Drought Prevention and Mitigation, AZ

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Introduction

A drought is an event of prolonged shortages in the water supply. It can have a substantial impact on the ecosystem and agriculture of the affected region and harm to the local economy.

Cost of Poor Quality (COPQ)

Process	Internal Failure	External Failure	Appraisal	Prevention
Before the drought	Sporadic or periodic precipitation reduction. High temperature and little rain.	Population increase. Forest vegetation destroyed by humans.	Disaster assessment system	Protect environment, reduce greenhouse gas emissions
Weather modification council	Shortage of funds. Not authorized by government.	Devices broken. Weather reason.	Expert advice.	Periodic equipment inspection.
Bureau of reclamation	Shortage of materials. No building plan.	Earthquake, No suitable terrain	Engineering inspection	Geological exploration, giving reasonable plan to make government authorize.
Forest Service	Lack of labor and funding.	Forest fire, unsuitable tree species, hurricane and tornado destruction. Pest.	Plant growth rate and forest density.	Choose the right geolocation. Deworming.

Six Sigma

Six Sigma Approach is a set of administrative, statistical concepts and techniques for process improvement

Six Sigma seeks to improve the quality of process outputs

Six Sigma focus on minimizing variability in processes and eliminating the cause of defects

Phases of Six Sigma

- Define
- Measure
- Analyze
- Improve
- Control

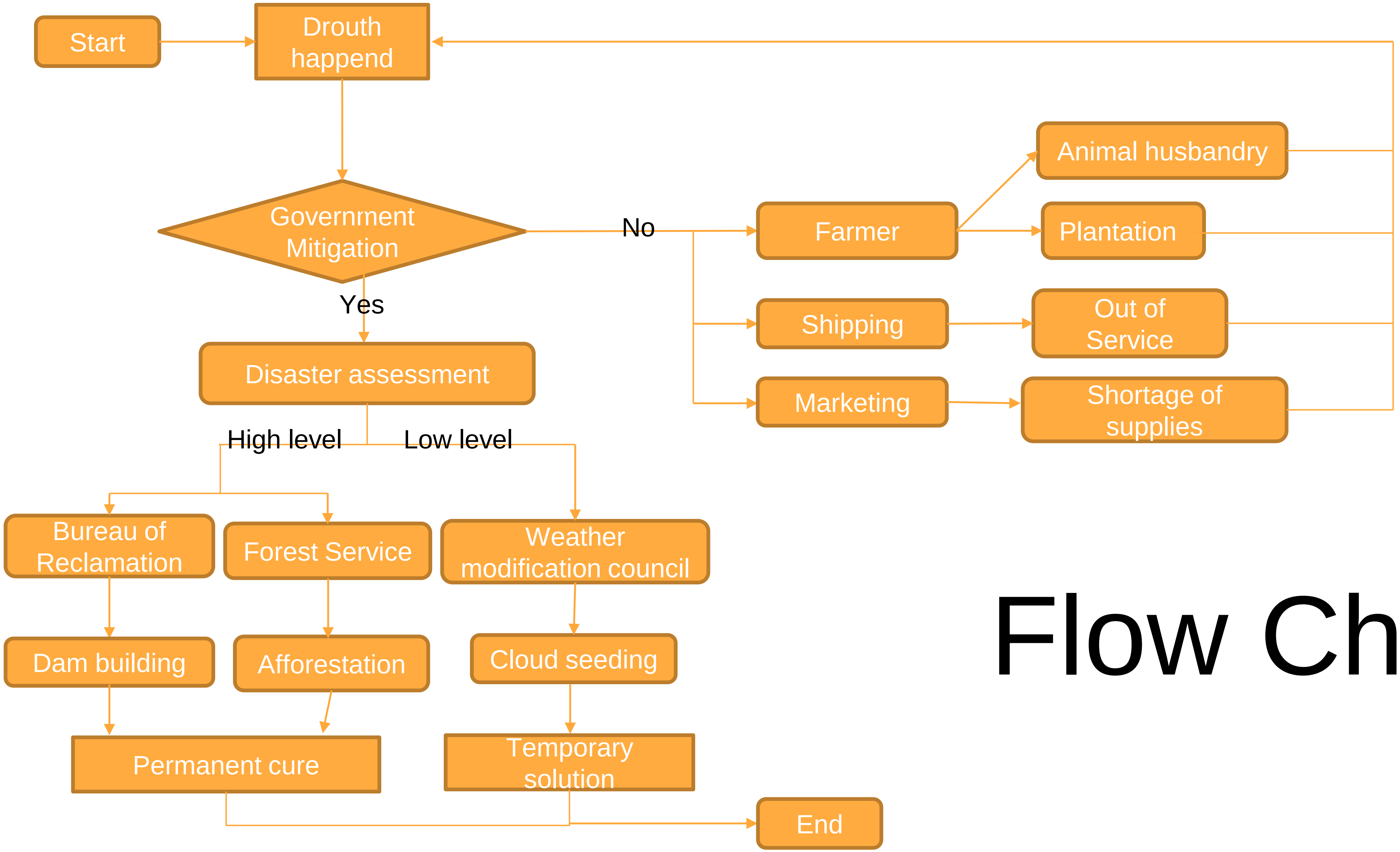
Define

The government mitigation will face the following challenge:

- Lack of labor for large projects such as dam building and afforestation
- Lack of funds to start project
- A big number of refuges come into city
- Inadequate amount of food

