An Application of Single and Double Acceptance Sampling Plans for a Manufacturing System

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Abstract- Due to result of increasing competition in production enterprises, the prices have been determined by customers. So, the product costs must be improved at lack of quality costs except basic costs. Therefore, the enterprises will increase their profits and will sustain manufacturing and organizational processes.

An input quality control is a preventive technique to decrease costs of products and tardiness in the system when every receiving lot is controlled. In this point, enterprises must have decisions for accepting or rejecting receiving lots according to randomly chosen units. In this paper, a bearing cap has been evaluated by single and double acceptance sampling techniques in a bakery machines manufacturing company.

Keywords- Acceptance Sampling Plans, Statistical Quality Control, Input Quality Control, Manufacturing Costs.

Bir Üretim Sistemi için Tek ve Çift Kabul Örneklemesi Planları Uygulaması

Özet- Üretim işletmelerinde artan rekabetin sonucu olarak ürün satış fiyatlarını müşteriler belirlemektedir. Bu yüzden ürün maliyetleri bakımından temel maliyetlerin yanı sıra kalite maliyetleri de iyileştirilmelidir. Bundan dolayı, işletmeler kendi faydalarını artıracak ve işletme faaliyetleri olarak üretim ve organizasyonel süreçlerini devam ettireceklerdir.

Girdi kalite kontrolü, sistem için her yeni parti büyüklüğünün sisteme gelişinde üretim ve gecikme maliyetlerini önleyici bir kontrol tekniğidir. Bu noktada işletmeler rassal olarak seçilen partilere gore ilgili partilere kabul yada ret kararları alacaklardır. Bu çalışmada, bir ekmek makineleri üretimi yapan bir işletmede mil yatağı parçası tek ve çift kabul örneklemesi teknikleri ile değerlendirilmiştir.

Anahtar Kelimeler- Kabul Örneklemesi Planları, İstatistiksel Kalite Kontrol, Girdi Kalite Kontrolü, Üretim Maliyetleri.

1. INTRODUCTION

The production processes are very complex type of organizational structures. Thus, the variable factors which affects to system are occurred frequently that causes to some failures and interruptions. Generally, decreasing of production system failures is more important for all company. In this point, the process control become firstly for higher performance and productivity by using input resources in quality control. The most important thing is to understand what term quality means as in off-line and/or online quality control. There are as many definitions of quality as there are quality consultants, but commonly accepted variations include:

- fitness for use [1],
- conformance to requirements [2],
- the totality of characteristics of an entity that bear on its ability to satisfy stated and implied need [3].

Quality control is also a process employed to ensure a certain level of quality in a product or service. It may include whatever actions a business deems necessary to provide for the control and verification of certain characteristics of a product or service. The basic goal of quality control is to determine whether the monitored process or product will fulfill these characteristics or not to ensure that the products, services, or processes provided meet specific requirements and are dependable, satisfactory. If we have large amount of tested units, we can't test all of them. This is a problem that we make destructive testing for solution of this problem by using statistical methods of quality control. Acceptance sampling which refers to the application of specific plans

to a designated lots or sequence of lots and lots of product are acceptable for this purpose as a statistical method [4, 5].

In this paper, we discuss single and double acceptance sampling plans to evaluate bearing cap part from a bakery machine manufacturing system for analyzing the effects of input quality control process.

2. MATERIALS AND METHODS

2.1. A Bakery Machines Manufacturing System

A bakery machines manufacturing company which is placed in Konya, Turkey is a leadership in bakery manufacturing sector. We are observed about the bearing cap that is a montage part in a bakery machine. Bearing cap parts are purchased with lots from a supplier. Thus, the input quality control is more important to make accept/reject decisions for improving of the organizational performance and better process outputs. The lot size data are given in results. In this study, single and double acceptance sampling plans are examined for a bakery machines manufacturing system.

2.2. Acceptance Sampling

Acceptance Sampling (AS) is concerned with inspection and decision making regarding products. AS was one of the major components of the field of statistical quality control, and was used primarily for incoming or receiving inspection. In the other hand, AS is used to make dispositions on accepting or rejecting a lot (or batch) of product that has already been produced. Herein, a sample is taken from the lot, and some quality characteristic of the units in the sample is inspected [6].

