PEMBANGUNAN PERISIAN BAGI REKABENTUK PLAN PERSAMPELAN AOQ/AOQL BAGI ATRIBUT UNTUK INDUSTRI PEMBUATAN

(SOFTWARE DEVELOPMENT FOR DESIGN OF AOQ/AOQL ATTRIBUTE SAMPLING PLAN FOR MANUFACTURING INDUSTRIES).

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ABSTRACT

Nowadays, quality control plays an important role in every manufacturing environment. As an effort to maintain the quality of the manufactured product many type of quality control has been implemented. One of them is the well-known acceptance-sampling plan, which can be classified into two categories, which is attributes and variables. There are many way on how to derive a sampling plan. One of them is through the usage of sampling plan table that is ready to be used. Even though it is a quite popular in deriving a sampling plan, sometimes it is quite difficult to administer. It is also a time consuming method and sometimes are not able to give the exact results. As an answer for the above problem, a study has been done on developing software for acceptance sampling plan. The main criterion of this project is to develop an attribute acceptance-sampling plan on a basis of AOQ and AOQL parameters. This project presentation is only about the Double Sampling plan. The first step in this project is to study the principles and the theories of acceptance sampling plan particularly Double Sampling plan. It is very essential to gain all the information and to determine all the necessary data used to develop a sampling plan. The final step is to learn all the basic rules of C programming language. After having a solid knowledge about C programming language, then it would be easier apply all the relevant equations and formulas into programming codes.

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NOTATION

c = Acceptance number.

d = Defective item.

n = Sample size.

N = Lot size.

P= Percent defective.

Pa = Probability of acceptance.

AOQ = Average Outgoing Quality.

AOQL = Average Outgoing Quality Limit.

LTPD= Lot Tolerance Percent Defective.

AQL= Acceptance Quality Level.

RQL= Rejectable Quality Limit.

ATI= Average Total Inspection

CHAPTER 1: PROJECT BACKGROUND

Here in this chapter, explanations will be given on the project background, which tells about acceptance sampling and its elements. There would also be an explanation about the objectives and scopes of this project. This is an important section of this project presentation as it gives the first insight of the whole project and for better understanding for what that will be discussed in the next chapter.

1.1 WORK SCOPE AND LIMITATION

This study is about the development of acceptance sampling software. Our main concern is just for the development purpose only. The analytical process of an acceptance sampling does not imply in this study.

A study has been done on acceptance sampling plan and especially on double sampling plan. The main purpose of this study is to get a basic idea on how to derive a sampling plan base on the relevant formulas and parameters of an acceptance-sampling plan. To develop this software, these formulas and parameters are converted into a C programming codes. This program were built base on the AOQ and AOQL parameters, which will then be presented into two cases.

In the first case, the sampling plan would be designed base on the value of the AOQL, acceptance number (c), and the lot size (N). These values are actually the values that are produced by the user. This software would give the output in term of the sample size and other parameters involved in developing a sampling plan.

In the second case, the sampling plan shall be design base on the AOQL, the acceptance, the lot size and also the percent defective. This software will then generate the value of the sample size (n), which varies from zero acceptance number until its maximum value. Here, this software is also capable in producing other parameters, such as the ATI and the LTPD.

LIMITATION

1. This software only concern on the Double Sampling Plan
2. This output of this software only gives a read only data.
3. To use this software, the user must first have at least a data of the sampling plan they wish to develop. However, the type of data depends on the selected cases presented by the software.

1.2 OBJECTIVE

The objective of this project is to study the principles and to develop software of an acceptance sampling on the basis of AOQ and AOQL parameters. This study of software development of AOQ/AOQL sampling plan for attribute is meant as a contribution to the manufacturing industries. By implementing a relevant information and data concerning acceptance sampling plan a program is to be develop by using the C programming language. The main objective of this project is to develop the most suitable sampling plan by using the developed software, which is a Double sampling plan. Other objectives of this project are as follows:

1. To learn the C programming language

2. To develop a program base on the relevant data and formula of acceptance sampling plan by using the C programming language.

3. To provide an alternative tools for developing a sampling plan.

4. To gain basic knowledge about Double sampling plan and its importance in Quality Control for manufacturing industries.

1.3 INTRODUCTION TO ACCEPTANCE SAMPLING

Acceptance sampling is an important filed of statistical quality control that was popularized by Dodge and Romig and originally applied by the U.S. Military to the testing of bullets during the World War II. If every bullet were tested in advanced, no bullets would be left to ship. If, on the other hand, none were tested, malfunctions might occur in the field of battle, with potentially disastrous results.

Dodge reasoned that a sample should be picked at random from the lot, and on the basis of information that was yielded by the sample; a decision should be made regarding the disposition of the lot. In general, the decision is either to accept or to reject the lot. This process is called *Lot Acceptance Sampling* or just *Acceptance Sampling*.

Acceptance sampling is a compromise between not doing any inspection at all and 100% inspection. The scheme by which representative sample will be selected from a population and tested to determine whether the lot is acceptable or not is known as an acceptance plan or sampling plan.

