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Control Charts for a Novel Exponent Power Rayleigh Distribution

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Abstract: In this Paper, we presented the distribution as A Novel Exponent Power Rayleigh (NovEPRD) probability density function, Distribution, and Survival and Hazard functions introduced by Bharathi et al (2022) and A Novel Exponent Power Rayleigh (NovEPR) distribution Properties and its Applications studied by Bharathi et al (2022) and then here we derived the Weighted Variance (WV), Weighted Standard Deviation (WSD) and Correction Factor (CF) for existed A Novel Exponent Power Rayleigh (NovEPR) distribution , this paper obtains the parameters of the control lines $\bar{X}$ and R drawn from the A Novel Exponent Power Rayleigh (NovEPR) distribution. These methods are compared with Newton Raphson's simulations. For these control charts, Type I risk is compared with different groups of A Novel Exponent Power Rayleigh (NovEPR) distribution. Simulation results show that the Skewness Correction (SC) method of Type I carries less risk than other methods. When the distribution is approximately equal, the type I risk of the Shewhart, W V, WSD and SC $\bar{X}$ plans is comparable, while the type I risk of the SC R plan is smaller.
Keywords: NovEPR, W V, WSD, SC- $\bar{X}$ and Type I risk of the SC-R plan.

I. INTRODUCTION

This study presents a new two-parameter probability distribution called modified Rayleigh distribution. The one parameter modified Rayleigh distribution is used as a base line to construct the new mode Simulation is constructed to declare theoretical properties, to show the flexibility of the new model. the applications of statistical methods in sports and health sciences have greatly attracted researchers. In sports sciences, numerous statistics are utilized to ascertain the performance of an individual player or a team. For example, in a football game, a player can have various statistical values such as (a) minutes played, (b) total goals, (c) total assists, (d) yellow card, (e) red card, (f) shots per game, (g) pass success percentage, (h) aerial duels won per game, (i) man of the match, and (j) man of the series or man of the tournament. For more brief information; see Moura et al. (2014). Whereas, in the healthcare sector, one often needs to know about (a) the number of patients admitted to the hospital, (b) the length of stay of patients at the hospital, (c) the number of doses received per day, (d) the survival time, and (e) the number of patients discharged from the hospital; see Shanafelt et al. (2020) and Zhang et al. (2020), Yousaf et al. (2020), Subrhamanyam et al. (2020) studied the Alpha Logarithm Transformed Rayleigh Distribution: Properties, Cai et al. (2021), Ananda-Rajah et al. (2021), Gozalpour et al. (2021), Eloranta et al. (2021), Salahuddin et al. (2021), and Ali et al. (2021).

1) The Probability density and Distribution functions of the NovEPRD

NovEPRD Specifications

We further contribute to this area by proposing another new approach, namely, a novel exponent power-Y (NovEP-X) family.

A random variable say X is said to follow a NovEP-Y family, if its PDF (Probability distribution function) $k(x;\sigma^2,\alpha)$ is given by

$$\frac{d}{dx}W(x;\sigma^2,\alpha) = w(x;\sigma^2,\alpha)$$

Here, $w(x;\sigma^2,\alpha)$ baseline Probability density function

$$k(x;\sigma^2,\alpha) = \frac{\alpha w(x;\sigma^2,\alpha)[1+W(x;\sigma^2,\alpha)]}{e^{1-W(x;\sigma^2,\alpha)}}\left(1-\frac{W(x;\sigma^2,\alpha)}{e^{1-W(x;\sigma^2,\alpha)}}\right)^{\alpha-1} \quad \dots (1.2.1)$$

$$k(x;\sigma^2,\alpha) = \frac{\alpha\left(1-e^{-x^2/2\sigma^2}\right)\left[2-e^{-x^2/2\sigma^2}\right]}{e^{e^{-x^2/2\sigma^2}}}\left(1-\frac{1-e^{-x^2/2\sigma^2}}{e^{e^{-x^2/2\sigma^2}}}\right)^{\alpha-1} \quad \dots (1.2.2)$$

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Where $x \in [0,\infty)$, $W(x;\sigma^2,\alpha)$ and $\alpha > 0$ is baseline distribution function.

A random variable say X is said to follow a NovEP-Y family, if its DF (distribution function) K(x;σ^2,α) is given by

$$K(x;\sigma^2,\alpha) = 1-\left(1-\frac{W(x;\sigma^2,\alpha)}{e^{1-W(x;\sigma^2,\alpha)}}\right)^{\lambda} \quad \ldots (1.2.3)$$

Where$\alpha > 0$, $x \in [0,\infty)$, $W(x;\sigma^2,\alpha)$ and $\alpha > 0$ is baseline distribution function.

To prove that K(x;σ^2,α) is a valid distribution function, a brief explanation is provided in the below

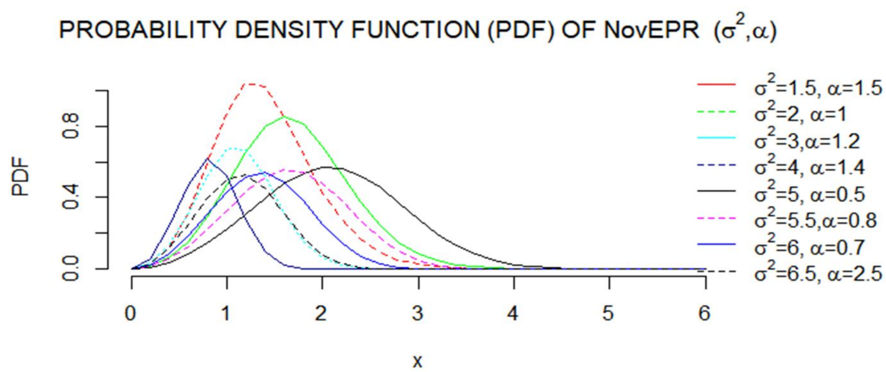
$$K(x;\sigma^2,\alpha) = 1-\left(1-\frac{(1-e^{-x^2/2\sigma^2})}{e^{1-(1-e^{-x^2/2\sigma^2})}}\right)^{\alpha}$$

$$= 1-\left(1-\frac{1-e^{-x^2/2\sigma^2}}{e^{e^{-x^2/2\sigma^2}}}\right)^{\alpha} \quad \ldots (1.2.4)$$

The graph for Probability density function f(x) of NovEPRD is given below Graph 1.1 for different values of the parameters.

