured in four terms as shown in the following table:

Table (15) Results of the arithmetic means and standard deviations for the second axis

Sequencing	Ferries	Mean	Standard deviation	arrangement	degree of application
1	The refinery adopts a clear and declared vision for the employees to implement quality standards	3.08	0.92	4	Medium
2	The refinery adopts clear goals for applying quality in its plans	3.27	0.93	2	Medium
3	The presence of a team specialized in defining the quality policy for the refinery's products	3.14	0.96	3	Medium
4	Existence of long-term plans to control quality according to the vision of the refiner	3.56	0.89	1	High
—	General Average	3.26	0.72	—	Medium

It is clear from the answers of the individuals shown in Table (15) that the degree of the planning principle in the application of quality standards was average according to the general average of the arithmetic mean, which amounted to 3.26, with a standard deviation of 0.72. Long-term plans to control quality according to the vision of the refinery", where the arithmetic average of the phrase was 3.56, with a standard deviation of 0.89, to show that the refinery has long-term plans to control the quality of its oil derivatives products, and the lowest degree of application was phrase No. (1) that states " The refinery adopted a clear and declared vision for the employees to implement quality standards." The arithmetic mean of the expression was 3.08, with a standard deviation of 0.92, indicating that the refinery's vision was not clear to its employees.

3.3 The principle of consolidating the culture of quality among employees

It was measured in four terms as shown in the following table:

Table (16) Results of the arithmetic means and standard deviations for the third axis

Sequencing	Ferries	Mean	Standard deviation	Arrangement	degree of application
1	Supporting the behavior of the refinery workers with the management's vision of applying quality standards	2.93	1.03	4	Medium
2	Spreading the culture of quality among individuals working in the refinery and in various departments	3.90	1.02	1	High
3	There is an interest in educating and training the refinery workers to understand the statistical methods for controlling the quality of oil products	3.18	1.08	2	Medium
4	Raising awareness among workers of respecting time in supporting their work within what is required of achieving quality in the oil product	3.00	1.12	3	Medium
—	General Average	3.25	0.68	—	Medium

It is clear from the answers of the individuals shown in Table (16) that the degree of the principle of consolidating the culture of quality among workers was average according to the general average of the arithmetic mean, which was 3.25, and with a standard deviation of 0.68. The culture of quality among individuals working in the refinery and in the various departments", where the arithmetic mean of the phrase was 3.90, with a standard deviation of 1.02, to show the attempt of the refinery management to spread the culture of quality among the workers and related to the quality of oil products, and the lowest degree of application was phrase No. (1) Which stipulates "supporting the behavior of workers in the refinery with the vision of the administration in applying quality standards", where the arithmetic mean of the phrase was 2.93, with a standard deviation of 1.03, indicating that the behavior of the workers was not supported in line with the vision of the refinery in applying quality standards for oil products.

3.4 Hypotheses Testing

For the purpose of testing research hypotheses in proving the validity of the hypothesis or not, it is necessary to analyze the results that have been reached, depending on the statistical package for social sciences SPSS and using the statistical methods that were mentioned previously, and this will be done as follows:

1- Testing the first hypothesis: This hypothesis states that "Iraqi refineries do not apply quality control standards to a high degree, and the level of quality of some oil products is not high." In the beginning, it is necessary to determine the level of quality of some oil products in the Iraqi refineries under study. The lengths of the five-point Likert scale categories were divided as follows: calculate the range (5 - 1 = 4) and then divide it by the largest value in the scale in order to obtain the length of the category. (i.e. 4 ÷ 5 = 0.8), after which this value is added to the lowest value in the scale represented by the correct one in order to determine the upper limit of the category, thus the length of the categories becomes as follows: from 1 to 1.8 the level of quality is bad, from 1.8 to 2.6 the level of quality is medium, 2.6 to 3.4 is good, 3.4 to 4.2 is good, 4.2 to 5 is excellent (Badis, 2016).

Table (17) The average quality of some crude oil products for the Iraqi refineries under study

Type of petroleum derivatives	Quality Values	Frequency	Quality Values × Frequency	Average Deviation %
Liquefied gas	2	35	70	1.1
Fuel oil	7	40	280	7
Kerosene	0	66	0	0
Normal gasoline	0	64	0	0.9
Average quality of petroleum products			2.25	

It is clear from Table (17) that the average quality of some crude oil products in the Iraqi refineries under study has reached 2.25, which belongs to the length of the category from 1.8 to 2.6, meaning that the quality level of these products is medium, and in order to find the percentage we divide this average by 5 to use our scale Likert pentagram, thus the level of quality of some crude oil products is estimated With 45%, it can be judged that the level of quality of some crude oil products is low, accordingly the null hypothesis of the first hypothesis H01 can be accepted.