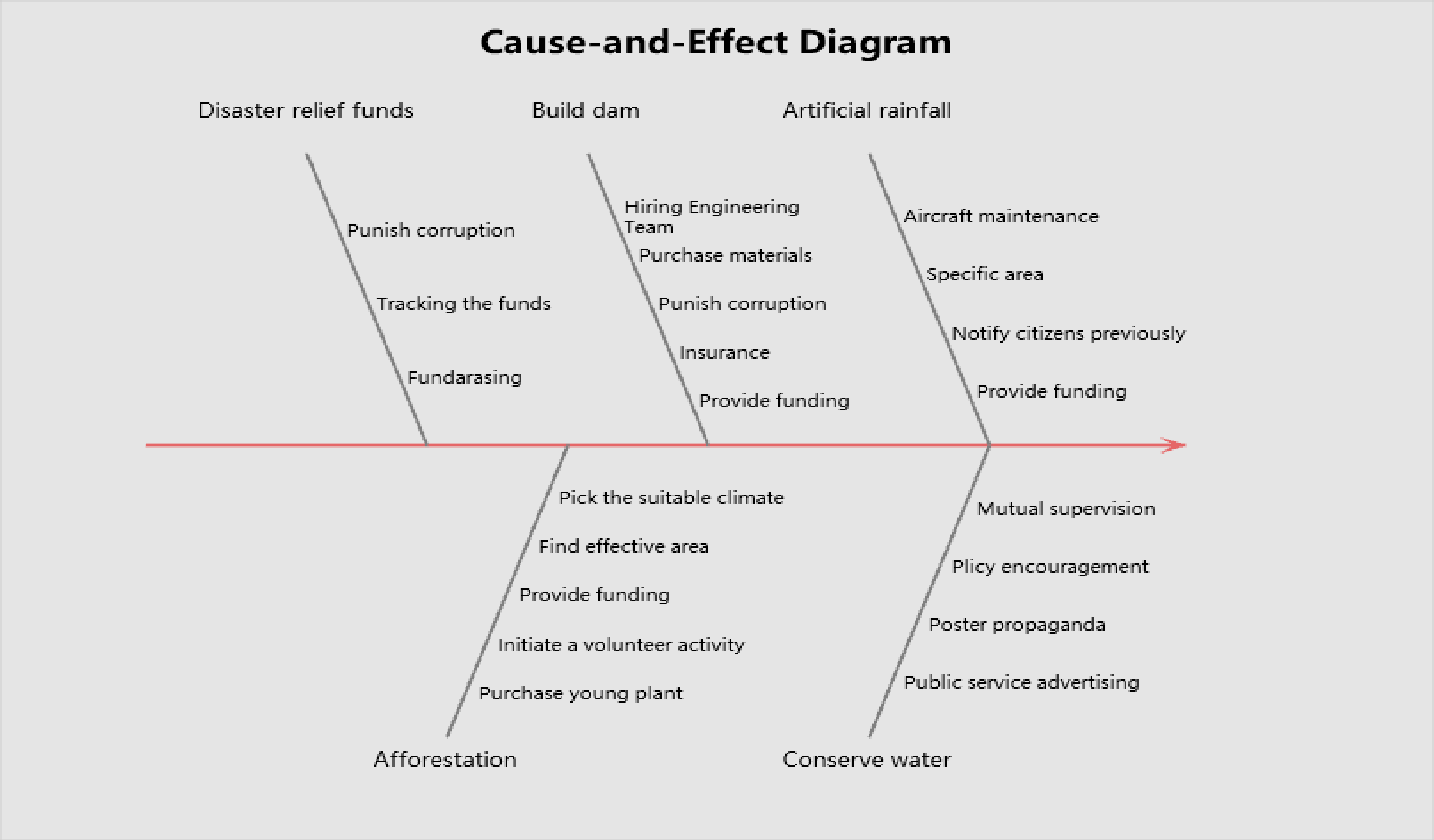
Measure

- Verify the project need
- Document the process
- Plan for data collection
- Validate the measurement system
- Measure the baseline performance
- Measure the process capability


Start
Drouth happend
Government Mitigation
No
Yes
Farmer
Animal husbandry
Plantation
Shipping
Out of Service
Marketing
Shortage of supplies
Disaster assessment
High level
Low level
Bureau of Reclamation
Forest Service
Weather modification council
Dam building
Afforestation
Cloud seeding
Permanent cure
Temporary solution
End

Flow Chart

Measure

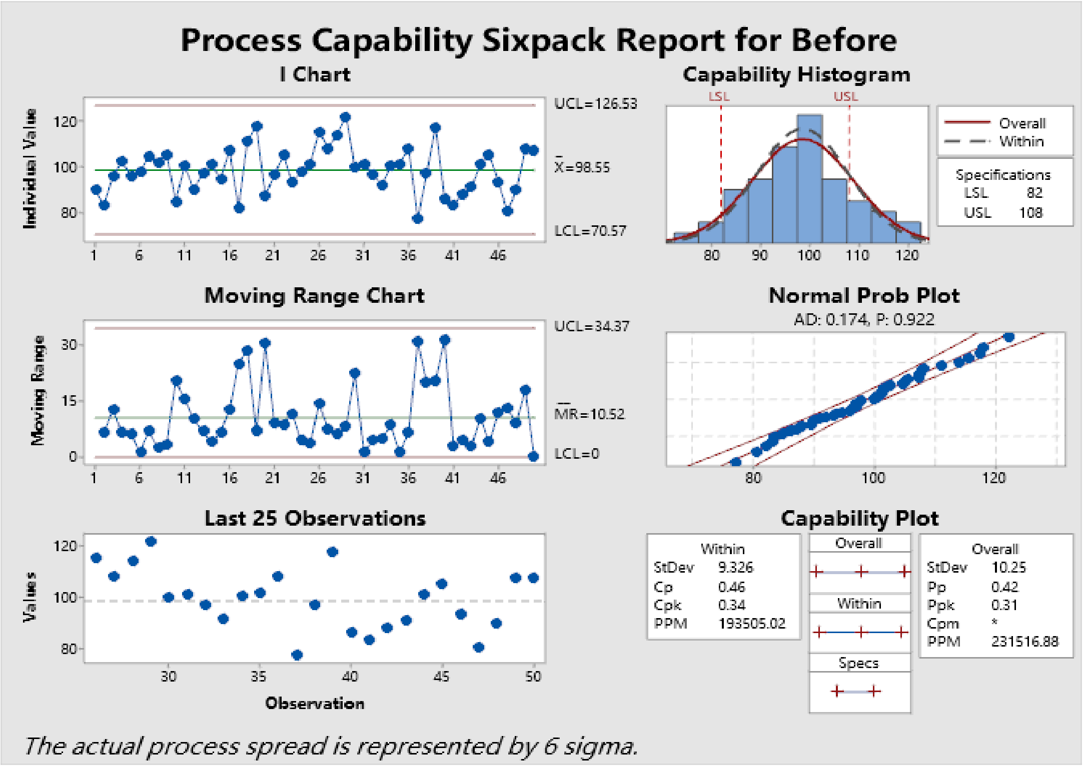


Cause-and-Effect Diagram
Disaster relief funds
Build dam
Artificial rainfall
Punish corruption
Tracking the funds
Fundarasing
Hiring Engineering Team
Purchase materials
Punish corruption
Insurance
Provide funding
Aircraft maintenance
Specific area
Notify citizens previously
Provide funding
Pick the suitable climate
Find effective area
Provide funding
Initiate a volunteer activity
Purchase young plant
Mutual supervision
Plicy encouragement
Poster propaganda
Public service advertising
Afforestation
Conserve water

Analyze

In this phase we begin to analyze the problem through statistical methods. The families of variation would be reviewed and the conclusion about which are the significant contributors to the final output.