A 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. While most of any quality efforts should be put toward the proactive approach found in a continuous quality improvement program, acceptance sampling still plays a practical role. Acceptance sampling is most likely to be useful in the following situations:

1. When testing is destructive.
2. When the cost of 100% inspection is extremely high.
3. When 100% inspection is not technologically feasible.
4. Scheduling would be seriously impacted.
5. When there are many items to be inspected and inspection error rate is sufficiently high.
6. When vendor has an excellent quality history.
7. When there are potentially serious product liability risks.
8. Incoming inspection with a new supplier for which little is known about its capability or quality history
9. New processes where statistical control is trying to be achieved

10. Processes where the quality is relatively poor.
11. Processes that experience flare-ups or special causes.

Furthermore, sampling plans are designed to assure a desired outgoing quality of manufactured goods to customers. If the actual outgoing quality is much better than the desired, it may be termed good but it results in unnecessary rejects and more inspection. Thus, a plan should be able to send outgoing quality as desired, and at the same time meet other objectives.

1.3.1 ADVANTAGES AND DISADVANTAGES OF SAMPLING

When acceptance sampling is contrasted with 100% inspection, it has the following advantages:

1. It is usually less expensive because there is less inspection.
2. There is less handling of the product, hence reduced damage.
3. It is applicable to destructive testing.
4. Fewer personnel are involved in inspection activities.
5. It is often greatly reduces the amount of inspection error.
6. The rejection of entire lots as opposed to the sample return the defectives often provides a stronger motivation to the vendor for the quality improvements.

Acceptance sampling also has several disadvantages, however. These include the following:

1. The risks of accepting “bad” lots and rejecting “good” lots.
2. Less information is usually generated about the product or about the process that manufactured the product.
3. Acceptance sampling requires planning and documentation of the acceptance sampling procedure whereas 100% inspection does not.

1.3.2 SAMPLING RISKS

There are two types of errors that can be made whenever an accept/reject decision is based on a sample. First, we might decide to reject a good lot, that is, one that should be accepted. Such an error is called a type I error. On the other hand, we might decide to accept a bad lot, one that should be rejected. That type of error is called type II error.

The probability of making a type I error is called the producer's risk, while the probability of making a type II error is called the consumer's risk. These probabilities are designated α and β, respectively.

The terms producer's risk and consumer's risk result from situations where the producer of a product sells the product to a consumer. If a good lot is rejected, this theoretically results in extra costs for the producers. Consequently, the producer wants to make the producer's risk of any sampling plan as small as possible. On the other hand, the acceptance of a bad lot theoretically results in extra costs for the consumer. The consumer, therefore, wants to make the consumer's risk of any sampling plan as small as possible.

In practice, however, an error of either type can create higher costs for both producer and consumer alike, and some equitable balance between producer's and consumer's risk must be obtained. However, the most attractive feature of acceptance sampling is that it allows one to balance two risks: the risk to the producer and the risk to the consumer. It turns out that these two types of risks uniquely determine a plan, and a thorough understanding of these basic principles will help in understanding more complex plans. These risks need to be fully understood in order to appreciate acceptance-sampling methodology. The relationship between the two types of error is illustrated on Figure 1.1:

Decision about the lot Quality of lot

	GOOD	BAD
ACCEPT	Correct decision	Type II error Consumer's risk = β
REJECT	Type I error Producer's risk = α	Correct decision

Figure 1.1 Errors and risk in sampling

1.3.3 CLASSIFICATION OF ACCEPTANCE PLAN

There are two major classifications of acceptance plans: based on *attributes* ("go, no-go") and based on *variables*. In attributes sampling plans, the quality parameter of the lot is simply the proportion or fraction of defective product in the lot. This parameter is designated *p'* and is called the lot fraction defective. The decision about lot quality is in attributes plans are based upon the number of defectives in the sample. The maximum allowable number of the defectives in the sample is designated *c* and is called acceptance number.

In variables acceptance plans, lot quality is determined by the means or average value of some measurable characteristics of the articles in the lot. This lot or population mean is designated *X'* and the sample statistic is *X*. However, in this report only the attribute sampling plans would be discussed much further.

1.3.4 TYPES OF ACCEPTANCE SAMPLING PLAN

Acceptance sampling plan is a sampling scheme and a set of rules for making decisions. The decisions, based on counting the number of defectives in a sample, can be to accept the lot, reject the lot, or even, for multiple or sequential sampling schemes, to take another sample and then repeat the decision process.

Acceptance sampling plans fall into the following categories:

- <u>Single sampling plans</u>

  One sample of items is selected at random from a lot and the disposition of the lot is determined from the resulting information. These plans are usually denoted as (n, c) plans for sample size n, where the lot is rejected if there are more than c defectives. These are the most common (and easiest) plans to use although not the most efficient in terms of average number of samples needed. The process of selecting a single sampling is shown in Figure 1.2:

