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Group acceptance sampling plan based on time truncation situation for transmuted Weibull distribution

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In this paper, we developed a time truncated group acceptance sampling inspection plan ($\mathcal{GASP}$) when lifetime of items follow the transmuted Weibull distribution. Plan parameters of proposed plan are computed for specified consumer's risk and results are presented in tabular form for better understanding. The operating characteristic (OC) values of the suggested plan are recorded for various quality levels for different set of consumers's risk. All presented tables are discussed in detail to explain the results associated with the study and chosen a hypothetical example to describe the obtained results. Comparison study is done for proposed plan and single acceptance sampling plan. At last, a real life example is used to illustrate the application of proposed plan in real life scenario.

keywords: Group acceptance sampling inspection plan,transmuted Weibull distribution, consumer's risk, operating characteristic value.

1 Introduction

Quality is the essential and indispensable part of every manufacturing process. Intention of manufacturers to produce good quality items, so that they are on the end of minimum loss and generate maximum revenue. It is not possible to check whole lot of items due to time, money, labour etc constraints and also manufacturer can not afford

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zero inspection of lot due to quality concern. Acceptance sampling inspection plans ($\mathcal{ASIP}$) is the mid way between complete inspection and zero inspection. In $\mathcal{ASIP}$, decision of acceptance or rejection of lot based on the choosen sample of items from the lot for specified acceptance number. $\mathcal{ASIP}$ classified in two broad regions: variable $\mathcal{ASIP}$ and attribute $\mathcal{ASIP}$. Attributes $\mathcal{ASIP}$ includes single acceptance sampling inspection plan ($\mathcal{SASP}$), double acceptance sampling inspection plan ($\mathcal{DASP}$), group acceptance sampling inspection plan ($\mathcal{GASP}$), chain acceptance sampling inspection plan ($\mathcal{CHSP}$), skip lot sampling inspection plan ($\mathcal{SKSP}$) etc. Several authors have developed variable $\mathcal{ASIP}$: Wu and Liu (2018), Sathya Narayanan and Rajarathinam (2013) for Pareto distribution, Maleki Vishkaei et al. (2019) and Saha et al. (2021b) for Lindley and Power Lindley distribution. Gupta and Gupta (1961), Gupta (1962), Aslam et al. (2010b), Tripathi et al. (2020b), Al-Omari (2018), Al-Omari et al. (2019) and Tripathi et al. (2020a) have developed the $\mathcal{SASP}$ for gamma distribution, normal and lognormal distribution, generalized exponential distribution, generalized half normal distribution, Sushila distribution, Rama distribution and exponentially distributed quality characteristics, respectively. Gui and Lu (2018), Rao (2011), Saha et al. (2021a), Tripathi et al. (2021b), Balamurali et al. (2020), Aslam et al. (2010a) have developed the $\mathcal{DASP}$ for different probability distributions. Birnbaum-Saunders distribution, inverse Rayleigh, Weibull and Half normal, generalized transmuted-exponential and extended odd Weibull exponential distribution are used by Aslam et al. (2011), Ramaswamy and Anburajan (2012), Aslam and Jun (2009) and Rao et al. (2014), Fayomi and Khan (2024), Ekemezie et al. (2024) and Alsultan (2024) respectively for the development of $\mathcal{GASP}$. Recently, Tripathi et al. (2022a), Tripathi et al. (2022b), Tripathi et al. (2022c), Tripathi et al. (2021a), Aslam et al. (2013) and Aslam et al. (2018) have developed other useful $\mathcal{ASIP}$, like $\mathcal{SKSP}$ and $\mathcal{CHSP}$ for various models.
We explored the literature and found a gap that no one attempted to develop the $\mathcal{GASP}$ for transmuted Weibull distribution $TrWD$. Therefore we contributed to the development of the $\mathcal{GASP}$ for $TrWD$ and obtained the minimum number of groups (g) which are required for acceptance or rejection of the lot. Also, OC values of proposed plan is calculated for specified values of θ, λ, r, c, P^*. Important findings of presented study are placed along with their description.
Rest of article is organized as follows: In section 2, we describe the importance of $TrWD$ along with mean property. We designed $\mathcal{GASP}$ for $TrWD$ and describe the procedure in section 3. Section 4 contains the description of all presented tables. Comparison study is discussed in section 5. Application of proposed plan is discussed in section 6. In section 7, we stated conclusive remarks of developed $\mathcal{GASP}$.

2 Transmuted Weibull distribution

This section contains description of the $TrWD$ which was introduced by Pobočíková et al. (2018). $TrWD$ is the 3-parameter distribution and authors has derived several properties and also, they have discussed the methods of estimation in case of $TrWD$. The probability density function (PDF) and cumulative distribution function (CDF) of

TrWD are given below [see Equations (1) and (2) respectively]:

$$f(x;\lambda,\eta,\sigma) = \frac{\eta}{\sigma}\left(\frac{x}{\sigma}\right)^{(\eta-1)} exp(-(x/\sigma)^{\eta})[1-\lambda+2\lambda exp(-(x/\sigma)^{\eta})];$$
$$x>0, |\lambda|\leq 1, \eta>0, \sigma>0 \qquad (1)$$

and

$$F(x;\lambda,\eta,\sigma) = [1-exp(-(x/\sigma)^{\eta})][1+\lambda exp(-(x/\sigma)^{\eta})]; \quad x>0, \lambda>0, \theta>0. \qquad (2)$$

The mean of *TrWD*

$$\mu = E(X) = \sigma\Gamma\left(1+\frac{1}{\eta}\right)(1-\lambda+\lambda 2^{-1/\eta}) \qquad (3)$$

? discussed the application of *TrWD* with three data set and they showed that *TrWD* performed better than the some popular distributions. Also they describe the reliability and survival properties of it.

