A FAMILY OF GROUP CHAIN ACCEPTANCE SAMPLING PLANS BASED ON TRUNCATED LIFE TEST

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Abstrak

Persampelan penerimaan merupakan prosedur kawalan kualiti berstatistik yang digunakan untuk menentukan sama ada untuk menerima atau menolak sesuatu lot, berdasarkan hasil pemeriksaan sampel. Bagi produk berkualiti tinggi, bilangan penerimaan sifar diambil kira dan ujian hayat ini selalunya diberhentikan pada masa tertentu, yang dipanggil ujian hayat terpangkas. Pelan yang melibatkan bilangan penerimaan sifar dianggap tidak adil terhadap pengeluar kerana kebarangkalian penerimaan lot menurun secara drastik pada kadar kerosakan yang sangat kecil. Untuk mengatasi masalah ini, persampelan berantai yang menggunakan maklumat lot sebelum dan selepas telah diperkenalkan. Bagi pelan persampelan berantai biasa, hanya satu produk yang boleh diperiksa pada satu masa, walaupun secara praktikalnya, penguji mampu memeriksa lebih dari satu produk serentak. Dalam situasi ini, pelan persampelan kumpulan berantai dengan sampel bersaiz kecil menjadi pilihan kerana ia menjimatkan masa dan kos pemeriksaan. Oleh yang demikian, adalah bermanfaat untuk membangunkan beberapa jenis pelan persampelan berantai dalam konteks ujian berkumpulan. Matlamat kajian ini adalah untuk membangunkan pelan persampelan baharu bagi kumpulan berantai (GChSP), kumpulan berantai yang diubahsuai (MGChSP), kumpulan berantai dua sisi (TS-GChSP) dan kumpulan berantai dua sisi yang diubahsuai (TS-MGChSP) menggunakan taburan Pareto jenis ke-2. Empat pelan tersebut juga digeneralisasikan berdasarkan beberapa nilai kadar kerosakan yang telah ditetapkan. Kajian ini melibatkan empat fasa: mengenal pasti beberapa kombinasi reka bentuk parameter; membangunkan prosedur; mendapatkan fungsi cirian pengoperasian; dan mengukur prestasi dengan menggunakan data simulasi dan data hayat yang sebenar. Pelan yang dibangunkan dinilai menggunakan beberapa reka bentuk parameter dan dibandingkan dengan pelan yang telah mantap berdasarkan bilangan kumpulan minimum, g dan kebarangkalian penerimaan lot, $L(p)$. Dapatan menunjukkan kesemua pelan yang dicadangkan mempunyai g yang lebih kecil dan $L(p)$ yang lebih rendah berbanding dengan pelan yang telah mantap. Kesemua pelan tersebut berupaya menjimatkan masa dan kos pemeriksaan, serta memberikan lebih perlindungan kepada pengguna daripada menerima produk yang rosak. Ini seharusnya memberi banyak faedah kepada pengamal industri terutamanya yang melibatkan ujian musnah untuk produk berkualiti tinggi.

Kata kunci: Persampelan berantai, Persampelan penerimaan kumpulan, Lengkung cirian pengoperasian, Ujian hayat terpangkas, Persampelan rantaian dua sisi.

Abstract

Acceptance sampling is a statistical quality control procedure used to accept or reject a lot, based on the inspection result of its sample. For high quality products, zero acceptance number is considered and the life test is often terminated on a specific time, hence called truncated life test. A plan having zero acceptance number is deemed unfair to producers as the probability of lot acceptance drops drastically at a very small proportion defective. To overcome this problem, chain sampling which uses preceding and succeeding lots information was introduced. In ordinary chain sampling plans, only one product is inspected at a time, although in practice, testers can accommodate multiple products simultaneously. In this situation, group chain sampling plan with small sample size is preferred because it saves inspection time and cost. Thus, it is worthwhile to develop the various types of chain sampling plans in the context of group testing. This research aims to develop new group chain (GChSP), modified group chain (MGChSP), two-sided group chain (TS-GChSP) and modified two-sided group chain (TS-MGChSP) sampling plans using the Pareto distribution of the 2nd kind. These four plans are also generalized based on several pre-specified values of proportion defective. This study involves four phases: identifying several combinations of design parameters; developing the procedures; obtaining operating characteristic functions; and measuring performances using both simulated and real lifetime data. The constructed plans are evaluated using various design parameters and compared with the established plan based on the number of minimum groups, g and probability of lot acceptance, $L(p)$. The findings show that all the proposed plans provide smaller g and lower $L(p)$ compared to the established plan. All the plans are able to reduce inspection time and cost, and better at protecting customers from receiving defective products. This would be very beneficial to practitioners especially those involved with destructive testing of high quality products.