Process Capability Sixpack Report for Before



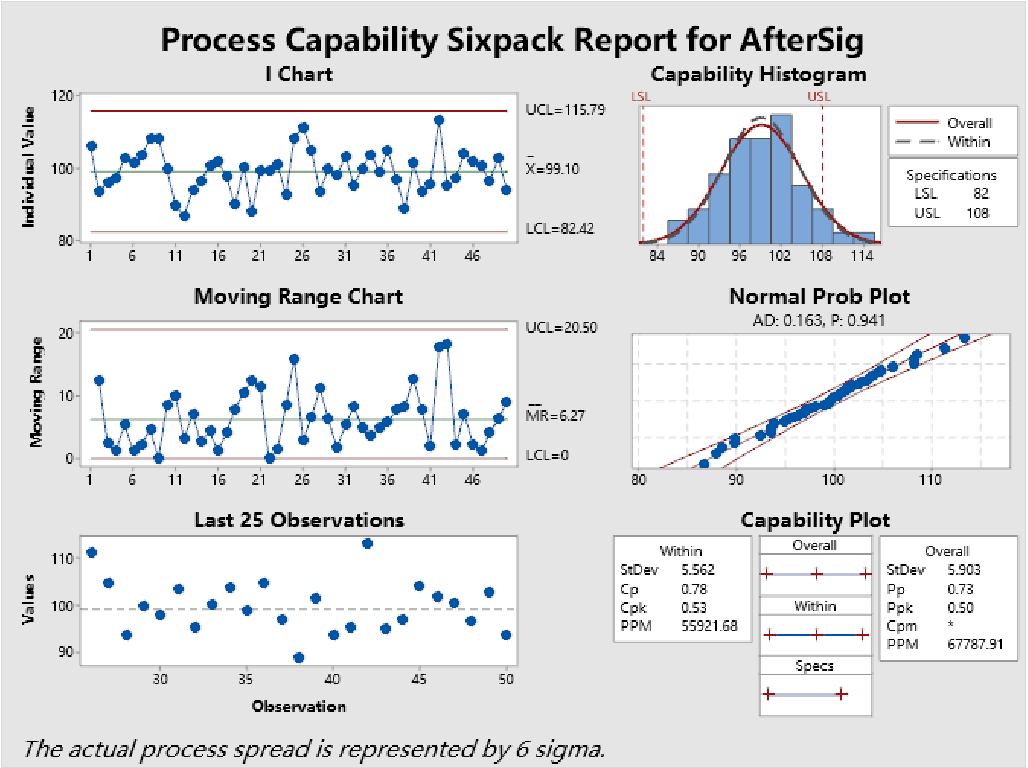
Improve

This phase designs a remedy, proves its effectiveness, and prepares an implementation plan.

1. Evaluate alternative remedies.
2. If necessary, design formal experiments to optimize process performance.
3. Design a remedy.
4. Prove the effectiveness of the remedy.
5. Deal with resistance to change.
6. Transfer the remedy.

Improve

Process Capability Sixpack Report for AfterSig



The capability analysis and capability sixpack after improvement, and we can see that Cp value is higher than the previous process capability.

Control

In this phase, we design and implement certain activities to hold the gains of improvement.

- Design controls and document the improved process.
- Validate the measurement system.
- Determine the final process capability.
- Implement and monitor the process controls

Acceptance Sampling Need:

- We are ready to donate 1000 pieces of supplies to the disaster area. Through the calculation of minitab and excel, we figured out that 80 out of the 1000 pieces of supplies need to be randomly checked for quality inspection n =80 (number of supplies in the random sample taken from the lot).
- Among the 80 items, we need to check whether more than 7 items are not qualified. c = 7 (Acceptance Number).
- If the number of defective items in the random sample of ‘n’ is more than ‘c’, then the lot is rejected.
- Therefore, we chose oc plan to conduct this quality inspection.

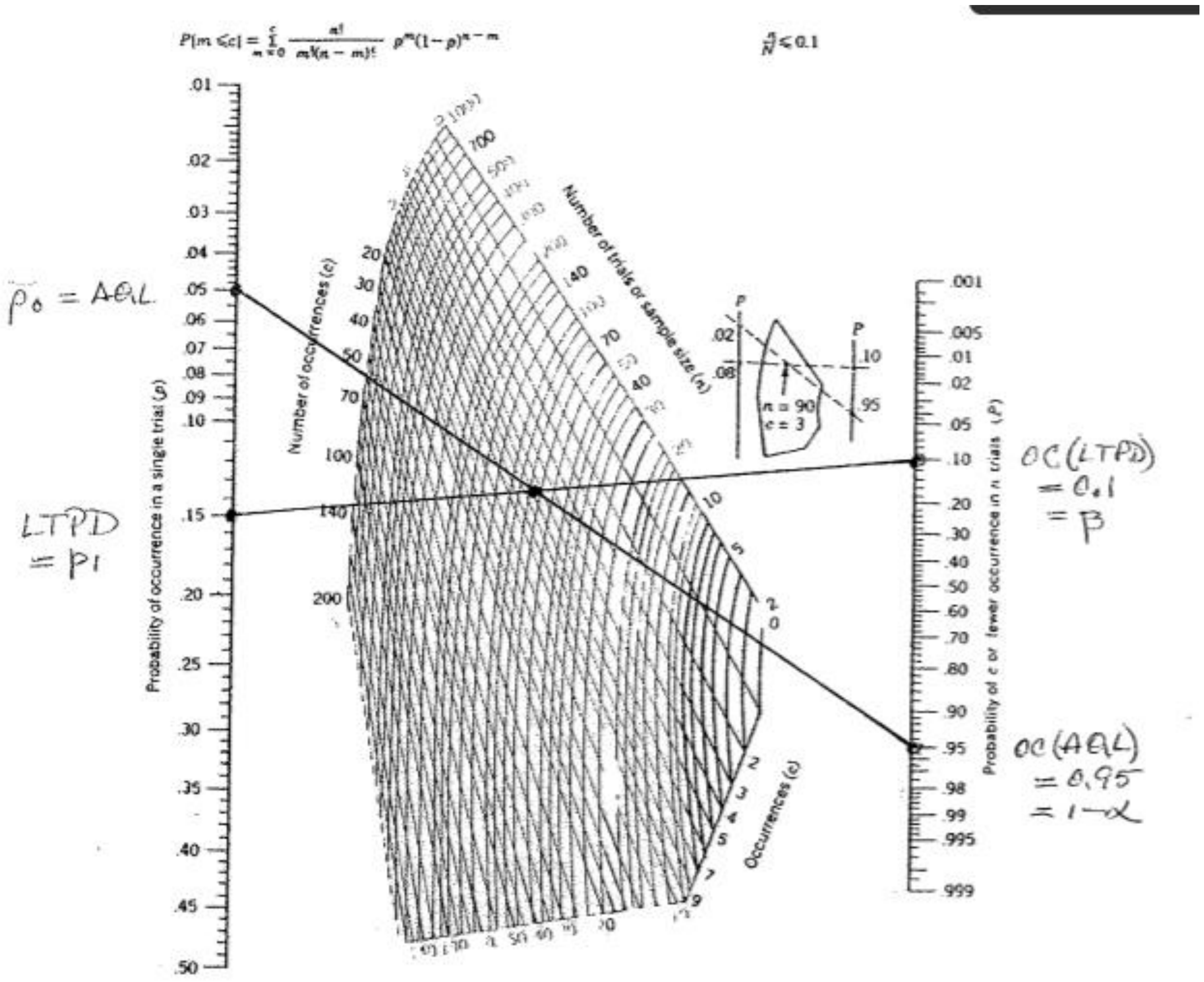
Introduction Operating Characteristic Function