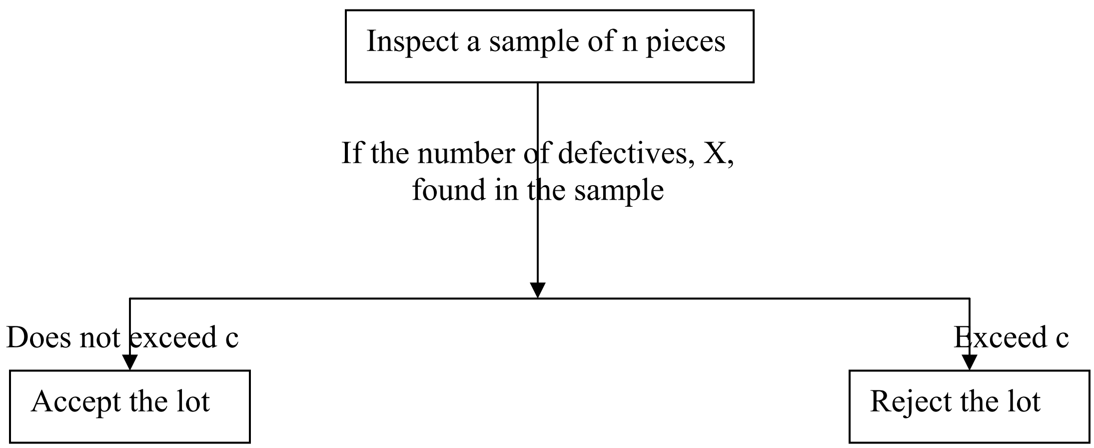

Figure 1.2 Single sampling

- <u>Double sampling plans</u>

  After the first sample is tested, there are three possibilities:

  1. Accept the lot
  2. Reject the lot
  3. No decision

  If the outcome is (3), and a second sample is taken, the procedure is to combine the results of both samples and make a final decision based on that information.

- Multiple sampling plans

  Multiple sampling plans are extensions of double sampling plans in the sense that an accept/reject decision need not be made after a single sample is taken. Multiple sampling plan are designed so that as many as seven samples may be taken before a final decision must be made. In other words, after the first six samples are taken, it is possible to decide to accept the lot, reject the lot, or taken another sample. The procedure for finding acceptance probabilities for multiple sampling plans is similar to that for double sampling plans, except that it is considerably more complicated.

- Sequential sampling plans

  This is the ultimate extension of multiple sampling plans where items are selected from a lot one at a time and after inspection of each item a decision is made to accept or reject the lot or select another unit.

- Skip lot sampling plans

  Skip lot sampling means that only a fraction of the submitted lots are inspected.

By comparing double sampling plan with single and multiple sampling plans, double-sampling plans has probably been the most popular, for reasons such as the following:
Double Sampling As Compared with Single Sampling

1. Psychologically, the idea of giving a lot of material a “second chance” before rejecting it has popular appeal. Double sampling is therefore sometimes easier to “sell” in the factory.

2. Double sampling plans permits a smaller first sample than is called for by the sample size of the corresponding single-sampling plan. When the percent nonconformance is either low or high in material submitted for inspection, it is frequently possible to accept or reject lots based upon the results of the first sample. In these instances, therefore, double sampling permits lower sampling costs.

Double Sampling As Compared with Multiple Sampling

1. Double-sampling plans are often easier to administer than multiple-sampling plans. The need for selecting successive samples in the proper fashion may require greater administrative control and more highly skilled inspection operators.
2. In theory, multiple sampling may often permit lower total inspection than double sampling for a given degree of protection because of the smaller sample sizes required. In practice, however, the greater complexity of multiple sampling may, in some cases, return the overall cost advantage to double sampling. This is particularly true when the percent nonconformance in submitted lots is low-say, 0.1 percent-in these cases, the amount of inspection required by single and double sampling plans based upon process averages is much the same for that for multiple sampling.

In spite of the popularity of double sampling, there are certain benefits unique to both single and multiple sampling. Here in this report, concentration will be made upon Double Sampling plans.

1.3.5 DOUBLE SAMPLING PLAN

The Double Sampling Plan consists of two sets of Acceptance Numbers, Rejection Numbers and Sample Sizes. It was invented to give a questionable lot another chance. For example, if in double sampling the results of the first sample are not conclusive with regard to accepting or rejecting, a second sample is taken. If the second sample is taken, the accept/reject decision is made after the second sample is combined with the first. The notation for a double sampling is as follows:

N = lot size, the number of articles in the lot

n_1 = the size of sample 1

n_2 = the size of sample 2

c_1 = the acceptance number for the first sample, the maximum number of defectives that allow an accept decision to be made after the first sample.

C_2 = the acceptance number for the two samples combined, the maximum number of defectives in the two samples combined that allows an accept decision to be made.

X_1 = the number of defectives in sample 1.

X_2 = the number of defectives in sample 2.

A double sampling plan operates as follows:

1. A sample of size n1 is drawn from the lot and X_1, the number of defectives is determined.
2. If $X_1 \leq c1$, the lot is accepted.
   If $X_1 \geq c2$, the lot is rejected.
   If $c1 < X_1 \leq c2$, sample number two is taken.
3. If sample number two is taken, the number of defectives in the second sample is added to the number of defectives in the first sample.
4. If $X_1 + X_2 \leq c2$, the lot is accepted
   If $X_1 + X_2 > c2$, the lot is rejected.