Keywords: Chain sampling, Group acceptance sampling, Operating characteristic curve, Truncated life test, Two-sided chain sampling.

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Glossary of Terms

a	Pre-specified testing time
c	Acceptance number
d	Rejection number
g	Total number of groups
$L(p)$	Probability of lot acceptance
r	Group size
t_0	Test termination time
α	Producer's risk
β	Consumer's risk
λ	Shape parameter of Pareto distribution of the 2nd kind
σ	Scale parameter of Pareto distribution of the 2nd kind
μ	Mean lifetime of a product
μ_0	Specified mean lifetime of a product
μ/μ_0	Mean ratio
p	Proportion defective
n	Sample size
AQL	Acceptable quality level
LTPD	Lot tolerance percent defective
AOQL	Average outgoing quality limit

List of Publications

Mughal, A.R., Zain,Z., & Aziz, N. (2015). Time Truncated Group Chain Sampling Strategy for Pareto Distribution of the 2nd kind. *Research Journal of Applied Sciences, Engineering and Technology,* 10(4), 471-474.

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CHAPTER ONE
INTRODUCTION

In this chapter, the fundamental concepts of quality control and uses of probability distributions in acceptance sampling plans are explained. The objective of the study, methodology and analysis on acceptance sampling plans are also discussed. Several group chain acceptance sampling plans for attributes are developed for experimenters in order to reach the accurate probability of lot acceptance at pre-specified design parameters.

1.1 Background

According to Juran (1951), "Quality means that a product meets customer needs leading to customer satisfaction, and quality also means all the activities in which a business engages in, to ensure that the product meets customer needs. You can think of this second aspect of quality as quality control - ensuring a quality manufacturing process". Quality is a measure of excellence or a state of being free from defects, deficiencies and considerable variations. The quality of a product is brought about by the consistent adherence and verifiable standards to achieve uniformity of production that satisfies consumer or user necessities (Deva and Rebecca, 2012).

The International Organization for Standardization (ISO), founded in 1947, is a worldwide association of national standards which has contributed significantly in recent years (Schilling & Neubauer, 2008). The ISO's standards offer guidance and tools for companies who want to ensure that their products meet customers'