The Operating Characteristic Function (also known as OC Function) is one of the most useful tools in practical statistical applications. The objective of this project is to enhance the links between OC Function theory and its practice, by providing an overview of the theoretical background and numerical examples and practical applications.

Though the study of OC, we will hopefully gain an increased awareness of the OC's great potential as a statistical tool, a better understanding of the theory, and be better able to use the OC Function.

α probability (also called producer’s risk): the probability of deciding that the alternative hypothesis (H1) is true, when in fact the null (H0) is true (e.g., risk of rejecting the batch as defective, when it is spec-compliant);
β probability (also called the consumer’s risk): the probability of deciding that the null hypothesis (H0) is true, when the alternative (H1) is true (e.g., the risk of accepting a defective product).
Acceptable Quality Level (AQL): a percent defective that is the base line requirement for the quality of the producer’s product.
Lot Tolerance Percent Defective (LTPD): a pre-specified high defect level that would be unacceptable to the consumer.
Lot Size (N) - Total Number of refugges.

Sampling Plan Parameters	
Lot Size (N)	80
AQL	0.05
LTPD	0.15
α	0.05
β	0.1



Important Parameters:
Lot Size: 1000
AQL: 0.05
LTPD: 0.15
Alpha: 0.05
Beta: 0.1
n: 80
c: 7

Use the Nomograph with the parameters given, to obtain a Starting Point.

Calculation

In order to improve the experimental results, we should compare the results from excel with minitab.

The data below is what we need to calculate

Probability of Acceptance (Pa);

Average Outgoing Quality (AOQ);

Average Total Inspection (ATI);

Then we should draw these curves using excel and minitab.

Experiment data

The right figure shows all data from excel.

n and c are given, then we can get PD and Pa.

AOQ and ATI are calculated.

We will show how we get them and draw

curves in the next.

1	OC Function Example			(See sheets 1 and 2)		
2						
3	n	80	c	7		
4						
5	PD	Pa		AOQ		ATI
6	0	1.00000		0	0	80
7	0.01	1.00000		0.0092	0.01	80.00141
8	0.02	0.99979		0.018396	0.02	80.18976
9	0.03	0.99721		0.027523	0.03	82.56663
10	0.04	0.98526		0.036258	0.04	93.55681
11	0.05	0.95341		0.043857	0.05	122.8642
12	0.06	0.89325		0.049307	0.06	178.2125
13	0.07	0.80357		0.05175	0.07	260.7179
14	0.08	0.69111		0.050866	0.08	364.1744
15	0.09	0.56761		0.046998	0.09	477.7953
16	0.1	0.44556		0.040991	0.1	590.0881
17	0.11	0.33492		0.033893	0.11	691.8777
18	0.12	0.24165		0.026678	0.12	777.6845
19	0.13	0.16777		0.020065	0.13	845.6525
20	0.14	0.11234		0.01447	0.14	896.6434
21	0.15	0.07272		0.010035	0.15	933.0999
22	0.16	0.04558		0.00671	0.16	958.0618
23	0.17	0.02772		0.004336	0.17	974.4946
24	0.18	0.01638		0.002713	0.18	984.929
25	0.19	0.00942		0.001646	0.19	991.3363
26	0.2	0.00527		0.00097	0.2	995.1493
27	0.21	0.00288		0.000556	0.21	997.3524
28	0.22	0.00153		0.00031	0.22	998.59
29	0.23	0.00080		0.000169	0.23	999.2669
30	0.24	0.00040		8.94E-05	0.24	999.6276
31	0.25	0.00020		4.62E-05	0.25	999.8152

