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Assess quality level of the final product by using Demerit system: A case study in one industry of General Company for Electronic Industries

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Abstract: *This research aims to use a demerit system as a method to evaluate the level of the quality of the final product. Demerit system was applied as a case study to obtain the research objectives in the factory of transformers and household appliances, which represents as a majority factory in the formations of the general company for Electronic Industries. In this research, the Reflective Product was selected as a sample research. Several of the quantitative and scientific instruments that represent demerit system were used to achieve the research objectives. The results demonstrations that adopted identified each of the level of the quality of the final Reflective Product and standard level of quality are very important during the period of the assessment final product.*

Keywords: *Product quality; Demerit system; value demerit; standard level of quality; Quality Index; Demerit quality control*

I. Introduction

Investigate the quality of product an important aim for any organizations, because of the poor quality of the products leads to affect customers' confidence. Thus, could be a reluctance to buy its products. This leads to encourage the majority of the organizations to focus on delivering a high level of the quality products.

Investigate the product quality is examined through three phases; (1) pre-production (2) during the process of production, and (3) post-production. To ensure that the quality of the product is investigated, this research use method to assess the quality of the product for all operation process such us, a demerit system to evaluate the quality level the final product (post-production). This is a significantstage to evaluate the quality of the final product, as it represents the last stage before delivery to the customer, which needs focus on this stage in order to provide defect-free products.

II. Methodology

Currently, increasing complexity of the product leads to the appearance of different types of defects in the final industrial product,which effects on product quality. In additional on, the emphasis on quality at any/or all stages of the production process and the manufacturing process is required. Furthermore, evaluatethe quality of the final product is important for investigatingthe level of production quality, because, it represents the last stage before delivery to the customer. Thisneeds focus on the last stage of the production process in order to avoid the arrival of defective products to customers, which may harm the reputation of the organization.

For this reason, theauthors'define the significant like this research, which can be expressed in the research problem by examining research questions.

The research questions were: -

1) What is the level of quality of the final product reflective during the evaluation period?
2) What is the quality standard reflective of the level of the final product during the period of assessment?
3) Does the factory can provide a reflective product quality level higher than the standard level of quality during the evaluation period?

The main objectives of this research are represented to identify; (1) the reflective quality level of the final product by using the demerit system (2) determine the standard level of quality reflective of the final product during the period of assessment, and (3) determine the industry's ability to presenting the highest level of product than the standard level of quality of reflective quality product during the period of assessment.

The main significance of thisresearch is attempting to identify the level of the final product quality by using demerit system.Therefore,identify the enhancements to be made in order to improve the level of quality.This is reflected in improving the reputation of the Reflective Product in the market, as well as, provides the information to directors about the effects of the control system through demerit that display on the quality

control, and motivates employees to establish new ideasthat associatedwith improving the quality and reducing the rates of defects in production.

This is research applied in the factory of transformers and household appliances of the general company for electronic industries, because it produces a severaltypes of complex products. This offers the possibility to apply the demerit system. Reflective product has been chosen to be the research sample.Thisresearch adoptedthe case study method as being suitable to like this research. The data collected by using a several methods such as; *(1) personal observations (2) interviews with the director's and staff, and (3) access to records and its formal documents.*The results enable the researchers to improve a rating system defects and assisted the factory area to evaluate the level of the quality product.

III. Literature Review

A. QUALITY

The term of (Quality) is commonly used in the English Language. This term originally translated from the Latin word (QUALITUS), which is also a translation of the Greek word (ποιοτεσ) discovered by Affiliation. The meaning of quality has been changed over time, but still (good quality) means the reliability of products or services according to the productivity requirement [1]. Garvin (1984) presented five basic entrances to quality. These are as the following [2]:-

1) Entrance depends on use: Refers to quality according to this approach as the appropriate use of the product; the reliability of products/services to perform their function according to the specifications accepted by customer's satisfaction.