In the last years, AS has become typical to work with suppliers to improve their process performance through by using of statistical process control (SPC) with designed experiments. It has been focused on when the inspection required is destructive testing, 100% inspection isn't feasible due to the cost or time so an AS plan is created to define how many samples must be taken to verify the lot.

Consequently, AS has an important point to remember is that the main purpose of acceptance sampling is to decide whether or not the lot is likely to be acceptable, not to estimate the quality of the lot. According to Schilling [4] an AS plan has much the effect of a lone sniper, while its scheme can provide a fusillade in the battle for quality improvement. In a view of ISO standard, an acceptance control chart combines consideration of control implications with elements of acceptance sampling. It is an appropriate tool for helping to make decisions with respect to process acceptance [7].

There are several AS methods for attributes and variables. The attribute sampling is a simple statistical method that utilizes representative samples to analyze traits of a large body of data and decides based on the number of defectives in a lot. Variables sampling is designed to predict the value of a given variable and to decide based on measurement values. Thus, statistically valid sampling plan tells us the probability of accepting bad lots and the probability of rejecting good lots in the manufacturing system [1, 5]. The other classifications are single, double, multiple and sequential sampling plans. Single and double acceptance sampling procedures are given in Figure 2 and proposed in this study.

In this point, some definitions are required which are given as follows:

- Acceptable Quality Level (AQL): is generally defined as the percent defectives that the plan will accept 95% of the time. Otherwise, lots that are at or better than the *AQL* will be accepted 95% of the time.
- Rejectable Quality Level (RQL) is the poorest level of quality for consumer.
- Lot Tolerance Percent Defective (LTPD) is generally defined as percent defective that the plan will reject 90% of the time.
- Likewise, a lot at or worse than the LTPD will be rejected 90% of the time.
- Operating Characteristic (OC) Curve is created by plotting the percent defective versus the matching probabilities of acceptance. The probability of acceptance is based on the number of samples to be evaluated and the quantity of rejects that are to be allowed. The OC curve is given in Figure 2.
- Producer's Risk (α) is the probability of rejecting the acceptable and it is typically 5%.
- Consumer's Risk (β) is the probability of accepting a defective sample and it is typically 10%.
- Average Outgoing Quality Level (AOQL) is a simple relationship between quality shipped and quality accepted.
- Average Total Inspection (ATI) is the average number of units inspected per lot, including all units in rejected lots.
- Average Sample Number (ASN) is the number of samples the receiver has to do.

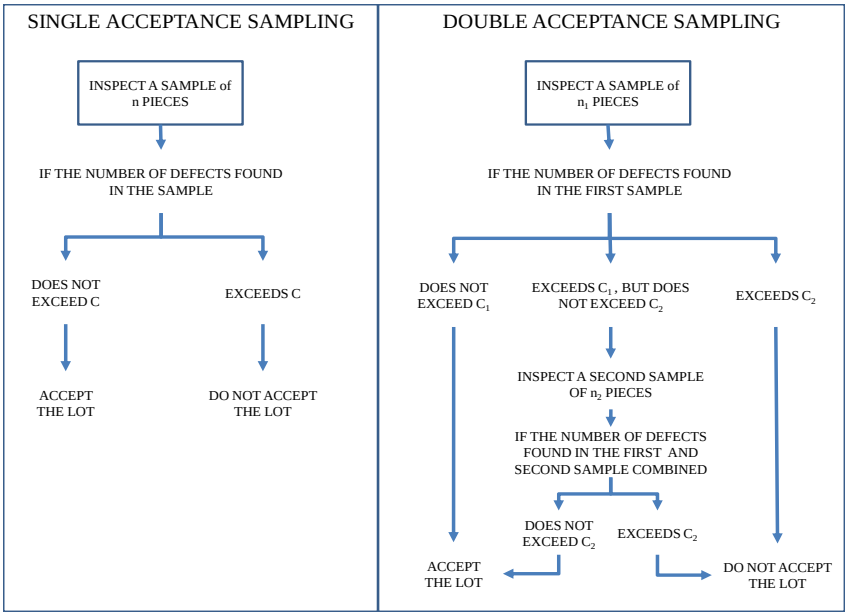

Figure 1. Procedures of Single and Double Acceptance Sampling [1]