Graph 1.1

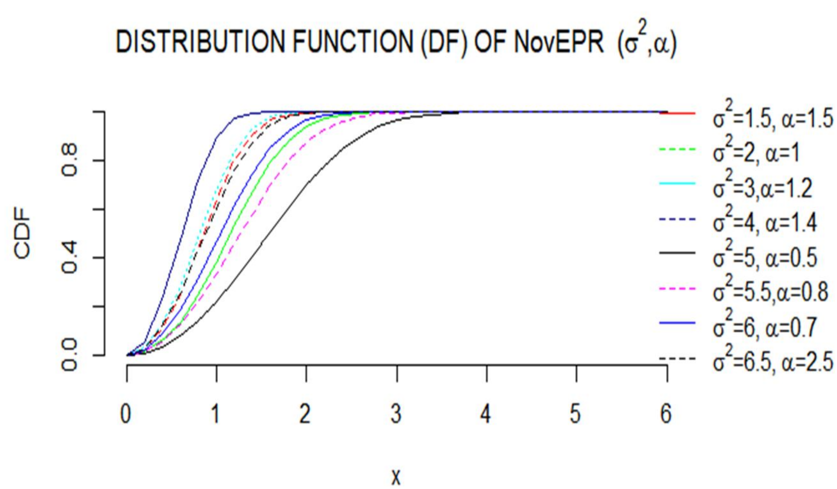
A NovEL EXPONENT POWER RAYLEIGH Distribution



The graph of Cumulative Distribution Function of NovEPRD is given below Graph 1.2 for different values of the parameters.

Graph 1.2

A NovEL EXPONENT POWER RAYLEIGH Distribution



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A random variable say X is said to follow a NovEP-Y family, if its SF (Survival Function) s(x;σ^2,α) is given by

$$s(x;\sigma^2,\alpha) = \bar{K}(x;\sigma^2,\alpha) = 1 - K(x;\sigma^2,\alpha) = \left(1 - \frac{W(x;\alpha,\sigma^2)}{e^{1-W(x;\alpha,\sigma^2)}}\right)$$

$$= \left(1 - \frac{1 - e^{-x^2/2\sigma^2}}{e^{e^{-x^2/2\sigma^2}}}\right) \quad \ldots (1.2.3)$$

Where $\alpha > 0$, x $\in [0,\infty)$, $W(x;\sigma^2,\alpha)$ and $\theta > 0$ is baseline distribution function.

A random variable say X is said to follow a NovEP-Y family, if its HF (Hazard Function) h(x;σ^2,α) is given by

$$h(x;\sigma^2,\alpha) = \frac{\alpha w(x;\sigma^2,\alpha)[1+W(x;\sigma^2,\alpha)]}{e^{1-W(x;\sigma^2,\alpha)}}\left(1 - \frac{W(x;\sigma^2,\alpha)}{e^{1-W(x;\sigma^2,\alpha)}}\right)^{-1} \quad \ldots (1.2.4)$$

$$h(x;\sigma^2,\alpha) = \frac{\alpha(1 - e^{-x^2/2\sigma^2})\left[2 - e^{-x^2/2\sigma^2}\right]}{e^{e^{-x^2/2\sigma^2}}}\left(1 - \frac{1 - e^{-x^2/2\sigma^2}}{e^{e^{-x^2/2\sigma^2}}}\right)^{-1}$$

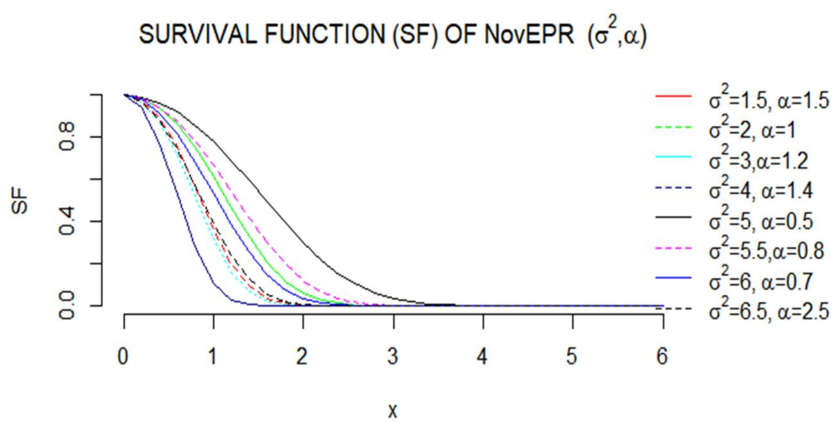
… (1.2.5)

Where $\alpha > 0$, x $\in [0,\infty)$, $W(x;\sigma^2,\alpha)$ and $\alpha > 0$ is baseline distribution function.

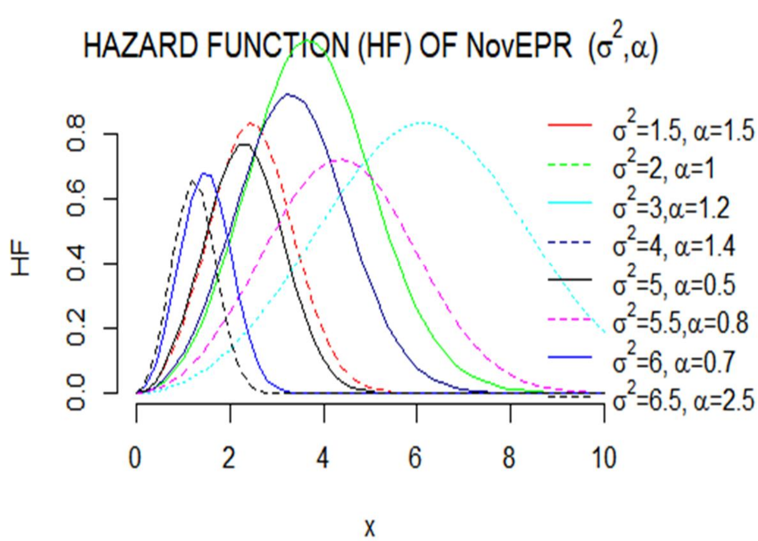
The graph for Survival function S(x) of NovEPRD is given below Graph 1.3 for different values of the parameters.

Graph 1.3

A Novel Exponent Power Rayleigh Distribution



The graph for Hazard function H(x) Novel Exponent Power-Rayleigh (NovEPR) distribution is given below Graph 1.4 for different values of the parameters.