2)Entrance depends on the product: In this approach, quality refers to the accuracy and the ability to measure the items or characteristics, which required in the product as customers wanted.

3)The entrance of excellence: The quality within this entrance in the product's ability to satisfy the customer expectations. In this approach, the majority of organizations attempted to relevance between product characteristics and customer expectations.

4)Entrance depends on manufacturing: refers that quality display according to entrance-making "defect-free products", by adopting on comparison final product with design specifications required. This is consistent with the concepts of quality in Japan.

5)Entrance depends on the value: This approach aims that quality considered through their relationship with the price, as some of the customers may prefer the products that have a lower price compared with low specifications. Juran and Godfrey (1999) argued that the quality term has several of meanings; but, in this research has highlighted two of the most important meanings for the quality. These are as follows [3]:-

a)Quality is those characteristics of the products that satisfactory to the customer needs. In this research, the quality directed to increase revenue. The purpose of providing the products or services within higher quality levels is to increase the customer satisfaction, which leads in general to increase revenues.

*b)Quality*is continuedact to remove the each of the defects and errors that need to extra work (re-work) in order to achieve, that leads to resented customers. In this case, the quality focus directed to the costs, as the higher quality means lower costs.

B. MEASURING (EVALUATION) PRODUCT QUALITY

The quality measure or evaluate are an important stage to achieve the quality of the product, because it contributions the majority of an organization to control progress that leads to achieving the goals of quality through the comparison between the actual performance and pre-defined goals [4]. The quality measurement is the first step to adjusting and improving the quality through the availability of accurate data required to analyse and solve the problems modify at the level of quality. Where, James Harrington the expert on the quality theme said; "measurement is the first step that leads to the control system, then ultimately leads to obtaining improved"[5]. The quality measure is a critical stage in the three main operations*; (1) quality planning (2) quality control, and (3) quality.*

The Bell Labs Inc. for "wired-mobile" had a significant impact on the development of quality measurement. In 1925, a new department had been established for the development and examination production process and quality measure for the quality of economic criteria. This leads to obtaining several benefits in this theme. This development is included; Acceptance samples, LTPD sampling tables, AOQL sampling tables, and the demerit system [7].

C. DEMERIT SYSTEM

In 1926, demerit system introduced for the first time by (Dodge), and has been applied exclusively to Western Electric Company. Where this system can be used with any product which has non-conformities varying degrees of risk. Therefore, it is determined according to the level of the defect and its impact on the product quality [9].

The main objective of the use of demerit system is to identify several different types of defects in the complex products at one time [10]. This is applied through classified defects into four categories with giving relative weights for each category according to the demerit system, as follows[11]:-

Class (A) Defects: Very serious, which established with a relative weight (100).

Class (B) Defects: Seriously, this established with a relative weight (50).

Class (C) Defects: Moderately serious, which established with a relative weight (10).

Class (D) Defects: Not serious, which established with a relative weight (1).

To apply the demerit system requires a series of steps to be followed:-

1) Calculating Value demerit ( ) by the equation (1) as follows [9, 10]:-

$$u = \frac{100d_a+50d_b+10d_c+1d_D}{n} \dots\dots\dots\dots)$$

Where;

: Number of demerit points for product unit.

d_a ,d_b, d_c,The number of defects diagnosed for category (A, B, C, D),during the evaluation period.

n: The number of units that have been evaluated during a specific period of time.

2) Determine the level of the quality levelof the final product in accordance with international standard ISO 9000 and related accessories, by relying on a number of demerit point diagnosed per unit as shown in Table 1 [12].