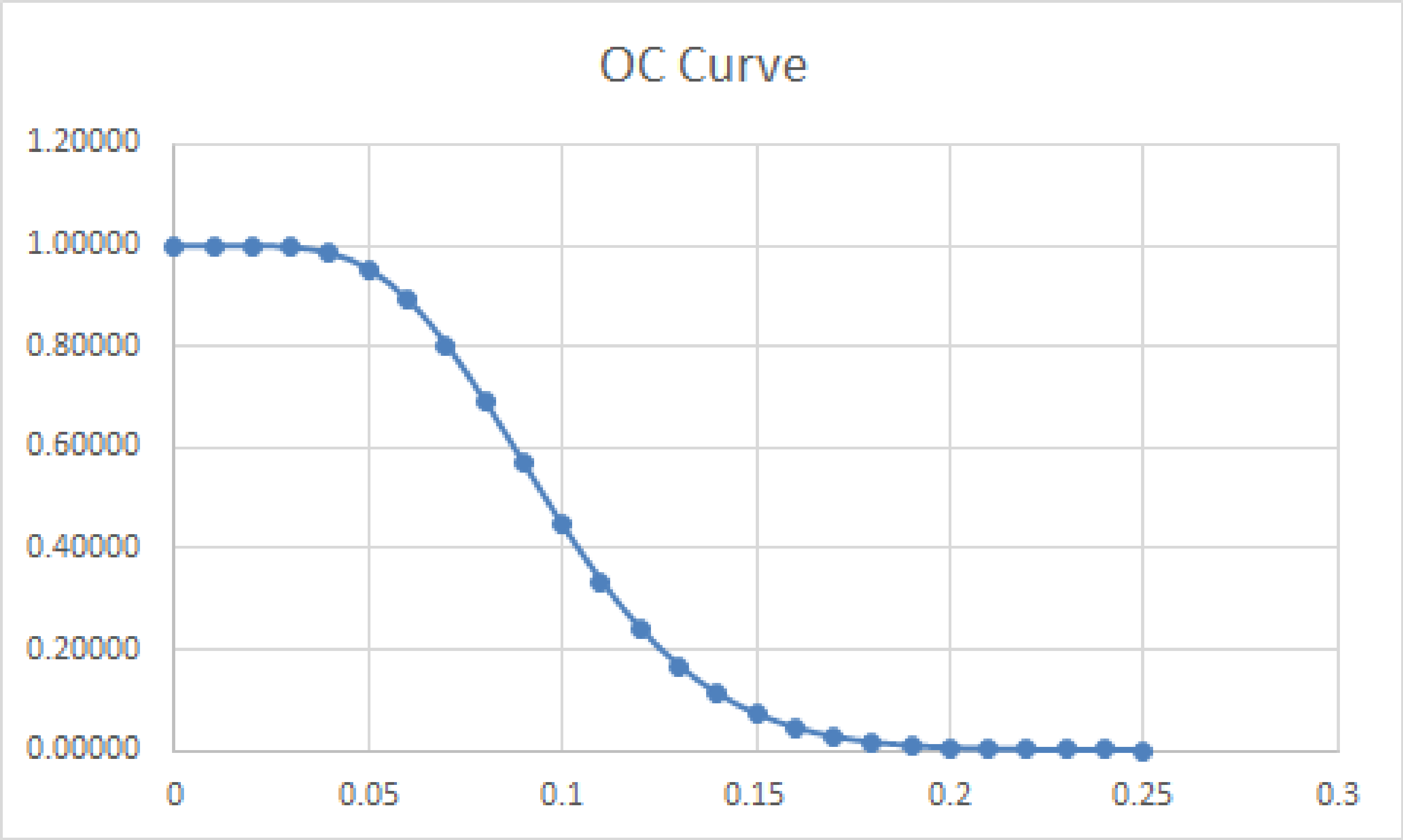
Operating Characteristic Curve

An Operating Characteristic Curve (OC Curve) is a probability curve for a sampling plan that shows the probabilities of accepting lots with various lot quality levels (%defectives).

The probability of acceptance (Pa) describes the chance of accepting a particular lot based on a specific sampling plan and incoming proportion defective. It is based on the binomial distribution.

$$P_a = \sum_{d=0}^{c} \frac{n!}{d!\,(n-d)!} p^d (1-p)^{n-a}$$

Operating Characteristic Curve



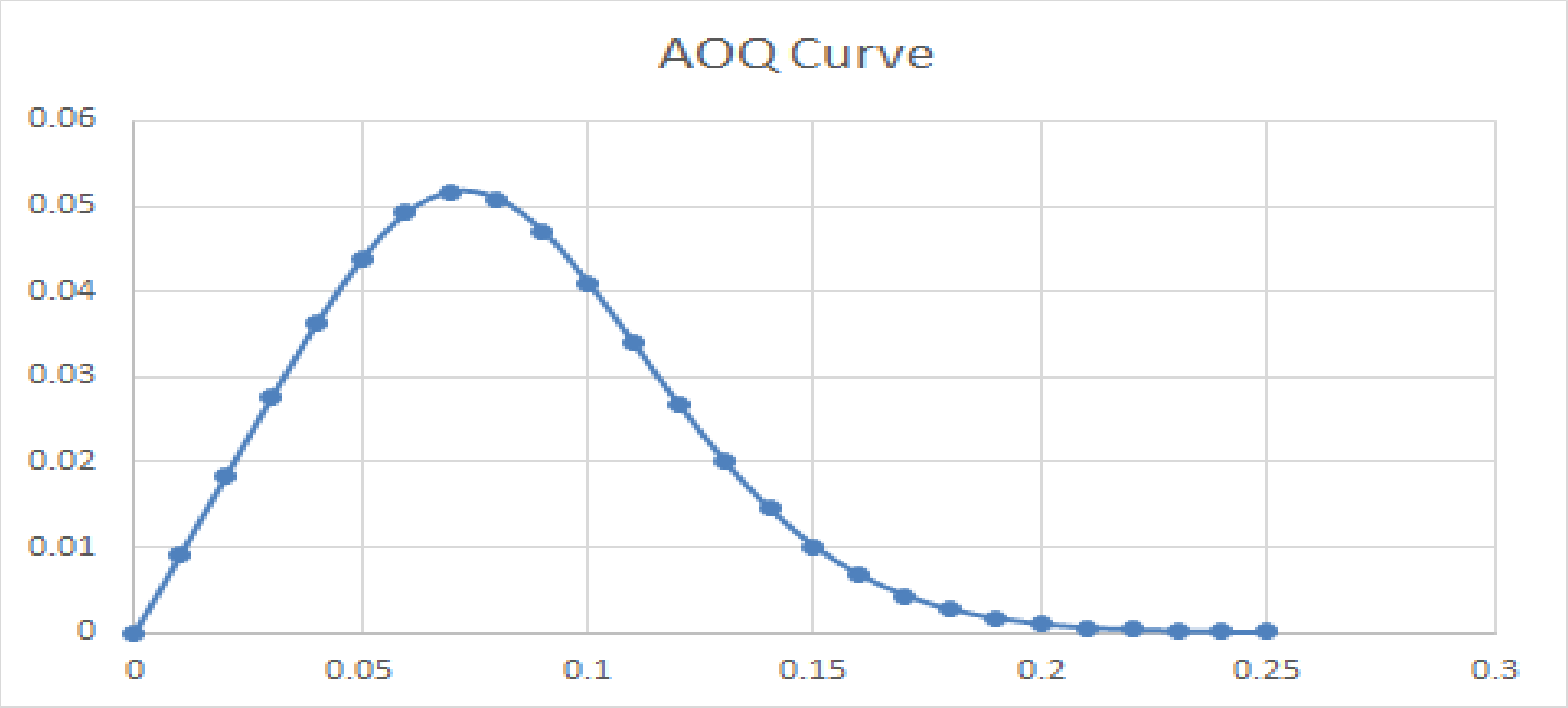
Average Outgoing Quality

The average outgoing quality is the average defective or defect rate in released lot assuming rejected lots are 100% inspected and all defectives/defects are removed.