A double sampling plan's operation is shown in Figure 1.3:

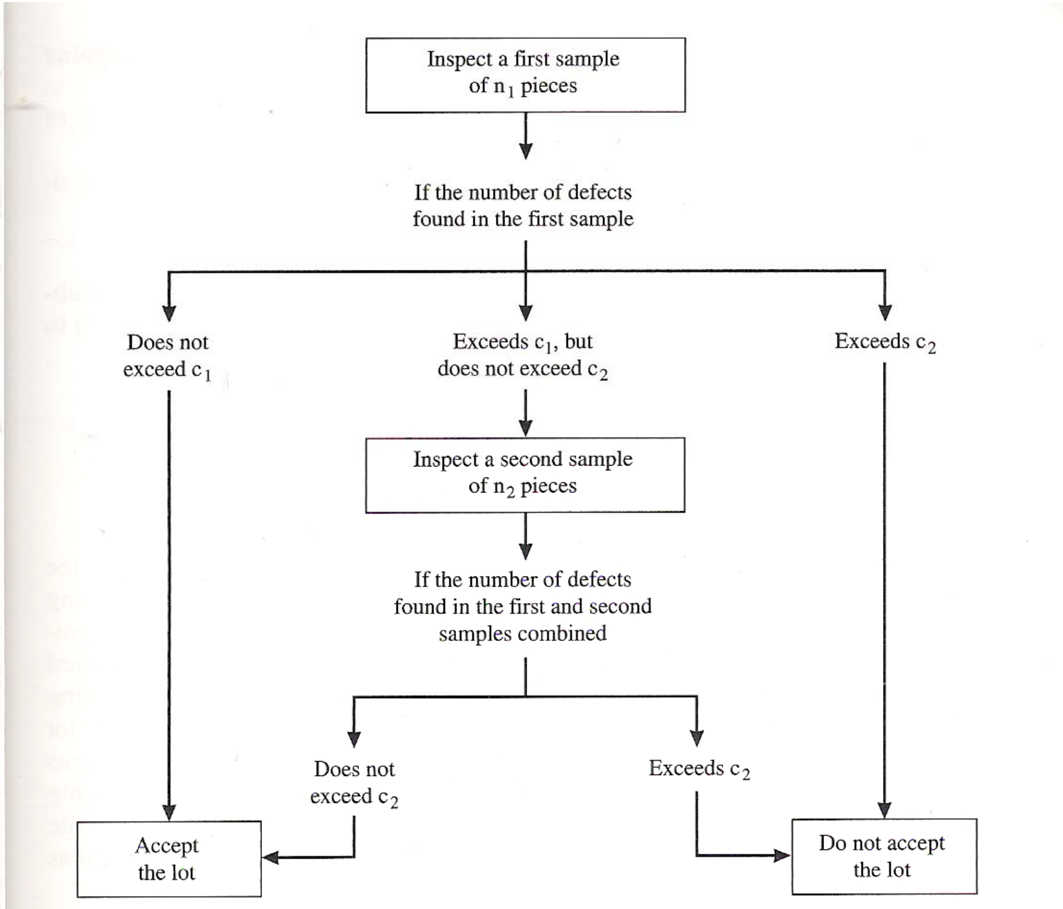

Figure 1.3 double sampling plan procedures.

1.3.6 THE OC CURVE

The term "operating characteristic curve" was probably first used by Col. H. H. Zornig of the Ballistic Research Laboratories at Aberdeen Proving Ground, Maryland, just before WWII. Its origins go back to the pioneering work I the Bell Telephone Laboratories in the 1920's, when the approach was termed "probability of acceptance curve".

An important measure of the performance of an acceptance-sampling plan is the operating-characteristics (OC) curve. OC curve displays the discriminatory power of the sampling plan that is shows the probability that a lot submitted with a certain fraction defective will be either accepted or rejected. OC curve is a graph showing what any particular sampling plan can be expected to do in terms of accepting and rejecting batches. The OC curve can be used for finding the probability that a lot of certain fraction defective (p) will be accepted or rejected.

The OC curve is determined by finding the acceptance probabilities under the plan for various values of the quality parameter p' (lot fraction defective) and plotting these values on a graph, the probability of the acceptance value is calculated from the basic of probability distribution. An OC curve is shown in figure 1.4:

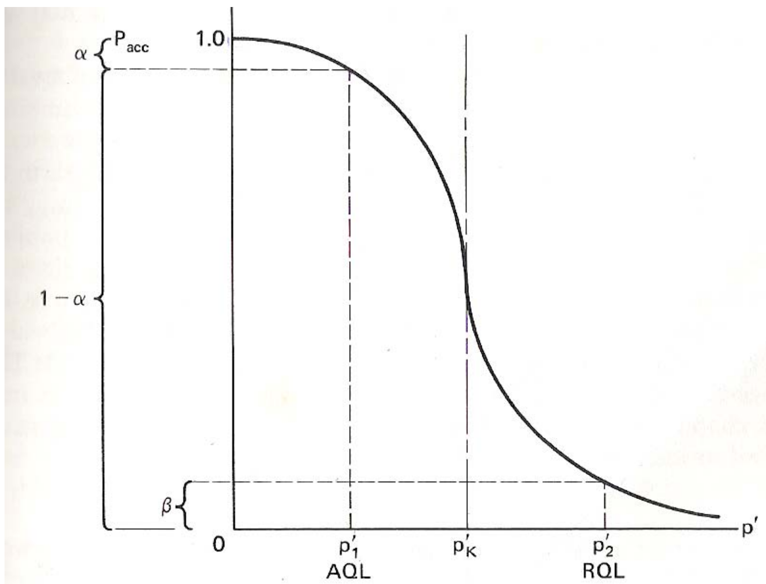

Figure 1.4 The OC curve

The vertical axis of the graph represent the probability of acceptance and is scaled from 0 – 1. The horizontal axis represents the value of the quality parameter. As long as the shape of the curve does not change the curve can be exactly defined by two points on the curve. These two points are normally chosen at (alpha) and (beta)

The sample size and the acceptance number are the most important factors in affecting the OC curve. When the sample size is increased and the acceptance number decreased, the curve become steeper and provides better protection for consumers and producer. Increasing in sample size will increase production cost so an appropriate sample size is required, that's why designing a sampling plan in term of determining the sample size is important.