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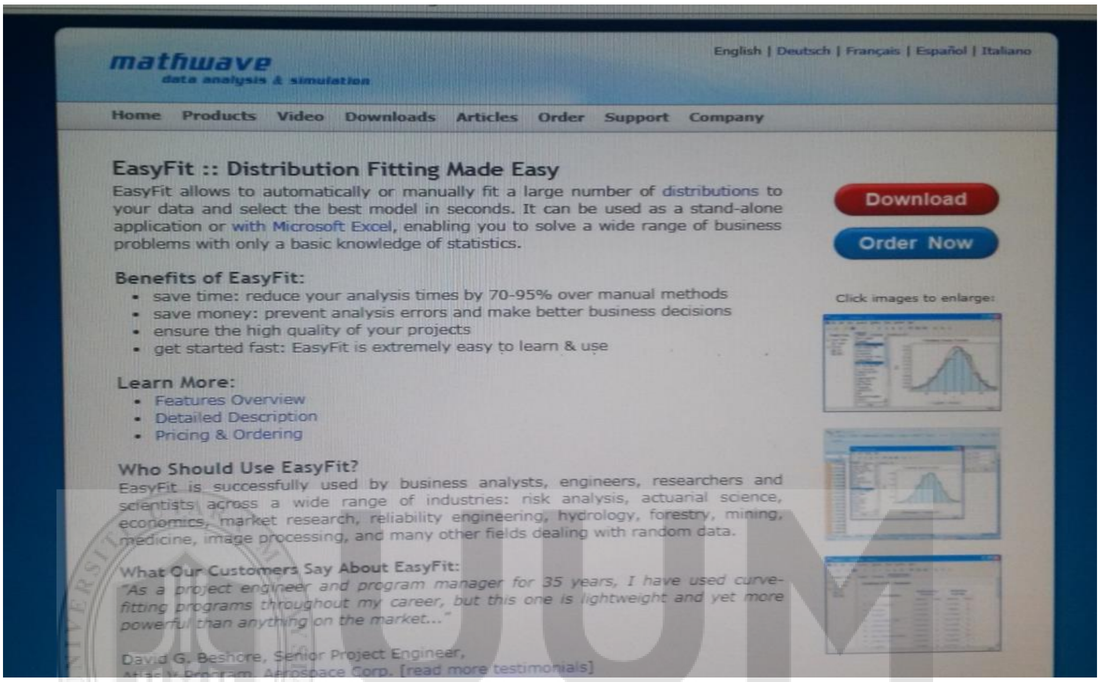
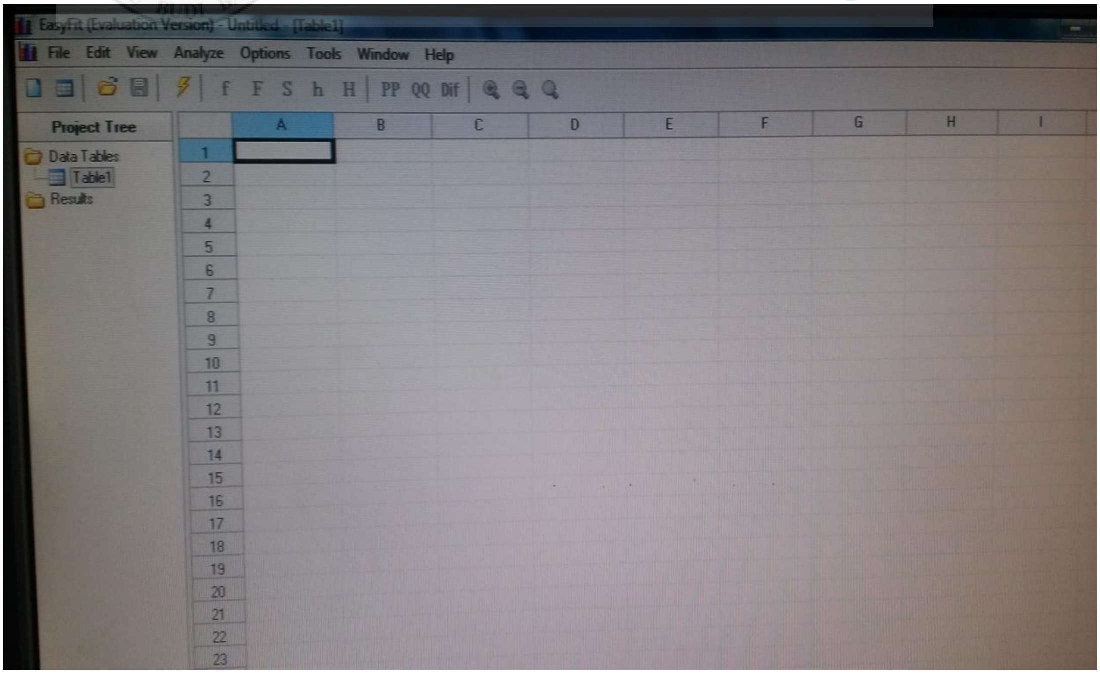
APPENDIX A