2) The Statistical properties of NovEPRD

In this section we presented some Statistical properties of NovEPRD, especially Quartile, Median and Mean and Variance.

- Quantile and random number generation of NovEPRD

Quantile Function (QF)

The QF of the NovEP-R distributions is its inverse DF and derived as

A random variable X ~ NovEP-R (σ^2, α) has Quantile function and is in the form The p^{th} quantile x_p of NovEP-R distribution is the root of the equation

$y = Q(u) = K^{-1}(u) = W^{-1}(z)$,

where $p = e^{-x^2/2\sigma^2}$ is the solution of

$$y = Q(p) = 1 - \left(1 - \frac{1-e^p}{e^{e^p}}\right)^\alpha \quad \ldots (1.3.1.1)$$

Random number generation

Let U~ U(0,1), then equation (1.2) can be used to simulate a random sample of size n from the NovEP-R distribution as follows

$$x_i = 1 - \left(1 - \frac{1-e^{u_i}}{e^{e^{u_i}}}\right)^\alpha \quad \ldots (1.3.1.2)$$

3) Mean and Variance of NovEPRD

The r^{th} moment about the origin of X ~ NovEP-R (σ^2, α) is given by

$\mu_r^1 =$

$$\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\frac{\alpha\sigma^{r+1}}{l!}(-1)^{i+j+k}\binom{\alpha-1}{i}\binom{i+1}{j}\binom{i+2}{k}\frac{\gamma(\frac{r+1}{2},((-(i+1)l+k+j)x)}{2((i+1)l-k-j)^{\frac{r+1}{2}}(-1)^{\frac{r-1}{2}}} \quad \ldots(1.5.1)$$

Mean = μ_1^1 =

$$\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\frac{\alpha\sigma^{2}}{l!}(-1)^{i+j+k}\binom{\alpha-1}{i}\binom{i+1}{j}\binom{i+2}{k}\frac{\gamma(1,((-(i+1)l+k+j)x)}{2((i+1)l-k-j)} \quad \ldots(1.5.2)$$

Variance = $\mu_2 = \mu_2^1 - (\mu_1^1)^2$

=

$$\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\frac{\alpha\sigma^{3}}{l!}(-1)^{i+j+k}\binom{\alpha-1}{i}\binom{i+1}{j}\binom{i+2}{k}\frac{\gamma(\frac{3}{2},((-(i+1)l+k+j)x)}{2((i+1)l-k-j)^{\frac{3}{2}}(-1)^{\frac{1}{2}}} -$$

$$\left(\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\sum_{k=0}^{\infty}\sum_{l=0}^{\infty}\frac{\alpha\sigma^{2}}{l!}(-1)^{i+j+k}\binom{\alpha-1}{i}\binom{i+1}{j}\binom{i+2}{k}\frac{\gamma(1,((-(i+1)l+k+j)x)}{2((i+1)l-k-j)}\right)^2 \quad \ldots(1.5.3)$$

4) Methods of Control charts

The aim of this section is to give the control limits of $\bar{X}$ control charts for skewed populations by considering the classic, WD, WSD and SC methods and to obtain the control limits of R control charts by considering the classic, WV and SC methods.

- Weighted Variance (WV) Method

The WV method with no assumptions on the population adjusts the control limits according to the skewness of the underlying population. The probability that the quality variable Z will be less than or equal to its mean M_z is $P_z = (Z \le M_z)$ at α% level of significance.

Case (i)

If the parameters of the process are known: The control limits of $\bar{Z}$ control chart are given by:

$$UCL_{\bar{z}} = M_{\bar{z}} + 3\frac{\sigma_z}{\sqrt{n}}\sqrt{2P_z} \quad (1.6.1.1)$$

$$LCL_{\bar{z}} = M_{\bar{z}} - 3\frac{\sigma_z}{\sqrt{n}}\sqrt{2Q_z} \quad (1.6.1.2)$$

$\frac{\sigma_z}{\sqrt{n}}$ is the standard error of $\bar{z}$, μ_z is the mean of z and $Q_z = 1 - P_z$

The control limits of Range (R) control chart are given by,

$$UCL_R = M_R + 3\sigma_R \sqrt{2P_z} \quad (1.6.1.3)$$

$$LCL_R = \left[M_R - 3\sigma_R\sqrt{2Q_z}\right]^+ \quad (1.6.1.4)$$

Here M_R and σ_R are the mean and standard deviation of range of sample size 'n' and $Q_z = 1 - P_z$

$\left[M_R - 3\sigma_R\sqrt{2Q_z}\right]^+$ is denote the max ($M_R + 3\sigma_R\sqrt{2P_z}$, 0)

Case (ii)

If the parameters of the process unknown: The control limits of $\bar{Z}$ control chart are given by:

$$\widehat{P_z} = \frac{\sum_{i=1}^{r}\sum_{j=1}^{m}\varphi(\bar{Z} - z_{ij})}{rm}$$

Where r and n are the number of samples and the number of observations in a subgroup, and $\varphi(Z) = 1$ for $Z \geq 0$,
= 0 otherwise.

Usually, M_z is estimated by the grand mean of the subgroup means $\bar{Z}$ and M_R is estimated by the mean of the subgroup ranges $\bar{R}$.
The control limits of $\bar{Z}$ control chart are given by:

$$UCL_{\bar{z}} = \bar{\bar{Z}} + 3\frac{\bar{R}}{d_2^*\sqrt{n}}\sqrt{2\widehat{P_z}} = \bar{\bar{Z}} + W_U\bar{R} \quad (1.6.1.5)$$

$$LCL_{\bar{z}} = \bar{\bar{Z}} - 3\frac{\bar{R}}{d_2^*\sqrt{n}}\sqrt{2(1 - \widehat{P_z})} = \bar{\bar{Z}} - W_L\bar{R} \quad (1.6.1.6)$$

The control limits of Range control chart are given by:

$$UCL_R = \bar{R}\left[1 + 3\frac{d_3^*}{d_2^*\sqrt{n}}\sqrt{2\widehat{P_z}}\right] = V_U\bar{R} \quad (1.6.1.7)$$

$$LCL_R = \bar{R}\left[- 3\frac{d_3^*}{d_2^*\sqrt{n}}\sqrt{2\widehat{P_z}}\right] = V_L\bar{R} \quad (1.6.1.8)$$

Where d_2^* and d_3^* are the control chart constants for $\bar{Z}$ and $\bar{R}$ charts based on weighted variance.