The performance of a double sampling plan can be conveniently summarized by means of its operating-characteristics (OC) curve. The OC curve for double sampling is somewhat more involved than the OC curve for single sampling.

1.3.7 ACCETABLE QUALITY LIMIT (AQL)

The AQL of a sampling plan is a level of quality routinely accepted by the sampling plan. It is generally defined as the percent defective (defectives per hundred units X 100%) that the sampling plan will accept 95% of the time. This means lots at or better than the AQL are accepted at least 95% of the time and rejected at most 5% of the time.

The AQL can be determined using the OC curve by finding that quality level on the bottom axis that corresponds to a probability of acceptance of a.0.95 (95%) on the left axis.

Associated with the AQL is a confidence statement one can make. If the lot passes the sampling plan, one can state with 95% confidence that the quality level of the lot is equal to or better than the AQL. On the other hand, if the lot fails the sampling plan, one can state with 95% confidence that the quality level of the lot is worse than the AQL. The AQL is used to help describe the protection provided by a sampling plan that is what the sampling plan will accept.

1.3.8 LOT TOLERANCE PERCENT DEFECTIVE (LTPD)

The LTPD of the sampling plan describes what the sampling plan will reject. The LTPD of a sampling plan is the level of quality routinely rejected by the sampling plan. It is generally defined as the percent defective (number of defectives per hundred units X 100%) that the sampling plan will reject 90% of the time. In other words, this is also the percent defective that will be accepted by the sampling plan at most 10% of the time. This means that lots at or worse than the LTPD are rejected at least 90% of the time and accepted at most 10% of the time.

The LTPD can be determined using the OC curve by finding that quality level on the bottom axis that corresponds to a probability of acceptance of 0.10 (10%) on the left axis.

Associated with the LTPD is a confidence statement one can make. If the lot fails the sampling plan, one can state with 90% confidence that the quality level of the lot is worse than the LTPD (i.e., the defective rate of the lot > LTPD). On the other hand, if a lot passes the sampling plan, then one can state with 90% confidence that its quality level is equal to or better than the LTPD. LTPD can also be known as RQL.

1.3.9 AVERAGE OUTGOING QUALITY LEVEL (AOQL)

The average outgoing quality limit (AOQL) is the maximum average outgoing quality (AOQ) for a given acceptance sampling plan for all levels of lot quality given that non-conforming lots are subjected to 100% inspection with replacement of non-conforming units with confirming units.

AOQL is a measure of the effectiveness of an acceptance-sampling plan. It is the amount by which it improves the quality of the lots submitted for inspection. Sampling plan will be more effective in improving the quality of poor lots than it will improve the quality lots that already it high quality level.

Widely used for evaluation of rectifying sampling plan. The average outgoing quality is the quality in the lot that results from the application of rectifying inspection.

AOQL is an average value of the lot quality that would be obtained over a long sequence of lots from a process with fraction defective p'. AOQ will vary as the fraction defective of the incoming lot varies. The curve that plots the average outgoing quality against incoming lot quality is called AOQ curve as shown in figure 1.5:

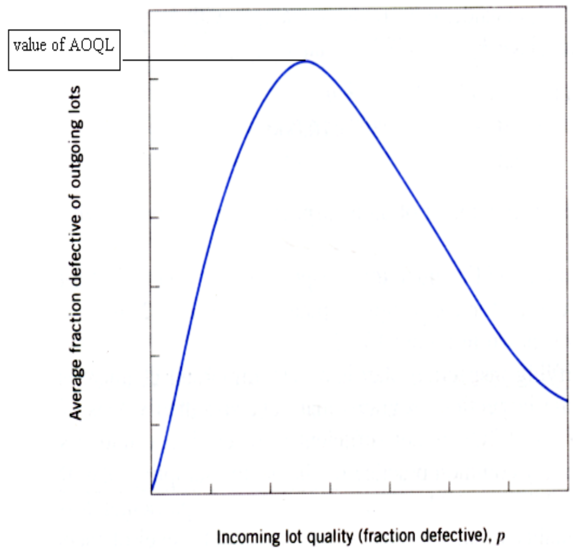

Figure 1.5 The AOQ curve with AOQL

From AOQ curve, as the incoming lot quality is good the value of the average outgoing quality is also very good and when the incoming lot quality is bad also leads to a very good level of quality in the outgoing lots. From the AOQ curve we can find AOQL. AOQL can be represented by the max point of AOQ in the curve as shown in figure 1.5 That is no matter how bad the fraction defective in the coming lots the outgoing lots will never have a worse quality level than the value of AOQL. The AOQ curve and AOQL assume rejected lots are 100% inspected, and is only applicable to this situation. They also assume the inspection is reasonably effective at removing defectives or defects (90% effective or more).

In this project the value of AOQL plays the important rules because the purposed of this project is to design a sampling plan that has specified value of AOQL. There are already a few standard sampling plan been developed using AOQL as the parameter.