3 Group Acceptance Sampling Inspection Plan ($\mathcal{GASP}$)

In this section, mathematical formulation of $\mathcal{GASP}$ [see, Aslam and Jun 2009] is discussed along with its procedure. In general $\mathcal{GASP}$ depends of group size r and number of groups g. Following is the procedure of proposed $\mathcal{GASP}$ under time truncated life test scheme.

- Choose number of groups g and allocate r items to each group. Then sample size becomes $n = rg$
- Choose an acceptance number, which allows maximum permissible number of defective in each group.
- Run the experiment for choosen g groups simultaneously upto predefined termination time t_0.
- Accept the lot if at most c items failed in all g groups. Otherwise reject the lot.

The binomial distribution is a useful tool for developing the GASIP (Group Acceptance Sampling Inspection Plan) when a sample is taken from a large lot. In order to determine the appropriate number of groups g, as well as the acceptance number (c) and termination time (t_0), various values need to be specified. Probability of acceptance of lot is:

$$\left[\sum_{i=0}^{c}\binom{r}{i}p^{i}(1-p)^{(r-i)}\right]^{g} \qquad (4)$$

p is the probability of failure of items of lot before truncation time when lifetime of items follows $TrWD$ and p can modified be written in terms of termination ratio $(\frac{t_0}{\mu_0})$ and quality ratio $(\frac{\mu}{\mu_0})$:

$$p = \left[1 - exp\left(-\left(\mathcal{C}\frac{t_0}{\mu_0}/\frac{\mu}{\mu_0}\right)^{\eta}\right)\right]\left[1 + \lambda exp\left(-\left(\mathcal{C}\frac{t_0}{\mu_0}/\frac{\mu}{\mu_0}\right)^{\eta}\right)\right] \quad (5)$$

where, $\mathcal{C}$ is:

$$\mathcal{C} = \Gamma\left(1 + \frac{1}{\eta}\right)(1 - \lambda + \lambda 2^{-1/\eta})$$

Determination of minimum number of groups can be determine by using following inequality:

$$\left[\sum_{i=0}^{c}\binom{r}{i}p^i(1-p)^{(r-i)}\right]^g \leq 1 - P^* \quad (6)$$

Where P^* is confidence level and $\beta = 1 - P^*$. For the determination of g, just replace the value of p in the inequality [see, Equation 6] for fixed value of group size r. All obtained value of minimum number of groups are placed in Tables $1-3$ for different values of θ. Probability of acceptance can be calculated for obtained values of minimum number of groups by using equation 4. OC values of proposed plan are reported in $4-6$ for chosen setup of P^*, r and c. OC values are very useful to look at the probability of acceptance of an individual lot based on g, r and c.

4 Discussion on Tables and hypothetical example

In this section, we discussed the results of presented tables. Minimum number of groups for (η and λ)= (0.75,0.75), $(1.75, 0.75)$ and $(1.25, 0.95)$ are obtained and placed in Tables $1-3$. To calculate the OC values, we have setups of r, c for different values of $P^* = 0.75, 0.90, 0.95, 0.99$, $t_0/\mu_0 = 1.25, 1.75, 2.25, 2.5, 3, 3.5, 4$ and $\mu/\mu_0 = 2, 3, 4, 5, 6, 7, 8, 9$. OC values are reported in Tables $4-6$ for specified values of μ/μ_0. Following are the important results from the presented Tables:

- Required minimum number of groups are increases for fixed value of termination time when c and r increases for given value of P^* and this result holds for all setup.
- Minimum number of groups decreases for fixed value of r and c and increasing value of termination ratio and this holds for all setup.
- Largest value of minimum number of groups occurs for $p^* = 0.99$, $r = 12$, $c = 10$ and $t_0/\mu_0 = 1.25$ and this results hold for all setup of (η, λ).
- OC value increases as μ/μ_0 increases and largest OC value occures at $\mu/\mu_0 = 9$ and this holds for all set up of P^* and (η, λ).

Hypothetical example: Suppose experimenter wants to establish a $\mathcal{GASP}$ to decide the accept and reject the lot when termination ratio(t_0/μ_0), group size (r) and acceptance number (c) are 1.25, 12 and 10 respectively for in case of ($\eta = 0.75, \lambda = 0.75$). For specified setup and $P^* = 0.95$, experimenter required 7 minimum number of groups and accept the lot if numbers of failure in each group is less than c then accept the lot otherwise reject the lot.