Now we will determine the degree of application of the Iraqi refineries under study to the standards of quality control management through the three axes that were studied and analyzed previously, and the arithmetic averages and standard deviations are shown in the following table:

Table (18) Results of the arithmetic means and standard deviations of the questionnaire axes

The hub	Arithmetic mean	standard deviation	application score	ranking	the decision
The principle of senior management's commitment to quality	3.44	0.74	High	1	Reject the null hypothesis
The principle of planning for the application of quality standards	3.26	0.72	Medium	2	Accept the null hypothesis
The principle of consolidating a culture of quality among employees	3.25	0.68	Medium	3	Accept the null hypothesis

From Table (18) we conclude the following:

A- Rejecting the null hypothesis and accepting the alternative hypothesis for the first axis regarding the commitment of senior management to quality, meaning that there is a high interest in quality control in Iraqi refineries, so the arithmetic mean for this axis was 3.44, with a standard deviation of 0.74, with a percentage of 68.8%.

B- Accepting the null hypothesis and rejecting the alternative hypothesis for the second axis of the principle of planning for the application of quality standards in Iraqi refineries, as there is a medium interest, so the arithmetic mean for this axis was 3.26, with a standard deviation of 0.72, with a percentage of 65.2%.

C - Accepting the null hypothesis and rejecting the alternative hypothesis for the third axis of the principle of strengthening the culture of quality among workers in Iraqi refineries, as there is a medium interest, so the arithmetic mean for this axis was 3.25, with a standard deviation of 0.68, with a percentage of 65%.

Thus, we accept the first null hypothesis H01, which states: "Iraqi refineries do not apply quality control standards to a high degree, and the level of quality of some oil products is not high."

3- Testing the second hypothesis: This hypothesis states that "there is no statistically significant relationship at the level of significance 0.05 between the commitment of senior management to quality and the quality of some oil products in Iraqi refineries." We infer this relationship by analyzing the Pearson correlation coefficient, the results of which are shown in the following table:

Table (19) Matrix of the correlation coefficient between the quality control department and the quality of some oil products

Quality Control Department		The principle of senior management's commit-ment to quality	The principle of planning for the application of quality standards	The principle of consolidating a culture of quality among employees	quality of some petroleum products
The principle of senior management's commitment to quality	correlation coefficient	1	0.72	0.61	0.69
	Moral level	0.000	0.000	0.000	0.000

We note from Table (19) that the results of the correlation coefficient related to the first axis "the principle of senior management's commitment to quality" indicate that there is a statistically significant relationship between the commitment of senior management to quality and the quality of some oil products produced in the Iraqi refineries under study, where the correlation coefficient was 0.69 and at the level of Significance of 0.000, which is less than 0.05, so the decision is to reject the second null hypothesis H02 and accept the alternative hypothesis which states that there is a statistically significant correlation between the commitment of senior management to quality and the quality of some oil products in Iraqi refineries, which is a direct and strong relationship.

4- Testing the third hypothesis: which states that "there is no statistically significant relationship at the level of significance 0.05 between planning for the application of quality standards and the quality of some oil products in Iraqi refineries." To infer this, the results of the following table will be analyzed:

Table (20) Matrix of the correlation coefficient between planning for applying quality standards and the quality of some oil products

Quality Control Department		The principle of senior management's commitment to quality	The principle of planning for the application of quality standards	The principle of consolidating a culture of quality among employees	quality of some petroleum products
correlation coefficient	The principle of planning for the application of quality standards	0.72	1	0.59	0.67
Moral level		0.000	0.000	0.000	0.000

We note from Table (20) that the results of the correlation coefficient related to the second axis "the principle of planning for the application of quality standards" indicate that there is a statistically significant relationship between planning for the application of quality standards and the quality of some oil products produced in the Iraqi refineries under study, where the correlation coefficient reached 0.67 with a level of significance of 0.000 which is less than 0.05, so the decision is to reject the third null hypothesis H03 and we accept the alternative hypothesis which states that there is a statistically significant correlation between planning for the application of quality standards and the quality of some oil products in Iraqi refineries, which is a direct and strong relationship.

1- Testing the fourth hypothesis: which states that "there is no statistically significant relationship at the level of significance 0.05 between strengthening the culture of quality among workers and the quality of some oil products in Iraqi refineries." In order to test the hypothesis, the following table will be analyzed:

Table (21) Matrix of the correlation coefficient between strengthening the culture of quality among workers and the quality of some oil products

Quality Control Department		The principle of senior management's commitment to quality	The principle of planning for the application of quality standards	The principle of consolidating a culture of quality among employees	quality of some petroleum products
correlation coefficient	The principle of consolidating a culture of quality among employees	0.61	0.51	1	0.72
Moral level		0.000	0.000	0.000	0.000

We note from Table (21) that the results of the correlation coefficient related to the third axis "the principle of strengthening the culture of quality among workers" indicate that there is a statistically significant relationship between strengthening the culture of quality among workers and the quality of some oil products produced in the Iraqi refineries under study, as the correlation coefficient reached 0.72 with a level of significance of 0.000 which is less than 0.05, so the decision is to reject the fourth null hypothesis H04 and we accept the alternative hypothesis which states that there is a statistically significant correlation between the consolidation of the culture of quality among workers and the quality of some oil products in Iraqi refineries, which is a direct and strong relationship.