- Weighted standard Deviation (WSD) method:

In WSD method, like WV method, a NovEPRD can be decomposed into two parts at its mean and each part is used to create a new symmetric distribution adjusted in accordance with the degree of skewness.

Case (i)

If the parameters of the process are known, the control limits of the $\bar{Z}$ charts are given by:

$$UCL_{\bar{z}} = M + 3\frac{\sigma}{\sqrt{n}}2P \quad (1.6.2.1)$$

$$UCL_{\bar{z}} = M - 3\frac{\sigma}{\sqrt{n}}2Q \quad (1.6.2.2)$$

Case (ii)

If the parameters of the process are known, the control limits of the $\bar{Z}$ charts are given by:

$$UCL_{\bar{z}} = \bar{\bar{Z}} + 3\frac{\bar{R}}{d_2^{**}\sqrt{n}}2\widehat{P_z} = \bar{\bar{Z}} + WS_U\bar{R} \quad (1.6.2.3)$$

$$LCL_{\bar{z}} = \bar{\bar{Z}} - 3\frac{\bar{R}}{d_2^{**}\sqrt{n}}2(1 - \widehat{P_z}) = \bar{\bar{Z}} - WS_L\bar{R} \quad (1.6.2.4)$$

d_2^{**}, WS_U and WS_L are control chart constants for weighted standard deviation method.

$$d_2^{**} = Pd_2(2n(1-P)) + (1-P)d_2(2nP) \quad (1.6.2.5)$$

$d_2(n)$ is d_2 when sample size is n.

- Skewness Correction (SC) method

SC method is used for constructing the $\bar{Z}$ and R control charts for NovEPRD distribution.

Case (i)

If the parameters of the process are known, the control limits of the $\bar{Z}$ and R control chart are given by

$$UCL_{\bar{z}} = M_{\bar{z}} + \frac{\sigma_z}{\sqrt{n}}(3 + c_4^*) \quad (1.6.3.1)$$

$$LCL_{\bar{z}} = M_{\bar{z}} + \frac{\sigma_z}{\sqrt{n}}(-3 + c_4^*) \quad (1.6.3.2)$$

$$UCL_R = M_R + 3\sigma_R(3 + d_4^*) \quad (1.6.3.3)$$

$$\mathrm{LCL_R} = \mathrm{M_R} + 3\sigma_R\,(-3 + d_4^*) \quad (1.6.3.4)$$

Here c_4^* and d_4^* are control chart constants for $\bar{Z}$ and R control chart in SC method.

$$c_4^* = \frac{\frac{4}{3}\mathrm{k}_3(\bar{Z})}{1+0.2k_3^2(\bar{Z})}$$

$$d_4^* = \frac{\frac{4}{3}\mathrm{k}_3(R)}{1+0.2k_3^2(R)}$$

Here $\mathrm{k}_3(\bar{Z})$ is the skewness of the subgroup mean $\bar{Z}$ and $\mathrm{k}_3(R)$ is the skewness of the subgroup range R .

Case (ii)

If the parameters of the process are unknown, the control limits of the $\bar{Z}$ and R control chart are given by

$$\mathrm{UCL}_{\bar{z}} = \bar{\bar{Z}} + \left(3 + \frac{\frac{4k_3}{3\sqrt{n}}}{1+0.2k_3^2/n}\frac{\bar{R}}{d_2^*\sqrt{n}}\right) = \bar{\bar{Z}} + A^*{}_U\bar{R} \quad (1.6.3.5)$$

$$\mathrm{LCL}_{\bar{z}} = \bar{\bar{Z}} + \left(-3 + \frac{\frac{4k_3}{3\sqrt{n}}}{1+0.2k_3^2/n}\frac{\bar{R}}{d_2^*\sqrt{n}}\right) = \bar{\bar{Z}} - A^*{}_L\bar{R} \quad (1.6.3.6)$$

The control limits of Range control chart are given by:

$$\mathrm{UCL_R} = \bar{R}\left[1 + (3 + d_4^*)\frac{d_3^*}{d_2^*}\right] = D_4^*\bar{R} \quad (1.6.3.7)$$

$$\mathrm{LCL_R} = \bar{R}\left[1 + (-3 + d_4^*)\frac{d_3^*}{d_2^*}\right]^+ = D_3^*\bar{R} \quad (1.6.3.8)$$

5) Iteration procedure for simulation study

The simulation consists of two segments.

The steps of each segment are described below.

Segment 1:

Step 1.1: Generate m - NOVEPR varieties for m = 3, 5, 7 and 9.

Step 1.2: Repeat step 1.1 into 30 times (k = 30).

Step 1.3: Compute the control limits using the Equations (1.6.1.5), (1.6.1.6), (1.6.1.7) and (1.6.1.8) for the weighted variance method, using the Equations (1.6.2.3) and (1.6.2.4) for the weighted standard deviation method and using the Equations (1.6.3.5), (1.6.3.6), (1.6.3.7) and (4.6.3.8) for the skewness correction method.

Segment 2:

Step 2.1: Generate m NOVEPR varieties using the procedure of step 1.1.

Step 2.2: Repeat step 2.1 into 100 times (k = 100).

Step 2.3: Compute the sample statistics for $\bar{Z}$ and R charts for four methods.

Step 2.4: Record whether the sample statistics calculated in step 2.3 are within the control limits of step 1.3. or not for all methods.

Step 2.5: Repeat steps 1.1 through 2.4, 10000 times and obtain an average Type I risk for each method. The average Type I risks of the four methods estimated by using Newton-Raphson simulation are given in the following Figures for selected combinations of ‘m’ and distribution. As the skewness, Type I risk of SC method is less than that of others methods. When the distribution is approximately symmetric, then the Type I risks of SC, WSD, WV and Shewhart.

6) Observations for Simulation

When the quality variable has a skew distribution, it might be misleading to observe the process by using the Shewhart $\bar{Z}$ and R control charts. Because of the variability in population, usage of Shewhart $\bar{Z}$ and R control charts in skew distributions causes the increase of Type 1 risk when the skewness increases. Therefore, to reflect the variability of the population, the WV, WSD and SC methods which use asymmetric control limits are applied in this study, as an alternative to the classical method.