Average Outgoing Quality curve represents the relationship between the quality of incoming and outgoing materials.

$$AOQ\ with\ rectifying\ inspection = \frac{P_a p(N-n)}{N}$$

Average Outgoing Quality Curve



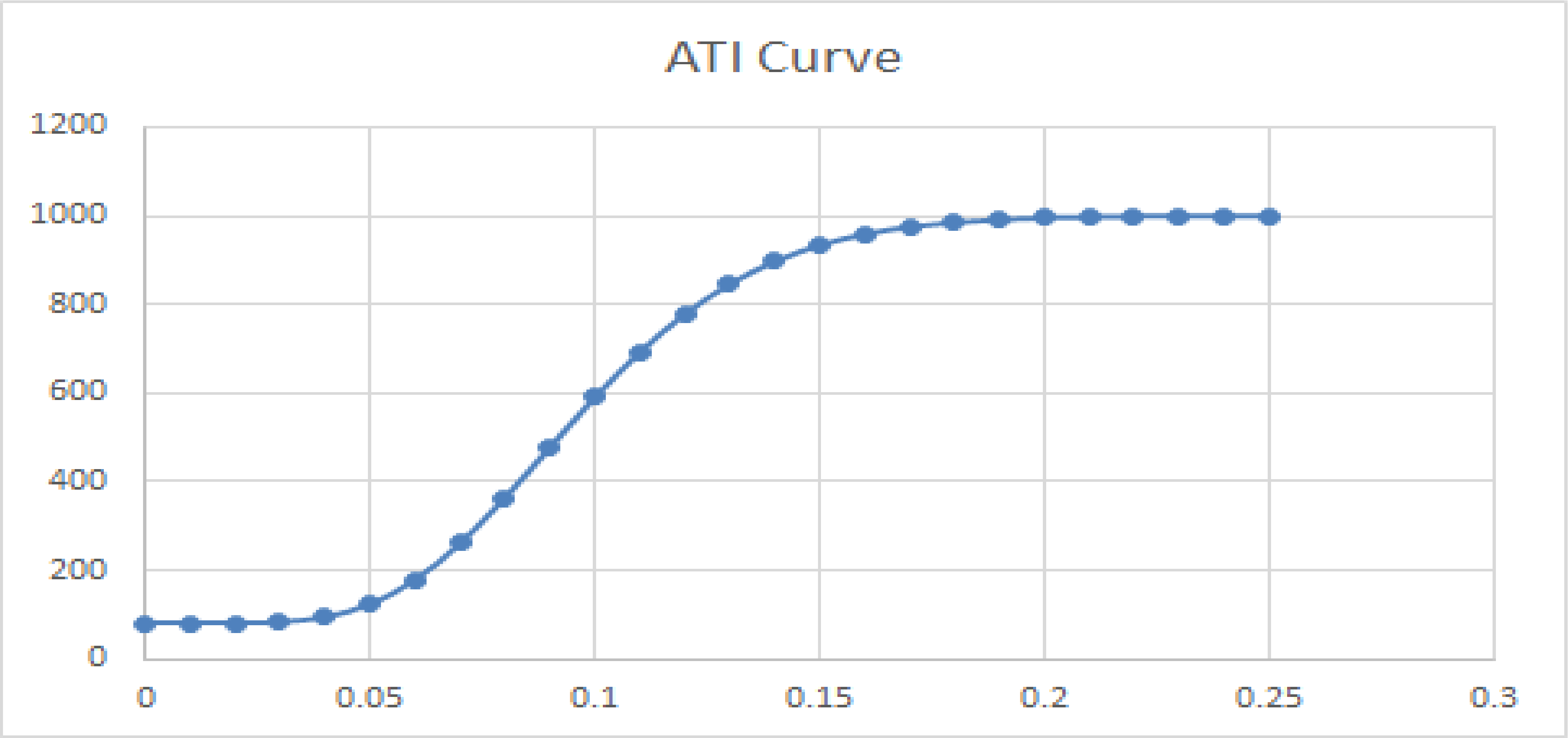
Average Total Inspection Curve

The average total inspection per lot depends on the incoming quality, the probability that the lot will be accepted, and the sample and lot sizes.

The Average Total Inspection shows the correlation between the quality of incoming materials and the number of items that need to be inspected.

$$ATI = n + (1 - p_a)(N - n)$$

Average Total Inspection Curve



Experiment results

Now, let’s check Minitab.

Lot Defects Per Unit

Lot Defects Per Unit	Probability of Acceptance
0.0005	1
0.0162632	0.999941
0.0320263	0.995446
0.0477895	0.961131
0.0635526	0.864462
0.0793158	0.706626
0.0950789	0.522993
0.110842	0.353171
0.126605	0.220057
0.142368	0.127939
0.158132	0.0700941
0.173895	0.0364924
0.189658	0.0181796
0.205421	0.0087161
0.221184	0.0040411
0.236947	0.0018190
0.252711	0.0007976
0.268474	0.0003416
0.284237	0.0001433
0.3	0.0000590