4. Conclusions

After testing the hypotheses, the following conclusions were reached:

1- The degree of application of quality control in the Iraqi refineries under study was high in the principle of the commitment of senior management to quality with a percentage of 68.8%, while the principle of planning for the application of quality standards and the principle of consolidating the culture of quality among workers, the degree of application was medium for each of them, and by a percentage of 65.2% and 65%, respectively.

The level of quality of crude oil products in the Iraqi refineries under study was not high, as it was estimated at 45%.

On this basis, the first null hypothesis H01 was accepted, which states that: "Iraqi refineries did not apply quality control standards to a high degree, and the level of quality of some oil products is not high."

2- There is a statistically significant relationship between the commitment of the senior management to the quality of some oil products in the Iraqi refineries under study, with a correlation coefficient of 0.69, so the second null hypothesis H02 was rejected and the alternative hypothesis was accepted, which states that there is a statistically significant correlation between two variables, it is a strong and positive relationship.

3- There is a statistically significant relationship between the principle of planning for applying quality standards and the quality of some crude oil products in the Iraqi refineries under study, with a correlation coefficient was 0.67, so the third null hypothesis H03 was rejected and the alternative hypothesis was accepted, which states that there is a statistically significant correlation between the two variables, it is a strong and positive relationship.

4- There is a statistically significant relationship between the principle of strengthening the culture of quality among workers and the quality of some oil products in the Iraqi refineries under study, with a correlation coefficient was 0.72, so the fourth null hypothesis H04 was rejected and the alternative hypothesis was accepted, which states that there is a statistically significant correlation Between the two variables, it is a strong and positive relationship.

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Appendix (1)

Resolution

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Paragraphs	No.
1	2	3	4	5		
					The principle of senior management's commitment to quality	
					The clear commitment of the senior management in the refinery to provide quality application requirements	1
					The support of the senior management by eliminating restrictions between the refinery departments	2
					Senior management commitment to achieving quality programs	3
					Control the senior management to apply the approved standards in the quality of its products	4
					The principle of planning for the application of quality standards	
					The refinery adopts a clear and declared vision for the employees to implement quality standards	5
					The refinery adopts clear objectives for the application of quality in its plans׀	6
					The presence of a team specialized in defining the quality policy for the refinery's products	7
					Existence of long-term plans to control quality according to the vision of the refiner	8
					The principle of consolidating a culture of quality among employees	
					Supporting the behavior of the refinery workers with the management's vision of applying quality standards	9
					Spreading the culture of quality among individuals working in the refinery and in various departments	10
					There is an interest in educating and training the refinery workers to understand the statistical methods for controlling the quality of oil derivatives	11
					Raising awareness among workers of respecting time in supporting their work within what is required of achieving quality in the oil product	12

الأساليب الإحصائية في الرقابة على جودة المشتقات النفطية في العراق

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مستخلص البحث

هدفت الدراسة إلى دراسة درجات الرقابة على الجودة لجودة بعض المشتقات النفطية في المصافي العراقية، ومدى قربها من تطبيق المواصفات العالمية، من خلال تطبيق الأساليب الإحصائية في ضبط الجودة على المشتقات النفطية في المصافي العراقية. حيث تم تطبيق إجابات عينة الدراسة لمجموعة من موظفي المصافي العراقية (مصفى الدورة، مصفى الناصرية، مصفى البصرة) على مبادئ الرقابة على إدارة الجودة، وحسب اختلاف الخصائص الشخصية (الجنس، العمر، المؤهل العلمي، عدد سنوات الخبرة، الموقع الوظيفي). ومن أجل تحقيق أهداف الدراسة قام الباحث بتصميم استبانة شملت (12) فقرة، ذلك لجمع المعلومات الأولية عن عينة الدراسة. وفي ضوء ذلك تم تحليل البيانات إحصائياً واختبار الفرضيات باستخدام الحزمة الإحصائية SPSS، فقد اعتمدت الدراسة على عينة عشوائية مكونة من 225 مفردة، الصالح منها 205 مفردة. حيث تم التوصل إلى عدد من النتائج أهمها: أن درجة تطبيق الرقابة على إدارة الجودة في المصافي محل الدراسة بنسبة 68.8% مبدأ التزام الإدارة العليا بالجودة، وبنسبة 65.2% لمبدأ التخطيط لتطبيق معايير الجودة، ونسبة 65% بالنسبة لمبدأ تدعيم ثقافة الجودة بين العاملين. وكان مستوى جودة بعض المشتقات النفطية في المصافي محل الدراسة بنسبة قدرت بـ 45%. بالإضافة لجود علاقة ارتباط ذات دلالة إحصائية بين تطبيق مبادئ الرقابة على إدارة الجودة وجودة بعض المشتقات النفطية.

نوع البحث: ورقة بحثية.

المصطلحات الرئيسة للبحث: النفط الخام ، المنتجات ، الفرضيات ، المبادئ ، مقياس ليكرت ، كرونباخ