1.4 C PROGRAMMING LANGUAGE

For developing this software, the C Programming languages were used. The C programming Language is a widely used programming language. It is available in almost every computer. C is actually a hardware independent, which makes it portable in most computers.

There are actually a few steps that are involved in constructing the program by using C. The first phase consists of editing a file. This is accomplished with an editor program. Here the users are assumed to know how to edit a program. The programmer types a C program with the editor and makes corrections if necessary, then storing the program on a secondary storage device such as on a disk. Next, the programmer gives the command to compile the program. The compiler translates the C program into machine language code (also referred to as *object code*). The next phase is called linking. A linker links the object code with the code for the missing functions to produce an executable image (with no missing pieces). The next phase is called loading. This is done by a loader, which, takes the executable image from disk and transfer it to memory. Finally the computer will then execute the program one instruction at a time. However, not all programs works on the first try. Here, editing the program codes are needed before executing it once again. Included in the next page is the chart on how the C programming language works.

A typical C environment.

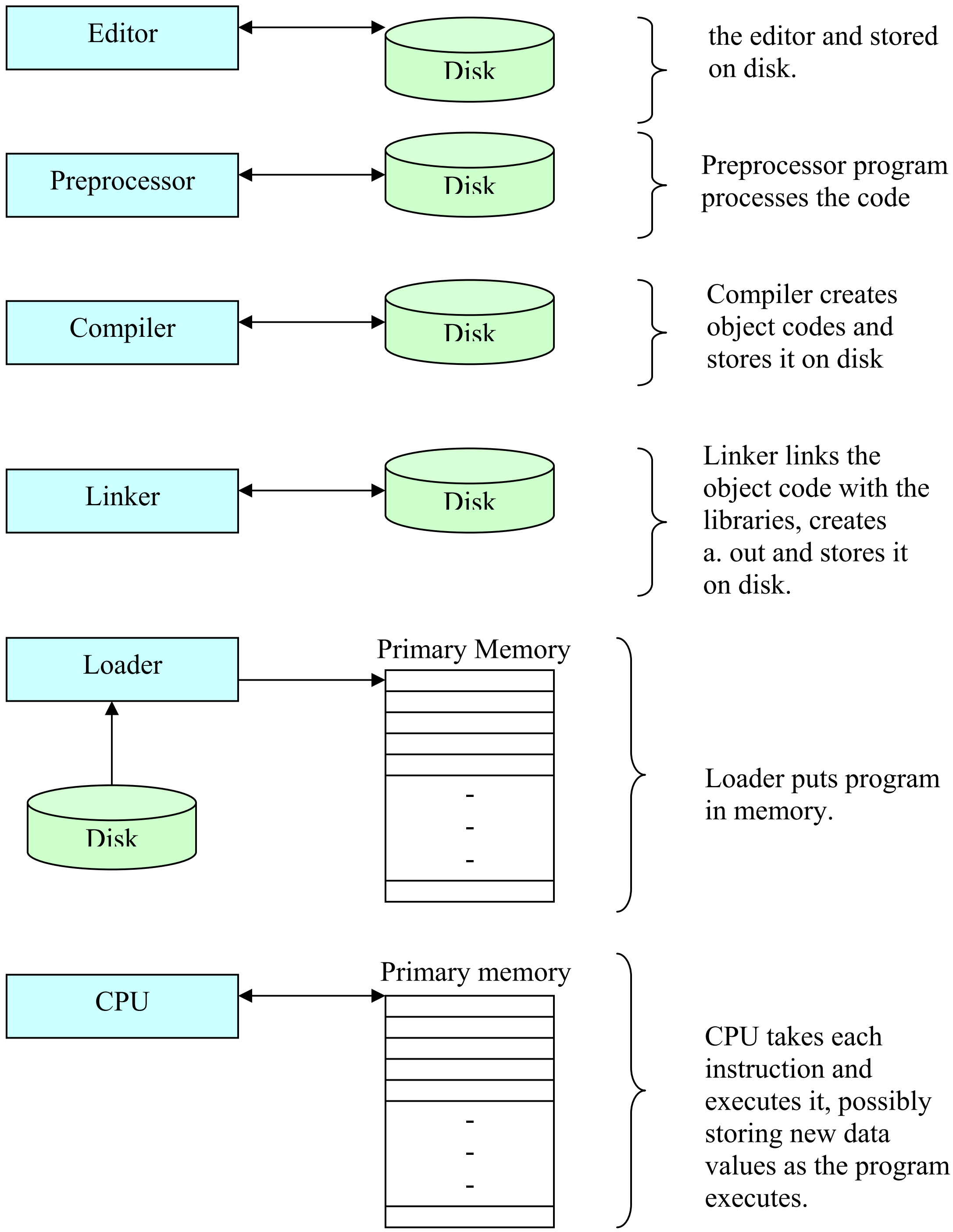

Figure 1.6 A typical C environment

CHAPTER 2 LITERATURE REVIEW

2.1 INTRODUCTION

Quality can be defined in many ways, ranging from "satisfying customers' requirements" to "fitness for use" to "conformance to requirements." It is obvious that any definition of quality should include customers, satisfying whom must be the primary goal of any business. Statistical quality control provides the statistical