Procedure of Using EasyFit - Distribution Fitting Software

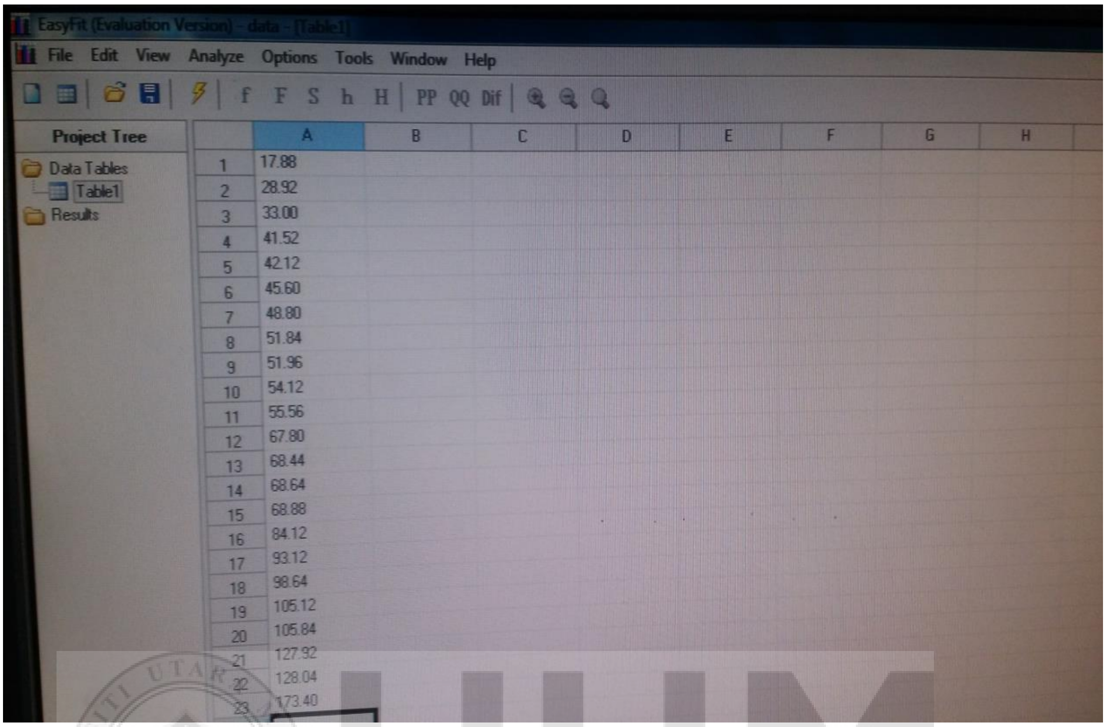
Step 1: Download the software



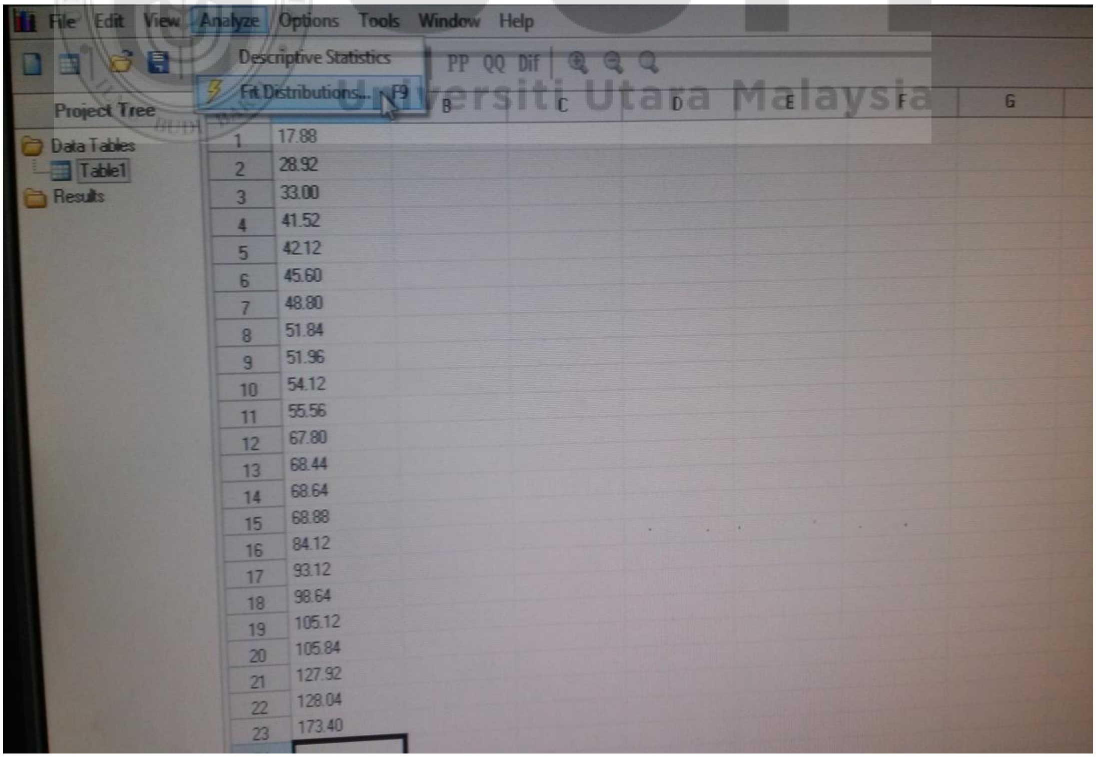
Step 2: Open the spreadsheet



Step 3: Enter the data



Step 4: Select fit distribution options



Step 5: Get the required results

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Data				Goodness of Fit - Summary				Fitting Results					
2	17.88							#	Distribution	Parameters				
3	28.92		Sr#	Distribution	Kolmogorov Smirnov Statistic			1	Pareto 2	a=1.6293 b=133.97				
4	33							2	Burr	k=0.26938 a=4.4062 b=39.729				
5	41.52							3	Burr (4P)	k=0.36392 a=0.85281				
6	42.12		1	Pareto 2	0.23587					b=2.1618 g=17.88				
7	45.6		2	Inv. Gaussian (3P)	0.24914			4	Cauchy	s=22.408 m=60.098				
8	48.8		3	Inv. Gaussian	0.26892			5	Chi-Squared	n=252				
9	51.84		4	Gen. Gamma (4P)	0.27032			6	Chi-Squared (2P)	n=92 g=-31.863				
10	51.96		5	Weibull (3P)	0.27129			7	Dagum	k=193.33 a=1.9496 b=2.3054				
11	54.12		6	Pareto	0.2988			8	Dagum (4P)	k=3.6174 a=1.3793				
12	55.56		7	Levy (2P)	0.29947					b=19.603 g=9.4152				
13	67.8		8	Gamma (3P)	0.33437			9	Error	k=1.0 s=648.93 m=252.85				
14	68.44		9	Chi-Squared (2P)	0.35376			10	Error Function	h=0.00109				
15	68.64		10	Kumaraswamy	0.36506			11	Exponential	l=0.00395				
16	68.88		11	Fatigue Life (3P)	0.3663			12	Exponential (2P)	l=0.00426 g=17.88				