When these methods are compared the results obtained for NovEPRD are:

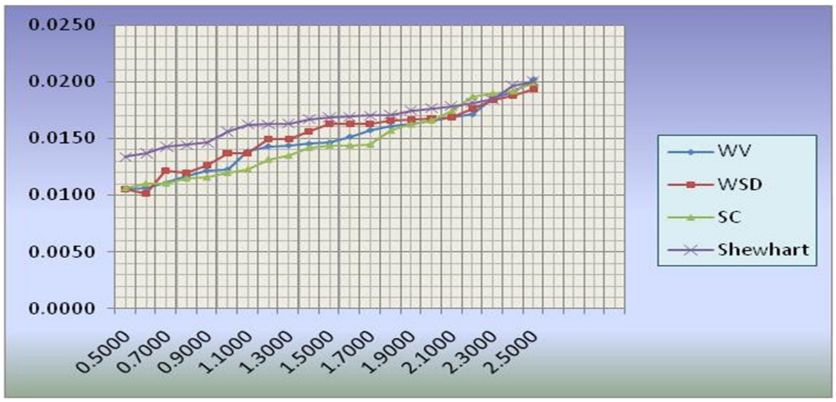
- The Shewhart chart has the worst performance. As the skewness increases, the type I risks of the Shewhart charts increases too much.
- When the distribution is approximately symmetric, then the type I risks of SC, WSD, WV and Shewhart charts are compareble, while the SC R chart a noticible smaller Type I risk.
- As the skewness increases, for chart WV gives better results than the Shewhart, WSD better than the Shewhart and WV , SC gives better results than other methods.

- As the skewness increases, for R chart WV gives better results than the Shewhart, SC gives better results than the Shewhart and WV .

7) **Simulation study**

By using Newton-Raphson Simulation, the type I risks of $\bar{Z}$ and R control charts based on classic Shewhart, WV , WSD and SC methods are compared. The NovEPR chosen since they can represent a wide variety of shapes from nearly symmetric to highly skewed at different level of significance values.

Fig 1.5 $\bar{Z}$ and R charts type I risks of SC, W SD, W V and Shewhart charts for n = 3 of NovEPR distribution



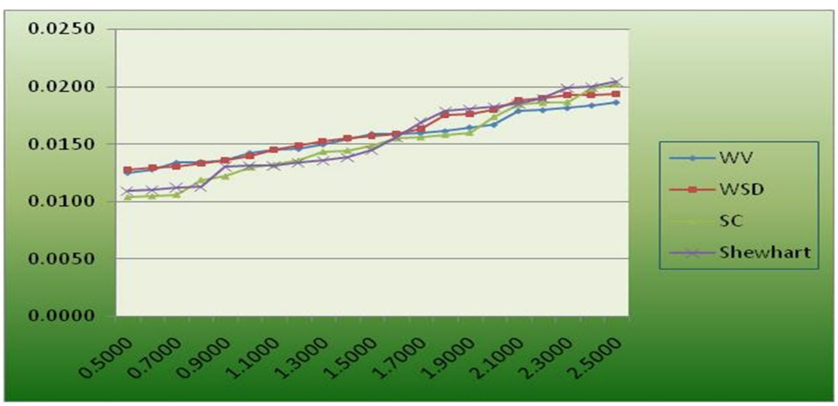


Fig 1.6 $\bar{Z}$ and R charts type I risks of SC, W SD, W V and Shewhart charts for n = 5 of NovEPR distribution

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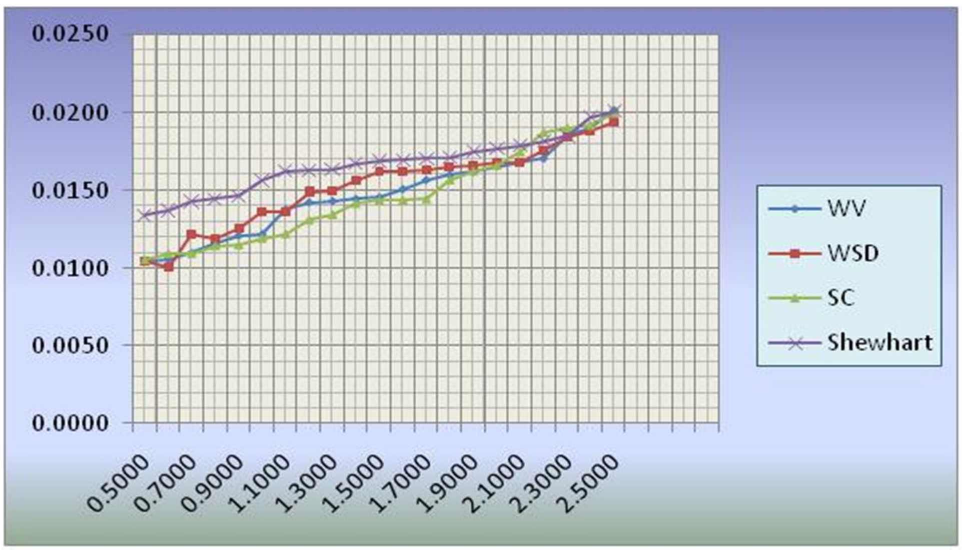
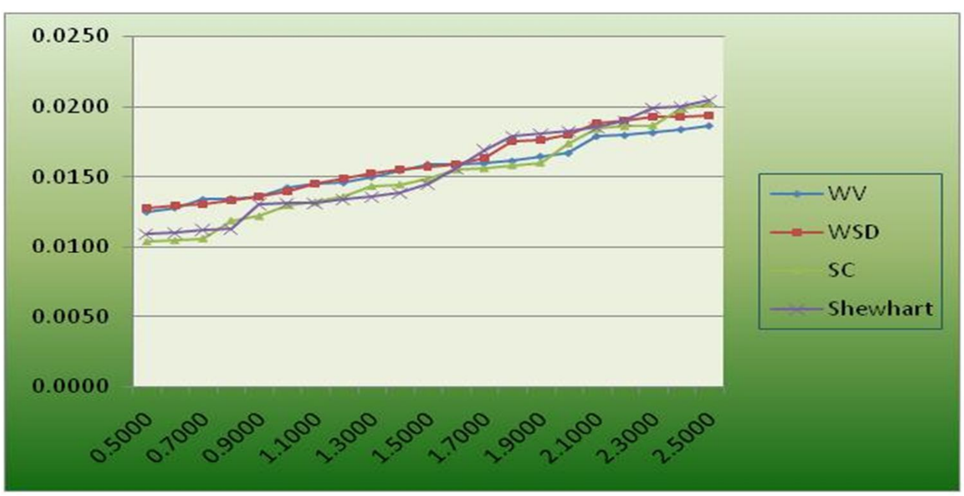
Fig 1.7 $\bar{Z}$ and R charts type I risks of SC, W SD, W V and Shewhart charts for n = 7 of NovEPR distribution





For simulation study $\bar{Z}$ and R charts constants W_U, W_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.1 gives $\bar{Z}$ and R charts constants of the WV method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.01$ level of significance.