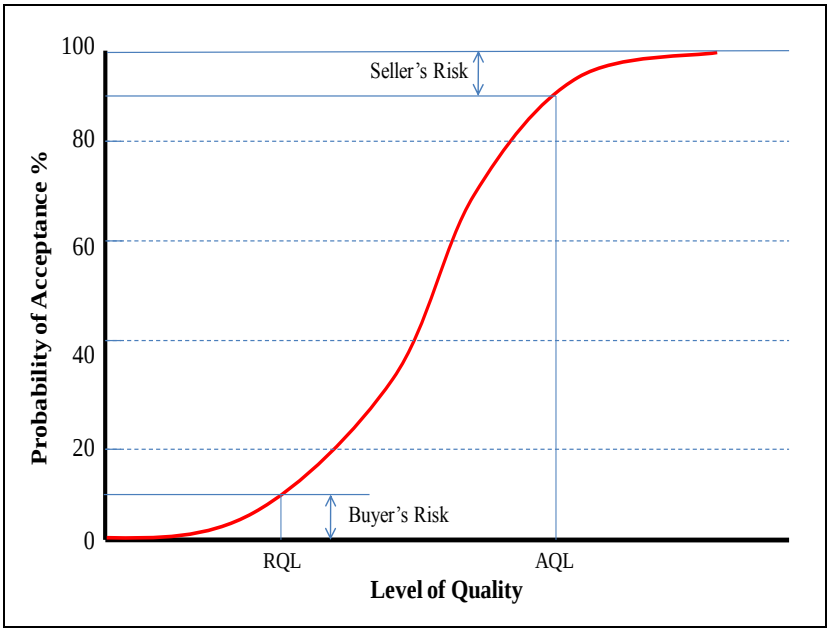

Figure 2. Operating Characteristic Curve [8]

For evaluating input quality control of bakery machine manufacturing company, we use WinQSB Acceptance Sampling Module as a computer program. The results are given in the next section.

3. RESULTS AND DISCUSSIONS

The lot size data are given in Table 1 for single and Table 2 for double AS plan with parameters about the bearing cap part in a bakery machine manufacturing. When the manufacturing system is followed, the lot size is 820 parts per lot. Then, OC, AOQ, ATI and ASN curves are obtained for single and double AS plans as Figure 3 and Figure 4.

Table 1. Parameters of Single Acceptance Sampling Plan

The Sampling Parameters	**Value**
Sample Size (n)	80
Acceptance Number (c)	7
AQL in % defective	4
RQL or LTPD in % defective	4
Producer's Risk (α)	5
Consumer's Risk (β)	10
Lot Size (N)	820
Probability Distribution	Binomial
Inspection Error: probability (%) of good item is classified as bad	0.1
Inspection Error: probability (%) of bad item is classified as good	0.1

Table 2. Parameters of Double Acceptance Sampling Plan

The Sampling Parameters	**Value**
First Sample Size (n_1)	50
First Acceptance Number (c_1)	3
First Rejection Number (r_1)	7
Second Sample Size (n_2)	50
Second Acceptance Number (c_2)	8
AQL in % defective	4
RQL or LTPD in % defective	4
Producer's Risk (α)	5
Consumer's Risk (β)	10
Lot Size (N)	820
Probability Distribution	Binomial
Inspection Error: probability (%) of good item is classified as bad	0.1
Inspection Error: probability (%) of bad item is classified as good	0.1