5 Comparison Study

In this section, we focused on comparison study between proposed plan (PP) and $\mathcal{SASP}$. For this purpose, we created Tables 8 and appropriate OC values for both plan are place in Tables for specified setups. In table, we can easily see that OC values for proposed plan is larger than $\mathcal{SASP}$ for all the considered setup.
From the presented comparison tables, It is easily seen that OC value for PP become higher as we increase the quality ratio μ/μ_0 and OC values of PP are larger as compared to the $\mathcal{SASP}$ even when quality of items are too high, i.e. for $\mu/\mu_0 = 8$, this result holds for all the setup of P^*. For the illustration purpose, we choose the $t_0/\mu_0 = 1.25, 1.75$ for the all considered value of parameter η, λ and displayed those in Figure $1-2$. From the figures, we conclude that PP perform better than the $\mathcal{SASP}$.

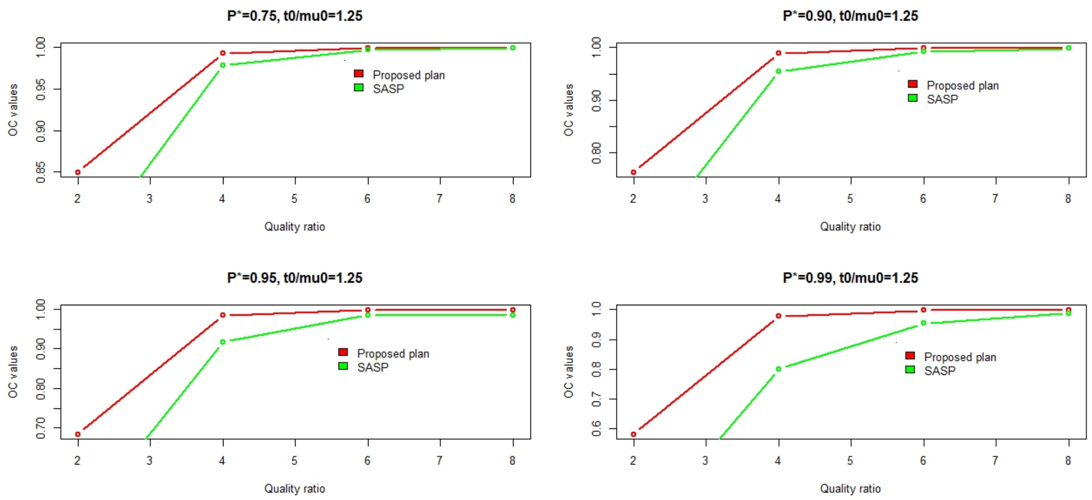

Figure 1: Comparison of PP and $\mathcal{SASP}$ from Table 8

6 Real data application

In this section, we deal with the application part of proposed study by using a real life situation. First we see the model fitting summary of chosen data set to prove that considered data set is suited well for our study and this model fitting summary consist