Table 1.1 $\bar{Z}$ and R charts constants W_L and W_U of the WV method for NovEPR distribution at $\alpha = 0.01$ level of significance

		WL				WU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.5000	0.5000	4.0206	1.1154	0.9178	0.9258	4.8139	2.7810	1.6287	1.4714
0.6000	0.5400	4.0287	1.1920	0.9563	0.9599	4.8221	2.7886	1.6323	1.4754
0.7000	0.5800	4.0544	1.4164	1.0689	1.0596	4.8482	2.8132	1.6438	1.4880
0.8000	0.6200	4.0587	1.5216	1.1216	1.1063	4.8526	2.8173	1.6458	1.4901
0.9000	0.6600	4.0592	1.5765	1.1492	1.1307	4.8531	2.8178	1.6460	1.4903
1.0000	0.7000	4.0681	1.6273	1.1747	1.1533	4.8622	2.8263	1.6500	1.4947
1.1000	0.7400	4.0784	1.6851	1.2037	1.1789	4.8727	2.8362	1.6546	1.4998
1.2000	0.7800	4.1011	1.6922	1.2072	1.1821	4.8959	2.8579	1.6648	1.5109
1.3000	0.8200	4.1054	1.6986	1.2104	1.1849	4.9002	2.8620	1.6668	1.5130
1.4000	0.8400	4.1089	1.7419	1.2322	1.2042	4.9038	2.8653	1.6683	1.5147
1.5000	0.8800	4.1099	1.7459	1.2341	1.2059	4.9048	2.8663	1.6688	1.5152
1.6000	0.9200	4.1241	1.7944	1.2585	1.2275	4.9193	2.8799	1.6752	1.5222
1.7000	0.9600	4.1380	1.9450	1.3340	1.2944	4.9334	2.8931	1.6814	1.5290
1.8000	1.0000	4.1423	1.9778	1.3505	1.3090	4.9377	2.8972	1.6833	1.5311
1.9000	1.0400	4.1475	2.0164	1.3699	1.3261	4.9431	2.9022	1.6857	1.5337
2.0000	1.0800	4.1478	2.0681	1.3958	1.3491	4.9433	2.9024	1.6858	1.5338
2.1000	1.1200	4.1637	2.3952	1.5599	1.4944	4.9596	2.9177	1.6929	1.5416
2.2000	1.1600	4.1667	2.4175	1.5711	1.5043	4.9626	2.9206	1.6943	1.5431
2.3000	1.2000	4.1772	2.5691	1.6471	1.5716	4.9733	2.9306	1.6990	1.5482
2.4000	1.2400	4.1774	2.7566	1.7412	1.6550	4.9735	2.9307	1.6991	1.5483
2.5000	1.3000	4.1845	3.0282	1.8775	1.7756	4.9808	2.9376	1.7023	1.5518

For simulation study $\bar{Z}$ and R charts constants W_U, W_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.2 gives $\bar{Z}$ and R charts constants of the W V method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.05$ level of significance.

Table 1.2 $\bar{Z}$ and R charts constants W_L and W_U of the WV method for NovEPR distribution at $\alpha = 0.05$ level of significance

		WL				WU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.5000	0.5000	4.1980	2.5279	1.6265	1.5534	4.9945	2.9505	1.7084	1.5585
0.7000	0.5200	4.2075	2.7216	1.7237	1.6394	5.0042	2.9595	1.7126	1.5631
0.9000	0.5400	4.2086	1.0883	0.9042	0.9138	5.0053	2.9606	1.7131	1.5637
1.1000	0.5600	4.2095	1.7577	1.2400	1.2112	5.0062	2.9615	1.7135	1.5641
1.3000	0.5800	4.2123	1.5354	1.1285	1.1124	5.0090	2.9641	1.7148	1.5655
1.5000	0.6000	4.2263	2.5076	1.6163	1.5443	5.0234	2.9775	1.7211	1.5724
1.7000	0.6200	4.2366	2.7286	1.7272	1.6425	5.0338	2.9874	1.7257	1.5774
1.9000	0.6400	4.2397	1.5336	1.1277	1.1116	5.0370	2.9903	1.7271	1.5789
2.1000	0.6600	4.2462	1.1164	0.9183	0.9263	5.0436	2.9965	1.7300	1.5821

2.3000	0.6800	4.2510	2.1099	1.4168	1.3676	5.0485	3.0011	1.7321	1.5845
2.5000	0.7000	4.2512	1.6252	1.1736	1.1523	5.0486	3.0013	1.7322	1.5845
2.7000	0.7200	4.2532	1.4505	1.0860	1.0747	5.0507	3.0032	1.7331	1.5855
2.9000	0.7400	4.2656	2.3116	1.5180	1.4573	5.0633	3.0150	1.7387	1.5916
3.1000	0.7600	4.2814	1.3427	1.0319	1.0268	5.0794	3.0302	1.7458	1.5994
3.3000	0.7800	4.2994	2.5521	1.6386	1.5641	5.0978	3.0474	1.7539	1.6082
3.5000	0.8000	4.3081	1.5922	1.1570	1.1376	5.1066	3.0557	1.7578	1.6125
3.7000	0.8200	4.3116	2.7372	1.7315	1.6463	5.1102	3.0590	1.7594	1.6142
3.9000	0.8400	4.3167	2.7323	1.7290	1.6442	5.1154	3.0639	1.7617	1.6167
4.1000	0.8600	4.3172	2.7890	1.7575	1.6694	5.1159	3.0644	1.7619	1.6170
4.3000	0.8800	4.3203	2.5578	1.6415	1.5666	5.1190	3.0673	1.7633	1.6185
4.5000	0.9000	4.3213	2.2366	1.4803	1.4239	5.1201	3.0683	1.7637	1.6190

For simulation study $\bar{Z}$ and R charts constants W_U, W_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.3 gives $\bar{Z}$ and R charts constants of the W V method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.1$ level of significance.