Table 1 Quality classifies according to the number of demerit points

Number of demerit points	Quality ratio	Quality Recognition	Class Quality
0 - 0.99	%100	Very Excellent	First
1 – 1.99	%90	Excellent	Second
2 – 2.99	%80	Very good	Third
3 – 3.99	%70	Good	Fourth
4 - 4.99	%60	Acceptable	Fifth
5 and over	-	Rejected	-

3- Calculating standard level of quality ( ), by using the following equation (2) [13, 14].

$$u_S = 100u_A + 5(+10 \quad + 1 \quad u_D \dots\dots\dots$$

Where;

: Standardized level of quality

, , ,and :The average defects per unit of each category *(A, B, C, and D)* for the number of samples. This is calculated as follows:-

$$= \frac{\sum d_a}{\sum n} = \quad :$$

$$u_C = \frac{\sum d_c}{\sum n} = \quad :$$

4- Calculating Quality Index ( ) for the comparable value demerit ( ) with the standard level of quality ( ). A calculates obtained by using the following equation [15].

$$I = \frac{u}{u_S} \dots\dots\dots\dots\dots\dots\dots\dots(3)$$

After determining the value of ( ), the evaluation will be conducted according to the following cases: -

A- If [= 1]; the level of quality is equal to the standard level of quality.

B- If [I <1]; the level of quality is better than the standard level of quality.

C- If [>1]; the level of quality is less than the standard level of quality.

5) Establishment of the demerit control chart for the number of demerits to determine the number of units that are outside the control limits, by using the following ***equations; 4, 5 and 6*** [13, 14].

$$CL = u_S \dots\dots\dots\dots\dots\dots\dots\dots(4)$$

$$UCL = u_S + 3\sigma_u \dots\dots\dots\dots(5)$$

$$LCL = u_S - 3\sigma_u \dots\dots\dots(6)$$

Where:-

CL: Central line

UCL: Upper Control Limit

LCL: Lower Control Limit

The standard deviation which is calculated according to the following equation (7):-

$$\sigma_u = \sqrt{\frac{(100)^2u_a + (50)^2u_b + (10)^2u_c + (1)^2u_d}{n}} \dots\dots(7)$$

IV. Application demerit System

- Examines the sample items, then the classification of defects into four categories as shown in Table (2). This Table shows the number of defects and classes that are found in every month.
- Calculating value demerit (u) by using equation (1), as well as, it's applied for the time-out of the other months.

$$u = \frac{100 * 0 + 50 * 1 + 10 * 1 + 1 * 4}{30}$$

$$u = 2.13$$

Table 2 The number and types of defects

Mon.	2013					2014				
	n	***Classes of defects***				***n***	***Classes of defects***			
		A	***B***	***C***	***D***		***A***	***B***	***C***	***D***
Jan.	-	0	0	0	0	25	0	0	2	5
Feb.	-	0	0	0	0	15	0	1	0	2
Mar.	30	0	1	1	4	25	0	0	3	2
Apr.	25	0	1	3	2	30	0	1	1	3
May	20	0	1	0	3	15	0	0	3	4
Jun.	-	-	-	-	-	-	-	-	-	-
July	35	0	1	2	4	25	0	2	1	4
Aug.	30	0	2	1	2	35	0	0	3	5
Sept.	20	0	1	2	5	20	0	1	0	4
Oct.	25	1	0	1	3	25	0	0	4	3
Nov.	20	0	1	0	2	20	0	0	3	1
Dec.	15	0	0	2	3	-	0	0	0	0
Total	220	1	8	12	28	235	0	5	20	33

- Determine the degree of level quality of the final product as shows in Table (1). The value of the demerit for the month of *March* is (2.13). So, the level of the production quality is (80%), this appears a very good. This method will be used to calculate demerit values and determine the level of quality for the time-out of the other months. The final results obtained showed in Table (3) and (4).