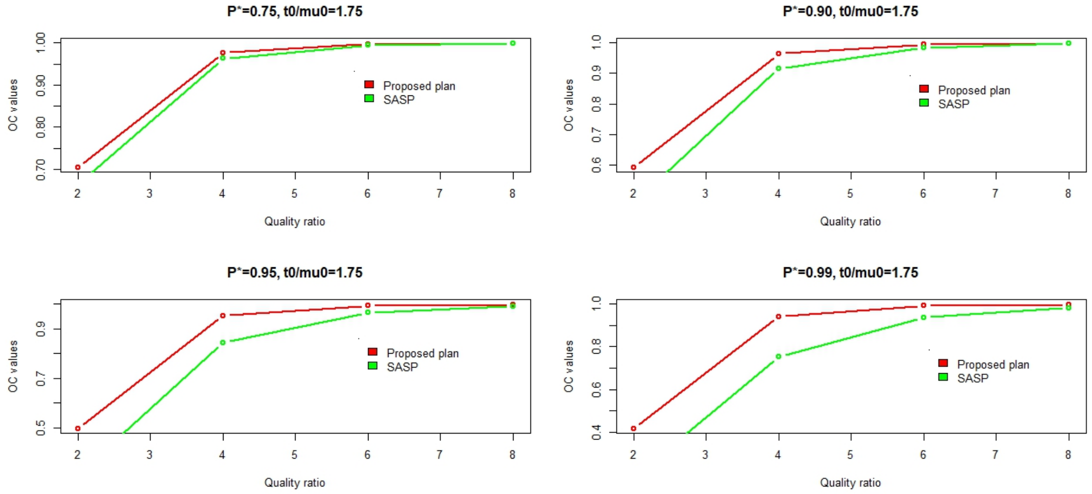

Figure 2: Comparison of PP and $\mathcal{SASP}$ from Table 8

two discrimination criteria, Akaike information criteria (AIC) and Bayesian information criteria (BIC), Kolmogorov-Smirnov (K-S) statistics and p-value. Also descriptive summary of data set is provided for better understanding. Log likelihood (L-L) and maximum likelihood estimates are reported in Table 7. Also descriptive summary, minimum (Min), maximum (Max), lower quartile, median, upper quartile, skewness and kurtosis of data set is reprted in 7. Histogram density, CDF and P-P plot is displayed in Figure 3. Lifetimes of Kevlar 49/epoxy strands subjected to constant sustained pressure at 90 percent stress level until the strand failure. Dataset was considered by Pobočíková et al. (2018), and the failure times in this dataset were as follows:
0.0251, 0.0886, 0.0891, 0.2501, 0.3113, 0.3451, 0.4763, 0.5650, 0.5671, 0.6566, 0.6748, 0.6751, 0.6753, 0.7696, 0.8375, 0.8391, 0.8425, 0.8645, 0.8851, 0.9113, 0.9120, 0.9836, 1.0483, 1.0596, 1.0773, 1.1733, 1.2570, 1.2766, 1.2985, 1.3211, 1.3503, 1.3551, 1.4595, 1.4880, 1.5728, 1.5733, 1.7083, 1.7263, 1.7460, 1.7630, 1.7746, 1.8275, 1.8375, 1.8503, 1.8808, 1.8878, 1.8881, 1.9316, 1.9558, 2.0048, 2.0408, 2.0903, 2.1093, 2.1330, 2.2100, 2.2460, 2.2878, 2.3203, 2.3470, 2.3513, 2.4951, 2.5260, 2.9911, 3.0256, 3.2678, 3.4045, 3.4846, 3.7433, 3.7455, 3.9143, 4.8073, 5.4005, 5.4435, 5.5295, 6.5541, 9.0960
Maximum likelihood estimates of chosen data set are $\eta = 1.0509395$, $\sigma = 1.4418208$ and $\lambda = -0.7957367$. Let specified mean lifetime and termination ratio are 0.40 and 1.25 respectively then termination time is 0.5. For setup $P^* = 0.95$, r=5, c=3, $t_0/\mu_0 = 1.25$, required minimum number of group are 2. Accept the lot if not more than 3 failures in each group, otherwise reject the lot.

7 Conclusions

In this proposed study, we developed the $\mathcal{GASP}$ for *TrWD* under time truncated scheme. We discussed the methodology of $\mathcal{GASP}$ which can be used for other non-normal distributions. Plan parameters of $\mathcal{GASP}$ are calculated for considered setups for known value of η and λ. OC values are presented in Tables for considered setups. Also we discussed the presented Tables along with its important trends regarding minimum number of groups and OC values. A comparison study is included to show the superiority of proposed plan with the $\mathcal{SASP}$ and it is shown through the table and figures. Utility of Tables are described with the help of example. At last, we showed the application of developed $\mathcal{GASP}$ by using real life example. Discussed methodology can be used for other non-normal distribution to develop the $\mathcal{GASP}$. Practitioner or research or industrialist may use proposed study to make a decision of acceptance or rejection of lot when real life situation coincide with presented plan.

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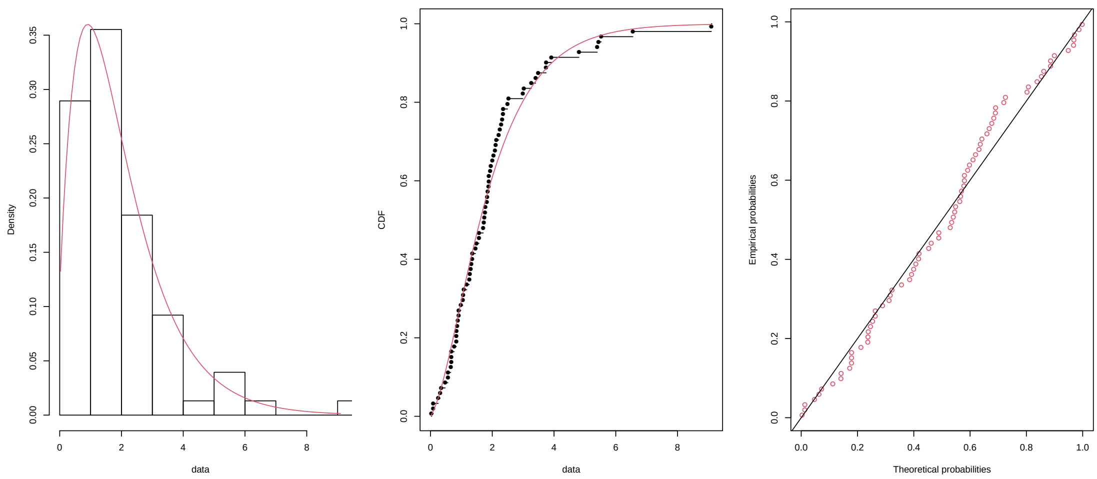

Figure 3: Histogram density, Empirical theoretical CDFs and P-P plot of considered data set.