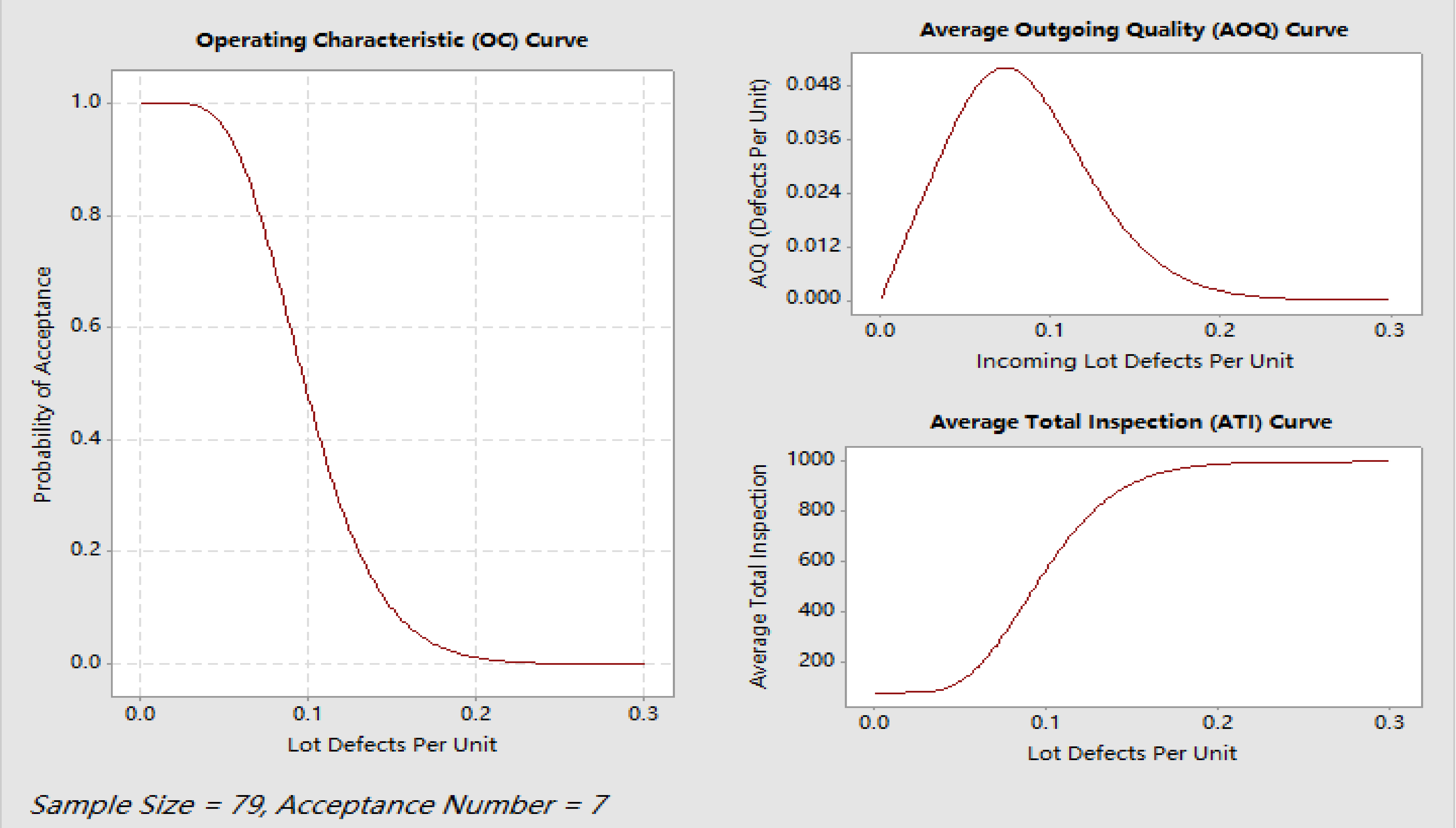
Incoming Lot Defects Per Unit

Incoming Lot Defects Per Unit	AOQ (Defects Per Unit)
0.0005	0.0004605
0.0162632	0.0149775
0.0320263	0.0293619
0.0477895	0.0423033
0.0635526	0.0505987
0.0793158	0.0516189
0.0950789	0.0457973
0.110842	0.0360537
0.126605	0.0256594
0.142368	0.0167755
0.158132	0.0102084
0.173895	0.0058445
0.189658	0.0031755
0.205421	0.0016490
0.221184	0.0008232
0.236947	0.0003970
0.252711	0.0001856
0.268474	0.0000845
0.284237	0.0000375
0.3	0.0000163

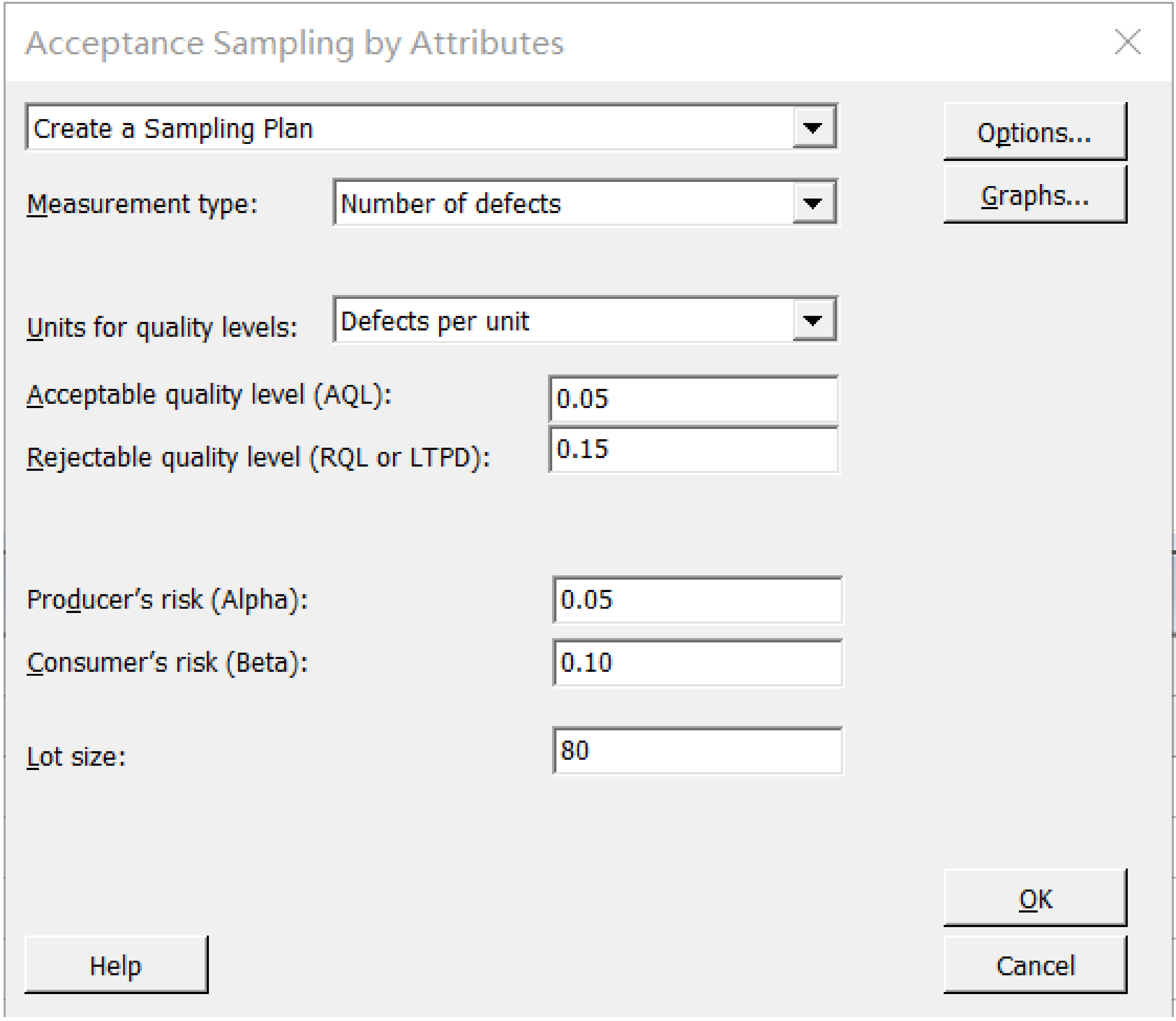
Average Total Inspection (ATI) Curve

Lot Defects Per Unit	Average Total Inspection
0.0005	79
0.0162632	79.0546
0.0320263	83.1941
0.0477895	114.799
0.0635526	203.831
0.0793158	349.197
0.0950789	518.323
0.110842	674.729
0.126605	797.327
0.142368	882.168
0.158132	935.443
0.173895	966.390
0.189658	983.257
0.205421	991.972
0.221184	996.278
0.236947	998.325
0.252711	999.265
0.268474	999.685
0.284237	999.868
0.3	999.946