Table 3 Value of the demerit and the level of quality reflective product in 2013

Mon.	2013			
	u	***Quality Rate***	***Quality Recognition***	***Class Quality***
Jan.	-	-		
Feb.	-	-		
Mar.	2.13	80%	Very good	Third
Apr.	3.28	70%	Good	Fourth
May	2.65	80%	Very good	Third
Jun.	-	-	-	-
July	2.11	80%	Very good	Third
Aug.	3.73	70%	Good	Fourth
Sept.	3.75	70%	Good	Fourth
Oct.	4.52	60%	Acceptable	Fifth
Nov.	2.6	80%	Very good	Third
Dec.	1.53	90%	Excellent	Second

Table 4 Value of the demerit and the level of quality reflective product in 2014

Mon.	2014			
	u	***Quality Rate***	***Quality Recognition***	***Class Quality***
Jan.	1	%90	Excellent	Second
Feb.	3.46	%70	Good	Fourth
Mar.	1.28	%90	Excellent	Second

Apr.	2.1	%80	Very good	Third
May	2.26	%80	Very good	Third
Jun.	-	-		
July	4.56	%60	Acceptable	Fifth
Aug.	1	%90	Excellent	Second
Sept.	2.7	%80	Very good	Third
Oct.	1.72	%90	Excellent	Second
Nov.	1.55	%90	Excellent	Second
Dec.	-	-		

As can be seen in Table3 & 4, the results obtain above are investigated the first question in this research.

- Calculating the value of a standard level of quality for a reflective product by using *equation 2*.

$$u_S = 100u_A + 50u_B + 10u_C + 1\,u_D$$

$$u_A = \frac{\sum d_a}{\sum n} = = 0.002198\,\frac{1}{455}$$

$$u_B = \frac{\sum d_b}{\sum n} = \frac{13}{455} = 0.028571$$

$$\frac{\sum d_C}{\sum n} u_C = = \frac{32}{455} = 0.07033$$

$$u_D = \frac{\sum d_D}{\sum n} = \frac{61}{455} = 0.134066$$

$u_S = 2.48$

As can be seen from the results above, that (u) estimated (2.48) as indicated in Table (2). The percentage of outcomes of the product quality in the factory of a transformer and home appliances for a reflective product during the years *(2013 and 2014)*were estimated at about 80%. This appears a very good rate. The class degree of level quality is the Third. These results answered the second question in the research.

5- Calculating Quality Index (I) by using equation (3). This is also applied for other months.

$$I = \frac{2.13}{2.48} = 0.85$$

As can be seen from the results obtained above, the quality index value for the month of March was less than 1. This means that the quality of a reflective product for this month has a better level degree of the standard quality. The final results for other months will be calculated quality indicator during the evaluation period, as illustrated in Tables 5 and 6.

As an be seen from the results indicated in Table 5 and 6, the factory appears to have the ability to produce higher level of the production than the standard level of the quality during the evaluation period. This represents appears an answer to the Third question research.

Table 3 Quality Index in 2013

Mon.	**2013**			
	u	***u_S***	***I***	***The status***
Jan.	-	-	-	
Feb.	-	-	-	
Mar.	2.13	2.48	0.85	Best
Apr.	3.28	2.48	1.31	Less
May	2.65	2.48	1.06	Less
Jun.	-	-	-	
July	2.11	2.48	0.85	Best
Aug.	3.73	2.48	1.50	Less
Sept.	3.75	2.48	1.50	Less
Oct.	4.52	2.48	1.81	Less
Nov.	2.6	2.48	1.04	Less

Dec.	1.53	2.48	0.61	Best

Table 4 Quality Index in 2014

Mon.	2014			
	u	u_S	I	*The status*
Jan.	1	2.48	0.40	Best
Feb.	3.46	2.48	1.39	Less
Mar.	1.28	2.48	0.51	Best
Apr.	2.1	2.48	0.84	Best
May	2.26	2.48	0.91	Best
Jun.	-	-	-	
July	4.56	2.48	1.83	Less
Aug.	1	2.48	0.40	Best
Sept.	2.7	2.48	1.08	Less
Oct.	1.72	2.48	0.69	Best
Nov.	1.55	2.48	0.62	Best
Dec.	-	-	-	