techniques necessary to assure and improve the quality of products. Most of the statistical quality control techniques used now has been developed during the last century. One of the most commonly used statistical tools, is acceptance-sampling technique that was developed by Dr. H. F. Dodge and H. G. Romig in 1928, at Bell Laboratories. Acceptance sampling is a process of statistical decision making about quality, i.e., conformance or nonconformance to standards, of a lot or population of manufactured articles. In acceptance sampling, this decision is based upon information obtained from a random sample of articles drawn from the lot (Braverman, 1981). A double sampling plan is a procedure in which, under certain circumstances, a second sample is required before the lot can be sentenced (Montgomery, 1991). In selecting a plan, it all depends on the purpose, the quality history, and the extent of knowledge of the process the steps involved in the selection and application of a sampling procedure are shown in the figure 2.1. On designing a sampling plan, many industries are more prefer to use one of the available published sampling tables. Of the many statistical sampling tables and plans that have been developed many have been published in a form, which makes them available for general use. Some of the most popular of these published plans are:

1. Dodge-Romig tables
2. Military Standard 105D; ANSI/ASQC Z1.4; ISO 2859-all essentially similar
3. Sequential plans
4. Continuous sampling plans

5. Chain sampling and skip-lot plans

6. Columbia sampling plans

(Feigenbaum, 1991)

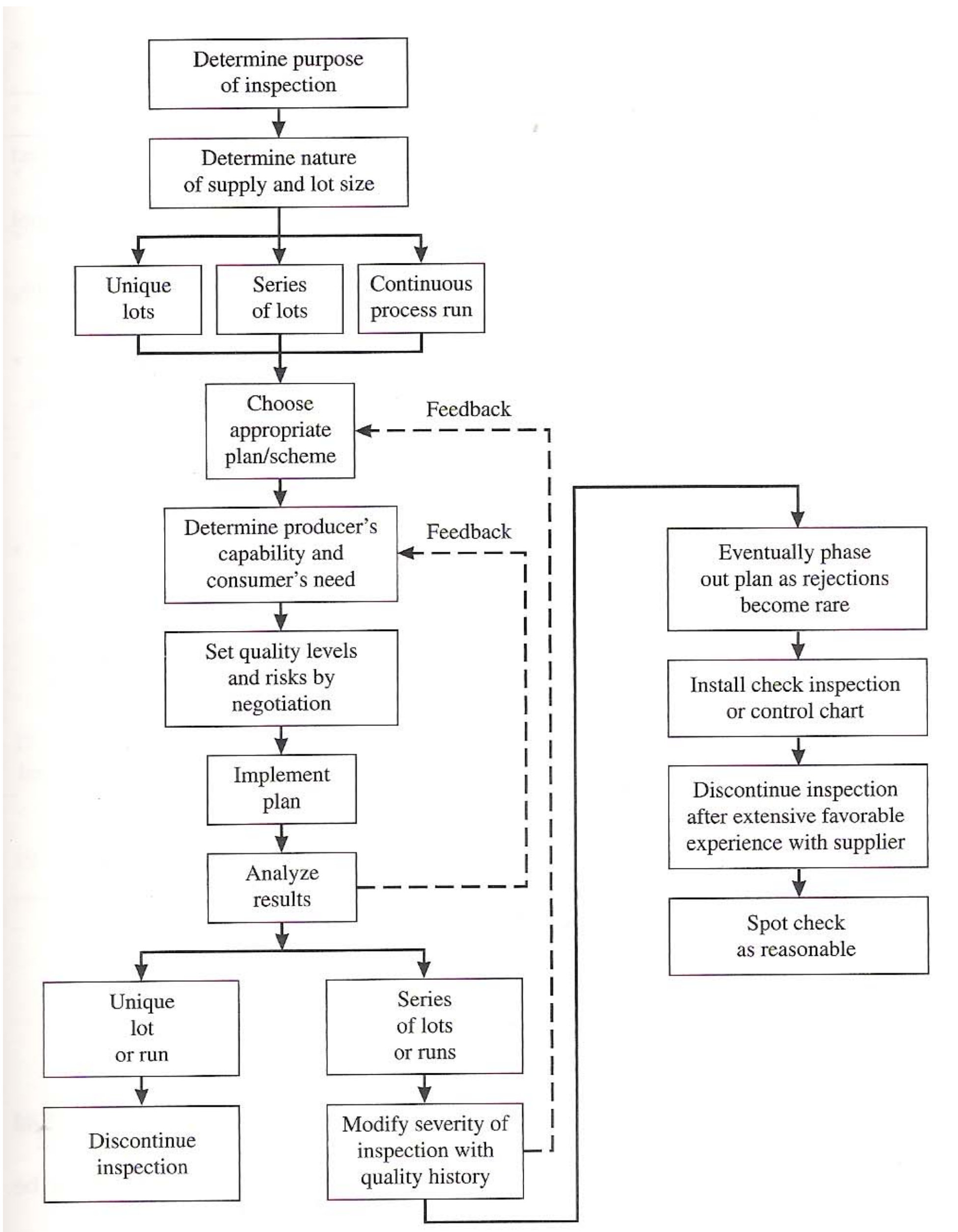

Figure 2.1 Check for implementation of sampling procedures. (Schilling, 1982)

2.2 DODGE-ROMIG SAMPLING TABLES

Dodge and Romig (1959) provides four sets of attributes plans emphasizing either lot-by-lot quality (LTPD) or long run quality (AOQL);