Table 1.3 $\bar{Z}$ and R charts constants W_L and W_U of the WV method for NovEPR distribution at $\alpha = 0.1$ level of significance

		WL				WU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.5000	0.5000	4.3762	2.8267	1.7763	1.6861	5.1760	3.1207	1.7884	1.6459
0.7000	0.5200	4.3911	1.4086	1.0649	1.0561	5.1911	3.1350	1.7950	1.6532
0.9000	0.5400	4.3952	1.9008	1.3119	1.2748	5.1953	3.1389	1.7969	1.6552
1.1000	0.5600	4.4052	2.7917	1.7588	1.6705	5.2055	3.1485	1.8014	1.6601
1.3000	0.5800	4.4175	2.7353	1.7305	1.6455	5.2181	3.1603	1.8069	1.6662
1.5000	0.6000	4.4345	2.9777	1.8521	1.7532	5.2354	3.1765	1.8146	1.6745
1.7000	0.6200	4.4424	1.3134	1.0172	1.0138	5.2434	3.1840	1.8181	1.6784
1.9000	0.6400	4.4580	2.2512	1.4876	1.4304	5.2592	3.1989	1.8251	1.6860
2.1000	0.6600	4.4838	1.1386	0.9295	0.9361	5.2856	3.2236	1.8367	1.6987
2.3000	0.6800	4.4855	1.7060	1.2141	1.1882	5.2873	3.2252	1.8375	1.6995
2.5000	0.7000	4.4893	2.3213	1.5228	1.4616	5.2911	3.2288	1.8392	1.7014
2.7000	0.7200	4.5016	2.4855	1.6052	1.5345	5.3037	3.2406	1.8447	1.7074
2.9000	0.7400	4.5076	2.1423	1.4330	1.3820	5.3098	3.2464	1.8474	1.7104
3.1000	0.7600	4.5101	1.2204	0.9705	0.9725	5.3123	3.2487	1.8485	1.7116
3.3000	0.7800	4.5279	1.3262	1.0236	1.0195	5.3305	3.2658	1.8565	1.7203
3.5000	0.8000	4.5327	1.4635	1.0925	1.0805	5.3353	3.2703	1.8587	1.7227
3.7000	0.8200	4.5521	1.2166	0.9686	0.9708	5.3551	3.2888	1.8674	1.7322
3.9000	0.8400	4.5578	1.8840	1.3034	1.2673	5.3609	3.2943	1.8699	1.7350
4.1000	0.8600	4.5691	1.8427	1.2827	1.2489	5.3724	3.3051	1.8750	1.7405
4.3000	0.8800	4.5722	1.8845	1.3037	1.2675	5.3756	3.3081	1.8764	1.7421
4.5000	0.9000	4.5844	1.6403	1.1812	1.1590	5.3880	3.3197	1.8819	1.7480

For simulation study $\bar{Z}$ and R charts constants V_U and V_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.4 gives $\bar{Z}$ and R charts constants of the W V method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at α = 0.01 level of significance.

Table 1.4 $\bar{Z}$ and R charts constants V_L and V_U of the WV method for NovEPR distribution at α = 0.01 level of significance

		VL				VU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.50	0.0000	0.0000	0.0000	0.0000	4.5318	2.6029	0.7835	0.4239
0.70	0.52	0.0000	0.0000	0.0000	0.0000	4.5323	2.6274	0.7891	0.4279
0.90	0.54	0.0000	0.0000	0.0000	0.0000	4.5597	2.6316	0.7900	0.4286
1.10	0.56	0.0000	0.0000	0.0000	0.0000	4.5678	2.6320	0.7901	0.4287
1.30	0.58	0.0000	0.0000	0.0000	0.0000	4.5691	2.6345	0.7907	0.4291
1.50	0.60	0.0000	0.0000	0.0000	0.0000	4.5704	2.6799	0.8010	0.4366
1.70	0.62	0.0000	0.0000	0.0000	0.0000	4.5757	2.6920	0.8037	0.4386
1.90	0.64	0.0000	0.0000	0.0000	0.0000	4.5829	2.6953	0.8045	0.4392
2.10	0.66	0.0000	0.0000	0.0000	0.0000	4.5863	2.7035	0.8063	0.4405
2.30	0.68	0.0000	0.0000	0.0000	0.0000	4.6045	2.7135	0.8086	0.4422
2.50	0.70	0.0000	0.0000	0.0000	0.0000	4.6191	2.7273	0.8117	0.4444
2.70	0.72	0.0000	0.0000	0.0000	0.0000	4.6249	2.7463	0.8160	0.4476
2.90	0.74	0.0000	0.0000	0.0000	0.0000	4.6375	2.7673	0.8208	0.4511
3.10	0.76	0.0000	0.0000	0.0000	0.0000	4.6477	2.7718	0.8218	0.4518
3.30	0.78	0.0000	0.0000	0.0000	0.0000	4.7214	2.7818	0.8241	0.4535
3.50	0.80	0.0000	0.0000	0.0000	0.0000	4.7265	2.7867	0.8252	0.4543
3.70	0.82	0.0000	0.0000	0.0000	0.0000	4.7273	2.8032	0.8289	0.4570
3.90	0.84	0.0000	0.0000	0.0000	0.0000	4.7364	2.8070	0.8298	0.4576
4.10	0.86	0.0000	0.0000	0.0000	0.0000	4.7387	2.8366	0.8365	0.4625
4.30	0.88	0.0000	0.0000	0.0000	0.0000	4.7393	2.8391	0.8371	0.4630
4.50	0.90	0.0000	0.0000	0.0000	0.0000	4.7470	2.8490	0.8393	0.4646

For simulation study $\bar{Z}$ and R charts constants V_U and V_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.5 gives $\bar{Z}$ and R charts constants of the W V method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at α = 0.05 level of significance.