6- Establishment the demerit control chart for the number of demerit system by using ***equations 4, 5 and 6.***

$$CL = u_S = 2.48$$

$$UCL = u_S + 3\sigma_u$$

$$\sigma_u = \sqrt{\frac{(100)^2 u_a + (50)^2 u_b + (10)^2 u_c + (1)^2 u_d}{n}}$$

$= 0.47014\sigma_u$

UCL=2. 48+ (3*0.47014)

UCL=3. 89

$$LCL = u_S - 3\sigma_u$$

LCL=2. 48-(3*0.47014)

LCL=1. 07

As can be seen from the results obtained above, the limits of the demerit control chart are identified. As well as, the values of the demerit were described in Tables 3 and 4. Figure (1) shows the demerit control chart.

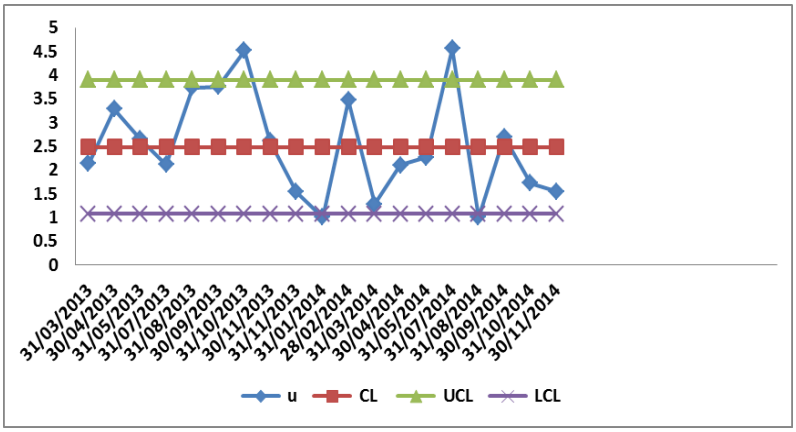

Fig..1. Demerit control charts for Reflective product (2013 -2014)

As can be seen in Figure 1 above, the results obtain from data collectedshowsas the following:-

- The demerit values during (u),for these months *(October/2013 and July/2014)* are equal to (respectively; 4.56 and 4.52) outside the control limits. This appears that level of quality isan upper control limit (UCL). This result shows the decline in the level of quality during these two months, this requires the identification of the causes of this decline in order to avoid it in the future.
- The demerit values (u) during the months *(December/2014 and August/2014)* is appeared equal to (1). This result is below the LCL.
- That the occurrence of demerit values (u) for months (December and August) for the year 2014 were under the LCL,which indicated depreciation of demerits. This means that the quality level of the product has been distinct for two months.
- The existence of four samples outside the level of control limits means that demerit control chart is statistically not significant. This has required identifying the samples that are outside the upper limit address UCL. This represents a high failure and a low level of the quality, while the demerit values were below the LCL. This represents the proportion of a few demerits and consequently the high level of the quality.

V. Conclusions

In this research, the results show a lack of rejected in the final production, because of the demerit values is less than 5. This devaluation of demerit values leads to an increase in the level of product quality reflector. The percentage of the standard level of quality of a reflective product was found (80%) during the evaluation period. This percentage shows; the quality of the reflective product is a very good. Becauseof it's turned out the factory's ability to provide a reflective product with a high level quality than the standard level of the quality. Furthermore, the demerit quality control of reflective product was not significant statistically, because of the presence of four batches found outside the standard control liner.

The low-value demerits lead to an increase in the level of the quality of the Reflective Product.The demerit system depends on four categories of defects, which are the main reason for obtaining a low-value of the demerits.

VI. Recommendations

Using the demerit system in the industrial organization provides the ability to determine the quality of a reflective product level, which are more accurate and detailed. Also, this system can assist the industrial company to improve the quality of a reflective product standard level by reducing the value of the demerits. Thus, improvement is in the quality level of the Reflective Product. This system is able to be applied in the industrial organization through the adopted qualitative control tools during the various production stages.

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