Lot tolerance percentage defective (LTPD):	Single sampling
	Double sampling
Average outgoing quality limit (AOQL):	Single sampling
	Double sampling

These plans differ from those in ANSI/ASQCZ1.4 in that Dodge-Romig plans assume that all rejected lots are 100% inspected and the defectives replaced with acceptable items. Plans with this feature are called rectifying inspection plans. The tables provide protection against poor quality on either lot-by-lot basis or average long run quality. The LTPD plans assure that a lot having poor quality will have a low probability of acceptance, i.e., the probability of acceptance (or consumer's risk) is 0.1 for a lot with LTPD quality. The LTPD values range from 0.5 to 10.0 percent defective. The AOQL plans assure that, after all sampling and 100 percent of rejected lots, the average quality over many lots will not exceed the AOQL. The AOQL values range from 0.1 to 10.0 percent. Each LTPD plan lists the corresponding AOQL, and each plan lists the LTPD. (Gryna)

The Dodge-Romig double sampling plan table for AOQL=4.0% are shown in the Appendix section (A1)

2.3 MILITARY STANDARD 105E (ISO 2859, ANSI/ASQC Z1.4)

The original version of the standard (MIL STD 105A) was issued in 1950. The last revision (MIL STD 105E) was issued in 1989, but canceled in 1991. The standard was adopted by the International Standards Organization as ISO 2859.

The tables give inspection plans for sampling by attributes for a given batch size and acceptable quality level (AQL). An inspection plan includes: the sample size/s (n), the acceptance number/s (c), and the rejection number/s (r). The single sampling procedure with these parameters is as follows: Draw a random sample of n items from the batch. Count the number of nonconforming items within the sample (or the number of nonconformities, if more than one nonconformity is possible on a single item). If the number of nonconforming items is c or less, accept the entire batch. If it is r or more then reject it. Inmost cases, r=c+1 (for double and multiple plans, there are several values for the sample sizes, acceptance, and rejection numbers).

The standard includes three types of inspection (normal, tightened, and reduced inspection). The type of inspection that should be applied depends on the quality of the last batches inspected. At the beginning of inspection, normal inspection is used. The types of inspection differ as follows:

- Tightened inspection (for a history of low quality) requires a larger sample size than in under normal inspection.
- Reduced sampling (for a history of high quality) has a higher acceptance number relative to normal inspection (so it is easier to accept the batch)

A plan is chosen from the tables as follows:

1. The following information must be known:
   - AQL
   - Lot size
   - Type of sampling (single, double, or multiple)

- Inspection level

2. Knowing the lot size and inspection level, a code letter is obtained from the appendix (A2) The table for Sampling plan for sample-size code letter K are shown in (A3)
3. Knowing the code latter, AQL, and the type of sampling, the sampling plan is read from tables, which were shown in (A5) until (A7).

There are special switching rules between the three types of inspection, as well as a rule for discontinuation of inspection. These rules are empirically based. (Shmueli, 2001)

2.4 SEQUENTIAL PLANS

These plans have to do with sampling inspection in which, after each unit is inspected, the decision is made to accept the lot, not to accept the lot, or to inspect another unit. These plans involve individual unit and thus differ from multiple sampling in AQL-type plans, which involve sampling of groups of units.

The tables also differ in at least two ways from the type of single and double sampling plans:

- Since sample sizes are smaller, sample results are analyzed, much more frequently
- The plans are ‘double-acting”.

With sequential plan, if an inspector finds a single nonconforming unit in a sample size of 40, the inspector can neither accept nor reject the lot but must select another sample. The inspector is operating in the band of indecision. This procedure can be carried on until the maximum sample size-160- is reached. At this point the band of indecision disappears and acceptance or rejection of the material can be finally decided. Appendix (A8) illustrates one form of a sequential sampling table.
(Feigenbaum, 1991)

2.5 CONTINUOUS SAMPLING

This plans are designed for application to a continuous flow of individual units of product that:

a. Involve acceptance or non-acceptance on a unit-by-unit basis.
b. Uses alternative periods of 100% inspection and sampling, depending upon the quality of the observed product.

The variety of generally available continuous sampling are designated as CSP-1, CSP-2, CSP-3, CSP-A, CSP-M, CSP-T, CSP-F, CSP-V, and CSP-R. These several approaches to continuous sampling have become characteristics of the wide variety of plans available for use in inspection under these conditions.
(Feigenbaum, 1991)

2.6 CHAIN SAMPLING AND SKIP LOT PLANS

A. Chain sampling has to do with sampling inspection in which the criteria for acceptance and non-acceptance of the lot partly depend upon the results of the inspection of immediately preceding lots. These plans designated ChSp-1, ChSp-C_1, C_2, and others, are oriented to the situation where the sampling acceptance number (c) is o. In the more usual lot-by-lot sampling, where small samples are involved, there can be rather undiscriminating OC curve which can make it difficult to pass even high-quality lots.

Chain sampling was develop by Harold Hodge to provide greater probability of acceptance of lots of relatively high-quality lots.

B. Skip-lot sampling has to do with a plan in which some lots in a series are accepted without inspection (other than possible spot checks) when the sampling results for a stated number of immediately preceding lots meets stated criteria. This represents an application of CSP-1 to lots rather than to individual units. It is an approach for eliminating inspection altogether on