17	84.12		12	Dagum	0.38245			13	Fatigue Life	a=1.4671 b=140.61				
18	93.12		13	Levy	0.38539			14	Fatigue Life (3P)	a=1.7939 b=108.2 g=12.943				
19	98.64		14	Fatigue Life	0.40547			15	Frechet	a=1.192 b=46.725				
20	105.12		15	Gumbel Max	0.4093			16	Frechet (3P)	a=1.3469 b=51.601 g=2.5763				
21	105.84		16	Burr (4P)	0.42473			17	Gamma	a=0.15182 b=1665.4				
22	127.92		17	Gen. Gamma	0.4326			18	Gamma (3P)	a=0.25399 b=1678.9 g=17.88				
23	128.04		18	Power Function	0.4521			19	Gen. Extreme Value	k=0.84681 s=33.58 m=51.257				
24	173.4		19	Uniform	0.45534			20	Gen. Gamma	k=1.107 a=0.31737 b=1665.4				
25			20	Normal	0.46872			21	Gen. Gamma (4P)	k=0.81331 a=0.41479				
26			21	Logistic	0.47529					b=511.92 g=17.88				
27			22	Hypersecant	0.48084			22	Gen. Pareto	k=0.83243 s=37.69 m=27.93				
28			23	Exponential	0.48267			23	Gumbel Max	s=505.97 m=-39.201				
29			24	Reciprocal	0.49366			24	Gumbel Min	s=505.97 m=544.9				
30			25	Error	0.49949			25	Hypersecant	s=648.93 m=252.85				
31			26	Laplace	0.49949			26	Inv. Gaussian	l=38.389 m=252.85				
32			27	Exponential (2P)	0.50574			27	Inv. Gaussian (3P)	l=45.407 m=240.8 g=12.056				
33			28	Error Function	0.51099			28	Johnson SB	g=1.6883 d=0.24833				
34			29	Johnson SB	0.52291					l=3719.0 x=23.482				
35			30	Rayleigh (2P)	0.53063			29	Kumaraswamy	a1=0.30997 a2=1.6971				