Table 1: Minimum number of groups for the proposed plan when η=0.75, λ=0.75

			t_0/μ_0						
P^*	r	c	1.25	1.75	2.25	2.5	3	3.5	4
0.75	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	1	1	1	1	1	1	1
	6	4	2	1	1	1	1	1	1
	7	5	2	1	1	1	1	1	1
	8	6	2	1	1	1	1	1	1
	9	7	2	1	1	1	1	1	1
	10	8	3	2	1	1	1	1	1
	11	9	3	2	1	1	1	1	1
	12	10	3	2	1	1	1	1	1
0.90	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	2	1	1	1	1	1	1
	5	3	2	1	1	1	1	1	1
	6	4	2	2	1	1	1	1	1
	7	5	3	2	1	1	1	1	1
	8	6	3	2	2	1	1	1	1
	9	7	3	2	2	1	1	1	1
	10	8	4	2	2	2	1	1	1
	11	9	5	3	2	2	1	1	1
	12	10	5	3	2	2	1	1	1
0.95	2	0	1	1	1	1	1	1	1
	3	1	2	1	1	1	1	1	1
	4	2	2	2	1	1	1	1	1
	5	3	2	2	1	1	1	1	1
	6	4	3	2	2	1	1	1	1
	7	5	3	2	2	2	1	1	1
	8	6	4	2	2	2	1	1	1
	9	7	4	3	2	2	2	1	1
	10	8	5	3	2	2	2	1	1
	11	9	6	3	2	2	2	1	1
	12	10	7	4	2	2	2	1	1
0.99	2	0	2	2	1	1	1	1	1
	3	1	2	2	2	1	1	1	1
	4	2	3	2	2	2	1	1	1
	5	3	3	2	2	2	2	1	1
	6	4	4	3	2	2	2	2	1
	7	5	5	3	2	2	2	2	1
	8	6	6	3	3	2	2	2	2
	9	7	6	4	3	2	2	2	2
	10	8	8	4	3	3	2	2	2
	11	9	9	5	3	3	2	2	2
	12	10	10	5	3	3	2	2	2

Table 2: Minimum number of groups for the proposed plan when η=1.75, λ=0.75

			t_0/μ_0						
P^*	r	c	1.25	1.75	2.25	2.5	3	3.5	4
0.75	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	1	1	1	1	1	1	1
	6	4	1	1	1	1	1	1	1
	7	5	1	1	1	1	1	1	1
	8	6	2	1	1	1	1	1	1
	9	7	2	1	1	1	1	1	1
	10	8	2	1	1	1	1	1	1
	11	9	2	1	1	1	1	1	1
	12	10	2	1	1	1	1	1	1
0.90	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	2	1	1	1	1	1	1
	6	4	2	1	1	1	1	1	1
	7	5	2	1	1	1	1	1	1
	8	6	2	1	1	1	1	1	1
	9	7	3	1	1	1	1	1	1
	10	8	3	1	1	1	1	1	1
	11	9	3	1	1	1	1	1	1
	12	10	3	1	1	1	1	1	1
0.95	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	2	1	1	1	1	1	1
	5	3	2	1	1	1	1	1	1
	6	4	2	1	1	1	1	1	1
	7	5	2	1	1	1	1	1	1
	8	6	3	1	1	1	1	1	1
	9	7	3	1	1	1	1	1	1
	10	8	4	1	1	1	1	1	1
	11	9	4	1	1	1	1	1	1
	12	10	4	2	1	1	1	1	1
0.99	2	0	2	1	1	1	1	1	1
	3	1	2	1	1	1	1	1	1
	4	2	2	1	1	1	1	1	1
	5	3	3	1	1	1	1	1	1
	6	4	3	2	1	1	1	1	1
	7	5	4	2	1	1	1	1	1
	8	6	4	2	1	1	1	1	1
	9	7	5	2	1	1	1	1	1
	10	8	5	2	1	1	1	1	1
	11	9	6	2	1	1	1	1	1
	12	10	6	2	1	1	1	1	1

Table 3: Minimum number of groups for the proposed plan when η=1.25, λ=0.95

			t_0/μ_0						
P^*	r	c	1.25	1.75	2.25	2.5	3	3.5	4
0.75	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	1	1	1	1	1	1	1
	6	4	1	1	1	1	1	1	1
	7	5	1	1	1	1	1	1	1
	8	6	1	1	1	1	1	1	1
	9	7	1	1	1	1	1	1	1
	10	8	1	1	1	1	1	1	1
	11	9	2	1	1	1	1	1	1
	12	10	2	1	1	1	1	1	1
0.90	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	1	1	1	1	1	1	1
	6	4	1	1	1	1	1	1	1
	7	5	2	1	1	1	1	1	1
	8	6	2	1	1	1	1	1	1
	9	7	2	1	1	1	1	1	1
	10	8	2	1	1	1	1	1	1
	11	9	2	1	1	1	1	1	1
	12	10	2	1	1	1	1	1	1
0.95	2	0	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1
	4	2	1	1	1	1	1	1	1
	5	3	2	1	1	1	1	1	1
	6	4	2	1	1	1	1	1	1
	7	5	2	1	1	1	1	1	1
	8	6	2	1	1	1	1	1	1
	9	7	2	1	1	1	1	1	1
	10	8	3	1	1	1	1	1	1
	11	9	3	1	1	1	1	1	1
	12	10	3	1	1	1	1	1	1
0.99	2	0	1	1	1	1	1	1	1
	3	1	2	1	1	1	1	1	1
	4	2	2	1	1	1	1	1	1
	5	3	2	1	1	1	1	1	1
	6	4	2	2	1	1	1	1	1
	7	5	3	2	1	1	1	1	1
	8	6	3	2	1	1	1	1	1
	9	7	3	2	1	1	1	1	1
	10	8	4	2	1	1	1	1	1
	11	9	4	2	1	1	1	1	1
	12	10	4	2	1	1	1	1	1

Table 4: OC values of the sampling plan of r=5 and c=3 for a given P^* with $\eta = 0.75$, $\lambda = 0.75$