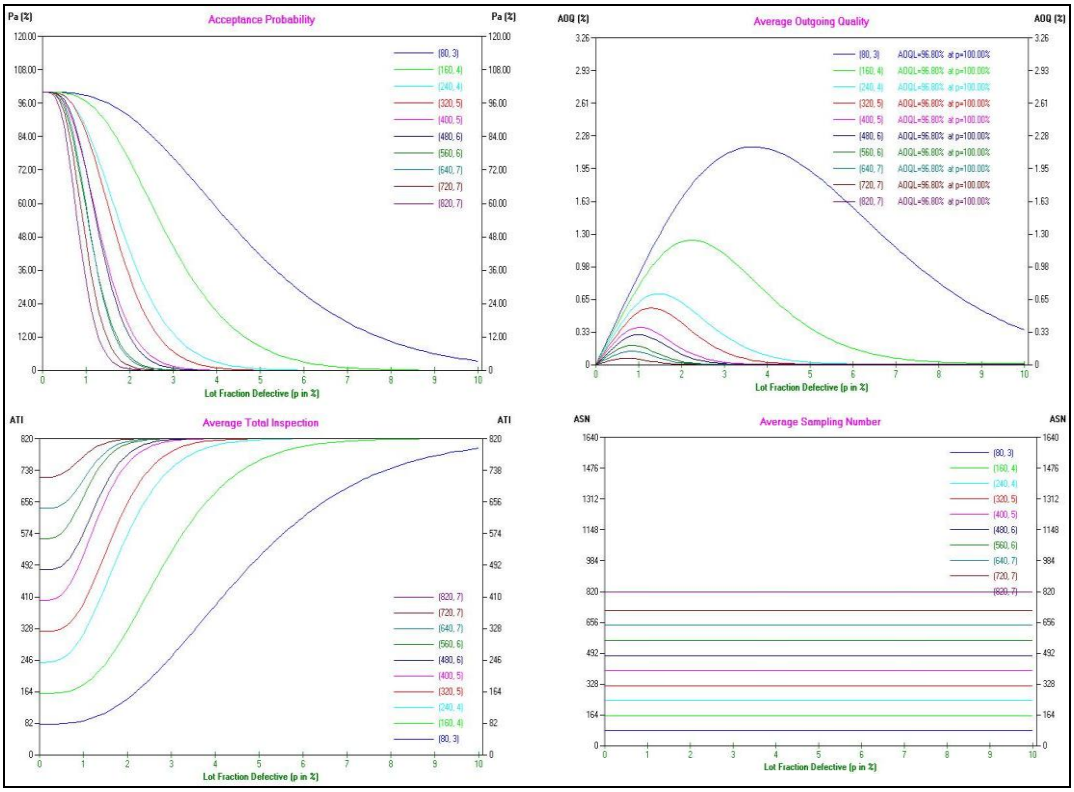

Figure 3. Result Graphics of Single Acceptance Sampling

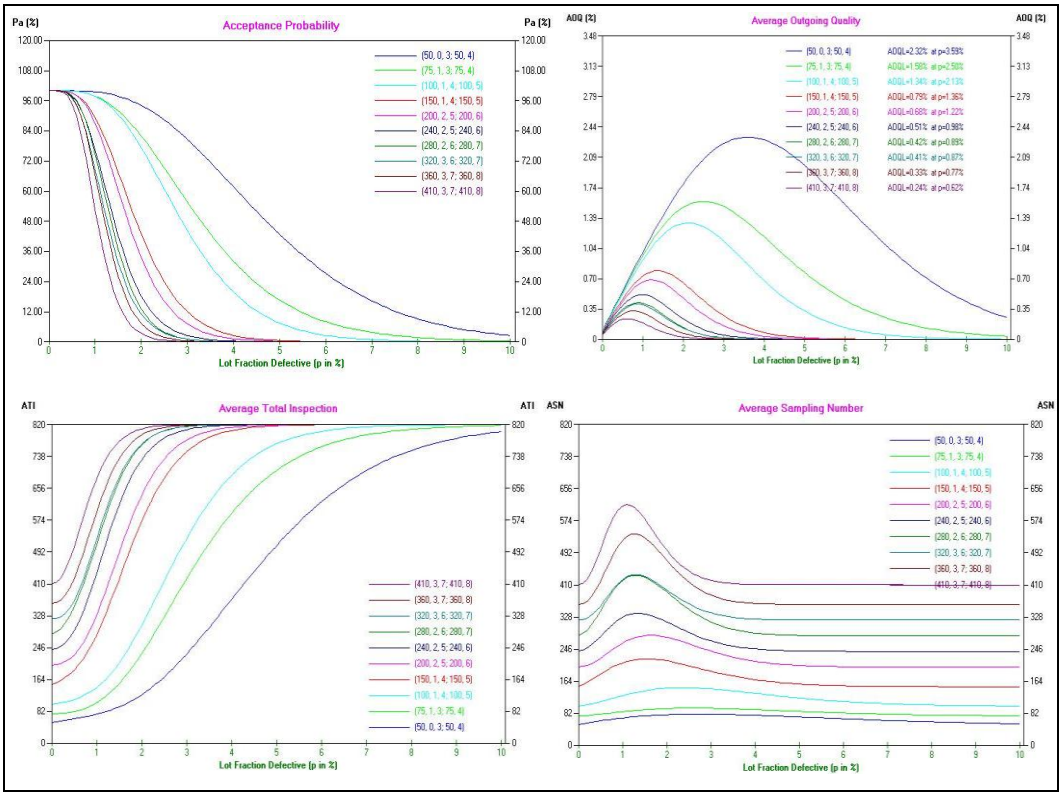

Figure 4. Result Graphics of Double Acceptance Sampling

Table 3. Results of Single and Double Acceptance Sampling Plans

Single Sampling				
Plan	**n**	**c**	**Pa (%)**	**AOQL (%)**
1	80	3	58.4927	2.1550
2	160	4	21.2616	0.7120
3	240	4	3.0342	0.0935
4	320	5	0.9025	0.0271
5	400	5	0.0896	0.0061
6	480	6	0.0268	0.0046
7	560	6	0.0023	0.0042
8	640	7	0.0007	0.0042
9	720	7	0.0001	0.0042
10	820	7	0.0000	0.0042

Double Sampling							
Plan	**n_1**	**c_1**	**r_1**	**n_2**	**c_2**	**Pa (%)**	**AOQL (%)**
1	50	0	3	50	4	61.7080	2.2903
2	75	1	3	75	4	32.1090	1.1767
3	100	1	4	100	5	19.8247	0.6769
4	150	1	4	150	5	2.5580	0.0801
5	200	2	5	200	6	1.2340	0.0381
6	240	2	5	240	6	0.2963	0.0087
7	280	2	6	280	7	0.0757	0.0020
8	320	3	6	320	7	0.0827	0.0021
9	360	3	7	360	8	0.0216	0.0005
10	410	3	7	410	8	0.0038	0.0001

As a result, ten sampling plans are executed and a result table is given as Table 3 for each methods. According to Table 3, the plan number 1 is the best probability of acceptance (Pa) for single (58.49%) and double (61.71%) sampling plans. When both of them are compared about value of Pa, the double sampling plan must be selected. Then, in a view of average outgoing quality level (AOQL), the best value is 2.29% in the plan number 1 as double sampling.

Consequently, we can say for the part of bearing cap, the company must be selected the plan number 1 with double sampling that is n_1=50, c_1=0, r_1=3, n_2=50, c_2=4, Pa=61.71% and AOQL= 2.29%. Thus, the lack of quality levels are decreased on the product costs with a good product quality level as the parts receiving for the manufacturing processes. In otherwise, the better parts are being acceptable for this subject in the input quality control process.

4. CONCLUSIONS

In this paper, we are focused on single and double acceptance sampling plans to evaluate bearing cap part from a bakery machine manufacturing system for analyzing the effects of input quality control process and comparing of the best plans. Acceptance sampling provides mainly to decide whether or not the lot is likely to be acceptable, not to estimate the quality of the lot. Thus, the unit's sampling and inspection cost are decreased for the manufacturing cost and to improve outputs of better quality goods.

The further research can be to selecting of an acceptance plan and their effects of the sampling and inspection cost levels with the other methods which are multiple and sequential plans in acceptance sampling methods.

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