Graphs - Acceptance Sampling by Attributes



Minitab Acceptance Sampling



Minitab Acceptance Sampling

Acceptance Sampling by Attributes

Measurement type: Number of defects
Lot quality in defects per unit
Lot size: 1000
Use Poisson distribution to calculate probability of acceptance

Method

Acceptable Quality Level (AQL)	0.05
Producer's Risk (α)	0.05
Rejectable Quality Level (RQL or LTPD)	0.15
Consumer's Risk (β)	0.1

Generated Plan(s)

Sample Size	79
Acceptance Number	7

Accept lot if number of defects in 79 items ≤ 7; Otherwise reject.

Defects Per Unit	Probability Accepting	Probability Rejecting	AOQ	ATI
0.05	0.952	0.048	0.04383	123.4
0.15	0.096	0.904	0.01330	911.3

Average Outgoing Quality Limit(s) (AOQL)

AOQL	At Defects per Unit
0.05214	0.07347

Graphs - Acceptance Sampling by Attributes

Minitab Acceptance Sampling

Acceptance Sampling by Attributes

Measurement type: Number of defects
Lot quality in defects per unit
Lot size: 80
Use binomial distribution to calculate probability of acceptance

Acceptable Quality Level (AQL) 0.05
Producer's Risk (α) 0.05

Rejectable Quality Level (RQL or LTPD) 0.15
Consumer's Risk (β) 0.1

Generated Plan(s)
Sample Size 79
Acceptance Number 7
Accept lot if number of defects in 79 items ≤ 7; Otherwise reject.

Defects Per Unit	Probability Accepting	Probability Rejecting	AOQ	ATI
0.05	0.952	0.048	0.00059	79.0
0.15	0.096	0.904	0.00018	79.9

Average Outgoing Quality Limit(s) (AOQL)

AOQL	At Defects per Unit
0.00071	0.07347

“Inspection”

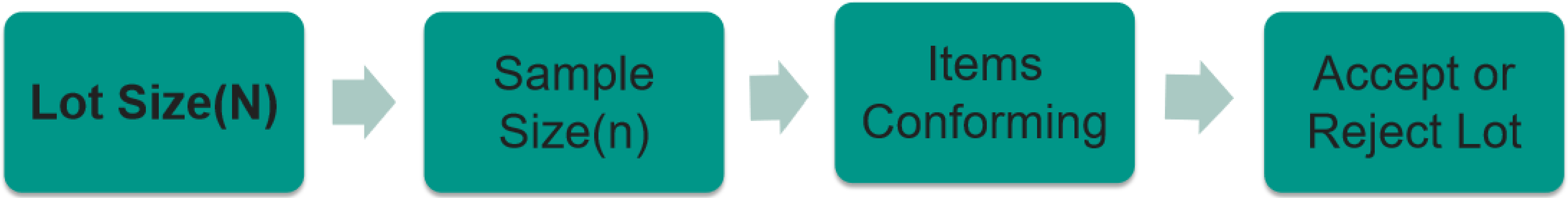
- Organized examination or formal evaluation exercise.
- Inspection includes measurement of an output and comparison to specified requirements to determine conformity.
- Determining conformance to standard.
- Good-bad product, measuring process capability, rating product quality.
- No inspection, small samples, large samples and 100% inspection.
- Competitions to reduce costs has resulted in pressures to reduce the amount of inspections.

“Inspection Cont’d”

- Prior knowledge available as to quality.
- Homogeneity of the lot.
- Allowable degree of risk.

“Acceptance Sampling”

Process of evaluating a portion of the product in a lot for the purpose of accepting or rejecting the entire lot



Used when

a) Cost of inspection is high in relation to the damage cost resulting from passing a defective product

b) 100% inspection is monotonous and causes inspection errors or,

c) Inspection is destructive

Disadvantages – sampling risks, greater administrative costs and less information about the product than provided by 100% inspection

Notations

Let N = 1000 (number of supplies in the lot)

n =80 (number of supplies in the random sample taken from the lot)

p = 5% (proportion defective in the lot)

I = $5 (inspection cost per supplies)

A = $50 (damage cost incurred if a defective supplies through the inspection)

c = 7 (Acceptance Number); if the number of defective items in the random sample of ‘n’ is more than ‘c’, then the lot is rejected

Pa = Probability that the lot will be accepted by sampling plan

“Break-even Point” – “Deming’s kp Rule”

If the sample size is small compared to the lot size, the break-even point, ‘pb’ is

$$pb = I/A$$

If the lot quality (p) is less than ‘pb’, total cost will be lowest with sampling inspection or no inspection.

If the lot quality (p) is more than ‘pb’, 100% inspection is suitable.

Determination of Inspection

- pb = (5/50) = (1/10);
- Since p(1-0.89325=0.10675)>pb, 100% inspection is recommended;
- Ideal inspection due to heavy fines imposed on faults;
- Although costs are high, we still prefer 100% inspection.

OC Conclusion

We have seen how the OC Function allows us to obtain acceptance sampling plans that meet both, the producer's and consumer's risks (α, β). The OC also helps us estimate the adequate sample sizes "n" required to obtain, with high confidence, one or more failures in our experiments. These OC Function properties allow us to control the quality of our incoming products, estimate certain parameters of interest such as the required sample sizes, which contribute to the design of better and more efficient experiments.

General Conclusion

- We donate 1000 pieces of supplies to the disaster area. Through the calculation of minitab and excel, we figured out that 80 out of the 1000 pieces of supplies need to be randomly checked for quality inspection.
- After we Calculation(p>pb), we decide to check 100 percent of supplies.