			μ/μ_0							
P^*	t_0/μ_0	g	2	3	4	5	6	7	8	9
0.75	1.25	1	0.5420855	0.7318394	0.8318905	0.8880917	0.9218143	0.9432160	0.9574410	0.9672642
	1.75	1	0.3650338	0.5774258	0.7117432	0.7962914	0.8511770	0.8880917	0.9137531	0.9321200
	2.25	1	0.2433151	0.4459998	0.5956732	0.6997477	0.7721871	0.8235014	0.8606385	0.8880917
	2.5	1	0.1987949	0.3903880	0.5420855	0.6524834	0.7318394	0.7894244	0.8318905	0.8637614
	3.0	1	0.1334938	0.2980794	0.4459998	0.5631005	0.6524834	0.7203425	0.7721871	0.8122231
	3.5	1	0.09062479	0.22743036	0.36503378	0.48260382	0.57742577	0.65248345	0.71174325	0.75873949
	4.0	1	0.0622984	0.1739041	0.2980794	0.4118349	0.5083683	0.5878075	0.6524834	0.7050722
0.90	1.25	2	0.2938567	0.5355889	0.6920418	0.7887069	0.8497417	0.8896564	0.9166933	0.9356000
	1.75	1	0.3650338	0.5774258	0.7117432	0.7962914	0.8511770	0.8880917	0.9137531	0.9321200
	2.25	1	0.2433151	0.4459998	0.5956732	0.6997477	0.7721871	0.8235014	0.8606385	0.8880917
	2.5	1	0.1987949	0.3903880	0.5420855	0.6524834	0.7318394	0.7894244	0.8318905	0.8637614
	3.0	1	0.1334938	0.2980794	0.4459998	0.5631005	0.6524834	0.7203425	0.7721871	0.8122231
	3.5	1	0.09062479	0.22743036	0.36503378	0.48260382	0.57742577	0.65248345	0.71174325	0.75873949
	4.0	1	0.0622984	0.1739041	0.2980794	0.4118349	0.5083683	0.5878075	0.6524834	0.7050722
0.95	1.25	2	0.2938567	0.5355889	0.6920418	0.7887069	0.8497417	0.8896564	0.9166933	0.9356000
	1.75	2	0.1332497	0.3334205	0.5065785	0.6340800	0.7245022	0.7887069	0.8349448	0.8688477
	2.25	1	0.2433151	0.4459998	0.5956732	0.6997477	0.7721871	0.8235014	0.8606385	0.8880917
	2.5	1	0.1987949	0.3903880	0.5420855	0.6524834	0.7318394	0.7894244	0.8318905	0.8637614
	3.0	1	0.1334938	0.2980794	0.4459998	0.5631005	0.6524834	0.7203425	0.7721871	0.8122231
	3.5	1	0.09062479	0.22743036	0.36503378	0.48260382	0.57742577	0.65248345	0.71174325	0.75873949
	4.0	1	0.0622984	0.1739041	0.2980794	0.4118349	0.5083683	0.5878075	0.6524834	0.7050722
0.99	1.25	3	0.1592955	0.3919650	0.5757030	0.7004441	0.7833041	0.8391382	0.8776798	0.9049723
	1.75	2	0.1332497	0.3334205	0.5065785	0.6340800	0.7245022	0.7887069	0.8349448	0.8688477
	2.25	2	0.05920225	0.19891582	0.35482654	0.48964686	0.59627295	0.67815451	0.74069867	0.78870694
	2.5	2	0.03951942	0.15240282	0.29385671	0.42573465	0.53558889	0.62319090	0.69204183	0.74608372
	3.0	2	0.01782059	0.08885133	0.19891582	0.31708223	0.42573465	0.51889333	0.59627295	0.65970631
	3.5	1	0.09062479	0.22743036	0.36503378	0.48260382	0.57742577	0.65248345	0.71174325	0.75873949
	4.0	1	0.0622984	0.1739041	0.2980794	0.4118349	0.5083683	0.5878075	0.6524834	0.7050722

Table 5: OC values of the sampling plan of r=5 and c=3 for a given P^* with $\eta = 1.75$, $\lambda = 0.75$

			μ/μ_0							
P^*	t_0/μ_0	g	2	3	4	5	6	7	8	9
0.75	1.25	1	0.8373333	0.9770149	0.9956144	0.9988983	0.9996587	0.9998761	0.9999491	0.9999770
	1.75	1	0.5038524	0.8785463	0.9701142	0.9914095	0.9971177	0.9988983	0.9995316	0.9997826
	2.25	1	0.2125007	0.6813778	0.8966668	0.9653229	0.9872177	0.9948058	0.9976964	0.9988983
	2.5	1	0.1242960	0.5630527	0.8373333	0.9407485	0.9770149	0.9903397	0.9956144	0.9978670
	3.0	1	0.03689257	0.34038241	0.68137782	0.86283893	0.94074848	0.97323251	0.98721769	0.99355050
	3.5	1	0.009720176	0.178882822	0.503852440	0.748464052	0.878546258	0.940748483	0.970114207	0.984302583
	4.0	1	0.002388383	0.084416505	0.340382406	0.610797646	0.790036124	0.889109223	0.940748483	0.967515017
0.90	1.25	2	0.7011270	0.9545582	0.9912481	0.9977979	0.9993175	0.9997521	0.9998982	0.9999539
	1.75	1	0.5038524	0.8785463	0.9701142	0.9914095	0.9971177	0.9988983	0.9995316	0.9997826
	2.25	1	0.2125007	0.6813778	0.8966668	0.9653229	0.9872177	0.9948058	0.9976964	0.9988983
	2.5	1	0.1242960	0.5630527	0.8373333	0.9407485	0.9770149	0.9903397	0.9956144	0.9978670
	3.0	1	0.03689257	0.34038241	0.68137782	0.86283893	0.94074848	0.97323251	0.98721769	0.99355050
	3.5	1	0.009720176	0.178882822	0.503852440	0.748464052	0.878546258	0.940748483	0.970114207	0.984302583
	4.0	1	0.002388383	0.084416505	0.340382406	0.610797646	0.790036124	0.889109223	0.940748483	0.967515017
0.95	1.25	2	0.7011270	0.9545582	0.9912481	0.9977979	0.9993175	0.9997521	0.9998982	0.9999539
	1.75	1	0.5038524	0.8785463	0.9701142	0.9914095	0.9971177	0.9988983	0.9995316	0.9997826
	2.25	1	0.2125007	0.6813778	0.8966668	0.9653229	0.9872177	0.9948058	0.9976964	0.9988983
	2.5	1	0.1242960	0.5630527	0.8373333	0.9407485	0.9770149	0.9903397	0.9956144	0.9978670
	3.0	1	0.03689257	0.34038241	0.68137782	0.86283893	0.94074848	0.97323251	0.98721769	0.99355050
	3.5	1	0.009720176	0.178882822	0.503852440	0.748464052	0.878546258	0.940748483	0.970114207	0.984302583
	4.0	1	0.002388383	0.084416505	0.340382406	0.610797646	0.790036124	0.889109223	0.940748483	0.967515017
0.99	1.25	3	0.5870769	0.9326176	0.9869009	0.9966986	0.9989765	0.9996282	0.9998473	0.9999309
	1.75	1	0.5038524	0.8785463	0.9701142	0.9914095	0.9971177	0.9988983	0.9995316	0.9997826
	2.25	1	0.2125007	0.6813778	0.8966668	0.9653229	0.9872177	0.9948058	0.9976964	0.9988983
	2.5	1	0.1242960	0.5630527	0.8373333	0.9407485	0.9770149	0.9903397	0.9956144	0.9978670
	3.0	1	0.03689257	0.34038241	0.68137782	0.86283893	0.94074848	0.97323251	0.98721769	0.99355050
	3.5	1	0.009720176	0.178882822	0.503852440	0.748464052	0.878546258	0.940748483	0.970114207	0.984302583
	4.0	1	0.002388383	0.084416505	0.340382406	0.610797646	0.790036124	0.889109223	0.940748483	0.967515017

Table 6: OC values of the sampling plan of r=5 and c=3 for a given P^* with $\eta = 1.25$, $\lambda = 0.95$

			μ/μ_0							
P^*	t_0/μ_0	g	2	3	4	5	6	7	8	9
0.75	1.25	1	0.5875783	0.8562156	0.9449936	0.9762167	0.9885706	0.9940149	0.9966401	0.9980034
	1.75	1	0.2858840	0.6452403	0.8334414	0.9182310	0.9572269	0.9762167	0.9860430	0.9914197
	2.25	1	0.1135164	0.4228351	0.6739512	0.8191056	0.8970537	0.9391749	0.9626463	0.9762167
	2.5	1	0.06795335	0.32773783	0.58757829	0.75752835	0.85621562	0.91244738	0.94499356	0.96435119
	3.0	1	0.02279946	0.18378771	0.42283510	0.62216699	0.75752835	0.84337958	0.89705365	0.93087735
	3.5	1	0.007266767	0.095966087	0.285884003	0.486281789	0.645240280	0.757528354	0.833441447	0.884182895
	4.0	1	0.002275427	0.047608454	0.183787707	0.364019510	0.530621752	0.661673786	0.757528354	0.825536141
0.90	1.25	1	0.5875783	0.8562156	0.9449936	0.9762167	0.9885706	0.9940149	0.9966401	0.9980034
	1.75	1	0.2858840	0.6452403	0.8334414	0.9182310	0.9572269	0.9762167	0.9860430	0.9914197
	2.25	1	0.1135164	0.4228351	0.6739512	0.8191056	0.8970537	0.9391749	0.9626463	0.9762167
	2.5	1	0.06795335	0.32773783	0.58757829	0.75752835	0.85621562	0.91244738	0.94499356	0.96435119
	3.0	1	0.02279946	0.18378771	0.42283510	0.62216699	0.75752835	0.84337958	0.89705365	0.93087735
	3.5	1	0.007266767	0.095966087	0.285884003	0.486281789	0.645240280	0.757528354	0.833441447	0.884182895
	4.0	1	0.002275427	0.047608454	0.183787707	0.364019510	0.530621752	0.661673786	0.757528354	0.825536141
0.95	1.25	2	0.3452483	0.7331052	0.8930128	0.9529990	0.9772718	0.9880656	0.9932914	0.9960108
	1.75	1	0.2858840	0.6452403	0.8334414	0.9182310	0.9572269	0.9762167	0.9860430	0.9914197
	2.25	1	0.1135164	0.4228351	0.6739512	0.8191056	0.8970537	0.9391749	0.9626463	0.9762167
	2.5	1	0.06795335	0.32773783	0.58757829	0.75752835	0.85621562	0.91244738	0.94499356	0.96435119
	3.0	1	0.02279946	0.18378771	0.42283510	0.62216699	0.75752835	0.84337958	0.89705365	0.93087735
	3.5	1	0.007266767	0.095966087	0.285884003	0.486281789	0.645240280	0.757528354	0.833441447	0.884182895
	4.0	1	0.002275427	0.047608454	0.183787707	0.364019510	0.530621752	0.661673786	0.757528354	0.825536141
0.99	1.25	2	0.3452483	0.7331052	0.8930128	0.9529990	0.9772718	0.9880656	0.9932914	0.9960108
	1.75	1	0.2858840	0.6452403	0.8334414	0.9182310	0.9572269	0.9762167	0.9860430	0.9914197
	2.25	1	0.1135164	0.4228351	0.6739512	0.8191056	0.8970537	0.9391749	0.9626463	0.9762167
	2.5	1	0.06795335	0.32773783	0.58757829	0.75752835	0.85621562	0.91244738	0.94499356	0.96435119
	3.0	1	0.02279946	0.18378771	0.42283510	0.62216699	0.75752835	0.84337958	0.89705365	0.93087735
	3.5	1	0.007266767	0.095966087	0.285884003	0.486281789	0.645240280	0.757528354	0.833441447	0.884182895
	4.0	1	0.002275427	0.047608454	0.183787707	0.364019510	0.530621752	0.661673786	0.757528354	0.825536141

Table 7: Model fitting and descriptive summary of data set

Descriptive Summary						
Min	Max	Lower Quantile	Median	Upper Quantile	Skewness	Kurtosis
0.0251	9.0960	0.8982	1.7362	2.3041	2.0196	5.6004
Model fitting Summary						
Model	L-L	AIC	BIC	K-S statistic	p-value	
TrWD	-121.43	248.86	255.8522	0.098776	0.4215	

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Table 8: Comparison of OC values of proposed plan and SASP of r=12 and c=10 for a given P^* with $\eta = 0.75$, $\lambda = 0.75$

P^*	t_0/μ_0	g	n	μ/μ_0							
				2		4		6		8	
				PP	SASP	PP	SASP	PP	SASP	PP	SASP
0.75	1.25	3	14	0.8498022	0.7426871	0.9931812	0.9783150	0.9993031	0.9970554	0.9998820	0.9994138
	1.75	2	13	0.7051158	0.6643066	0.9762008	0.9625826	0.9968492	0.9941147	0.9993796	0.9987178
	2.25	1	12	0.6971183	0.6971183	0.9648426	0.9648426	0.9942369	0.9942369	0.9987060	0.9987060
	2.5	1	12	0.6233385	0.6233385	0.9471947	0.9471947	0.9904487	0.9904487	0.9977219	0.9977219
	3	1	12	0.4854028	0.4854028	0.9000562	0.9000562	0.9783880	0.9783880	0.9942369	0.9942369
0.90	1.25	5	15	0.7624237	0.6007969	0.9886611	0.9540956	0.9988388	0.9928370	0.9998034	0.9984560
	1.75	3	14	0.5920941	0.4750604	0.9645144	0.9152463	0.9952775	0.9841605	0.9993796	0.9987178
	2.25	2	13	0.4859740	0.4628209	0.9309213	0.9036716	0.9885071	0.9806327	0.9974136	0.9951020
	2.5	2	13	0.3885508	0.3770031	0.8971779	0.8637568	0.9809886	0.9694328	0.9954489	0.9917249
	3	1	12	0.4854028	0.4854028	0.9000562	0.9000562	0.9783880	0.9783880	0.9942369	0.9942369
0.95	1.25	7	16	0.6840297	0.4582615	0.9841616	0.9166020	0.9983747	0.9850928	0.9983747	0.9850928
	1.75	4	15	0.4971883	0.3101463	0.9529680	0.8441231	0.9937083	0.9655865	0.9987595	0.9908617
	2.25	2	14	0.4859740	0.2694449	0.9309213	0.8075354	0.9885071	0.9529493	0.9974136	0.9866370
	2.5	2	13	0.3885508	0.3770031	0.8971779	0.8637568	0.9809886	0.9694328	0.9954489	0.9917249
	3	2	13	0.2436159	0.2417769	0.8101011	0.7690477	0.9572430	0.9368834	0.9885071	0.9806327
0.99	1.25	10	18	0.5812899	0.2274869	0.9774508	0.8003508	0.9976790	0.9536747	0.9996068	0.9874066
	1.75	5	16	0.4174949	0.1869659	0.9415597	0.7525258	0.9921415	0.9358793	0.9984496	0.9812604
	2.25	3	15	0.3387814	0.1405358	0.8981926	0.6855036	0.9828102	0.9074493	0.9961230	0.9705780
	2.5	3	14	0.2421987	0.1976853	0.8498022	0.7426871	0.9716189	0.9291691	0.9931812	0.9783150
	3	2	14	0.1143686	0.1034720	0.7291365	0.6058092	0.9365551	0.8660328	0.9828102	0.9529493

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