Table 1.5 $\bar{Z}$ and R charts constants V_L and V_U of the WV method for NovEPR distribution at α = 0.05 level of significance

		VL				VU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.50	0.0000	0.0000	0.0000	0.0000	4.7514	2.8824	0.8469	0.4701
0.70	0.52	0.0000	0.0000	0.0000	0.0000	4.7851	2.8839	0.8473	0.4704
0.90	0.54	0.0000	0.0000	0.0000	0.0000	4.7953	2.8856	0.8477	0.4706
1.10	0.56	0.0000	0.0000	0.0000	0.0000	4.7981	2.8975	0.8503	0.4726
1.30	0.58	0.0000	0.0000	0.0000	0.0000	4.8143	2.9083	0.8528	0.4744
1.50	0.60	0.0000	0.0000	0.0000	0.0000	4.8160	2.9251	0.8566	0.4772
1.70	0.62	0.0000	0.0000	0.0000	0.0000	4.8276	2.9551	0.8634	0.4821

1.90	0.64	0.0000	0.0000	0.0000	0.0000	4.8276	2.9585	0.8642	0.4827
2.10	0.66	0.0000	0.0000	0.0000	0.0000	4.8290	2.9605	0.8646	0.4830
2.30	0.68	0.0000	0.0000	0.0000	0.0000	4.8454	2.9655	0.8658	0.4839
2.50	0.70	0.0000	0.0000	0.0000	0.0000	4.8466	2.9662	0.8659	0.4840
2.70	0.72	0.0000	0.0000	0.0000	0.0000	4.8495	2.9749	0.8679	0.4854
2.90	0.74	0.0000	0.0000	0.0000	0.0000	4.8505	2.9782	0.8687	0.4860
3.10	0.76	0.0000	0.0000	0.0000	0.0000	4.8590	2.9889	0.8711	0.4877
3.30	0.78	0.0000	0.0000	0.0000	0.0000	4.8591	3.0114	0.8762	0.4915
3.50	0.80	0.0000	0.0000	0.0000	0.0000	4.8871	3.0224	0.8787	0.4933
3.70	0.82	0.0000	0.0000	0.0000	0.0000	4.8941	3.0241	0.8791	0.4936
3.90	0.84	0.0000	0.0000	0.0000	0.0000	4.9167	3.0346	0.8815	0.4953
4.10	0.86	0.0000	0.0000	0.0000	0.0000	4.9192	3.0409	0.8829	0.4964
4.30	0.88	0.0000	0.0000	0.0000	0.0000	4.9228	3.0535	0.8857	0.4984
4.50	0.90	0.0000	0.0000	0.0000	0.0000	4.9655	3.0693	0.8893	0.5010

For simulation study $\bar{Z}$ and R charts constants V_U and V_L of the WV method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.6 gives $\bar{Z}$ and R charts constants of the WV method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.1$ level of significance.

Table 1.6 $\bar{Z}$ and R charts constants V_L and V_U of the WV method for NovEPR distribution at $\alpha = 0.1$ level of significance

		VL				VU			
K3	PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.50	0.0000	0.0000	0.0000	0.0000	3.6476	1.6476	0.5676	0.2664
0.70	0.52	0.0000	0.0000	0.0000	0.0000	3.6502	1.6502	0.5683	0.2669
0.90	0.54	0.0000	0.0000	0.0000	0.0000	3.6552	1.6552	0.5686	0.2671
1.10	0.56	0.0000	0.0000	0.0000	0.0000	3.6773	1.6773	0.5767	0.2730
1.30	0.58	0.0000	0.0000	0.0000	0.0000	3.6828	1.6828	0.5797	0.2752
1.50	0.60	0.0000	0.0000	0.0000	0.0000	3.7036	1.7036	0.5802	0.2756
1.70	0.62	0.0000	0.0000	0.0000	0.0000	3.7136	1.7136	0.5811	0.2763
1.90	0.64	0.0000	0.0000	0.0000	0.0000	3.7269	1.7269	0.5816	0.2766
2.10	0.66	0.0000	0.0000	0.0000	0.0000	3.7416	1.7416	0.5833	0.2779
2.30	0.68	0.0000	0.0000	0.0000	0.0000	3.7436	1.7436	0.5855	0.2794
2.50	0.70	0.0000	0.0000	0.0000	0.0000	3.7476	1.7476	0.5922	0.2843
2.70	0.72	0.0000	0.0000	0.0000	0.0000	3.7657	1.7657	0.5933	0.2852
2.90	0.74	0.0000	0.0000	0.0000	0.0000	3.7662	1.7662	0.5940	0.2857
3.10	0.76	0.0000	0.0000	0.0000	0.0000	3.7878	1.7878	0.5957	0.2869
3.30	0.78	0.0000	0.0000	0.0000	0.0000	3.7978	1.7978	0.5964	0.2874
3.50	0.80	0.0000	0.0000	0.0000	0.0000	3.8155	1.8155	0.5975	0.2882
3.70	0.82	0.0000	0.0000	0.0000	0.0000	3.8231	1.8231	0.5984	0.2889
3.90	0.84	0.0000	0.0000	0.0000	0.0000	3.8488	1.8488	0.6004	0.2904
4.10	0.86	0.0000	0.0000	0.0000	0.0000	3.8733	1.8733	0.6036	0.2927
4.30	0.88	0.0000	0.0000	0.0000	0.0000	3.8752	1.8752	0.6038	0.2928
4.50	0.90	0.0000	0.0000	0.0000	0.0000	3.8766	1.8766	0.6069	0.2951

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For simulation study $\bar{Z}$ and R charts constants WS_U, WS_L of the WSD method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.7 gives $\bar{Z}$ and R charts constants of the WSD method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.01$ level of significance.

Table 1.7 $\bar{Z}$ and R charts constants WS_L and WS_U of the WSD method for NovEPR distribution $\alpha = 0.01$ level of significance

	WSL				WSU			
PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.0000	0.0000	0.0000	0.0000	4.3333	2.3333	0.7223	0.3793
0.52	0.0000	0.0000	0.0000	0.0000	4.3477	2.3477	0.7256	0.3816
0.54	0.0000	0.0000	0.0000	0.0000	4.3490	2.3490	0.7259	0.3818
0.56	0.0000	0.0000	0.0000	0.0000	4.3602	2.3602	0.7284	0.3837
0.58	0.0000	0.0000	0.0000	0.0000	4.3638	2.3638	0.7293	0.3843
0.60	0.0000	0.0000	0.0000	0.0000	4.3681	2.3681	0.7302	0.3850
0.62	0.0000	0.0000	0.0000	0.0000	4.3949	2.3949	0.7363	0.3894
0.64	0.0000	0.0000	0.0000	0.0000	4.3971	2.3971	0.7368	0.3898
0.66	0.0000	0.0000	0.0000	0.0000	4.4004	2.4004	0.7375	0.3903
0.68	0.0000	0.0000	0.0000	0.0000	4.4053	2.4053	0.7387	0.3912
0.70	0.0000	0.0000	0.0000	0.0000	4.4066	2.4066	0.7390	0.3914
0.72	0.0000	0.0000	0.0000	0.0000	4.4146	2.4146	0.7408	0.3927
0.74	0.0000	0.0000	0.0000	0.0000	4.4619	2.4619	0.7515	0.4005
0.76	0.0000	0.0000	0.0000	0.0000	4.4726	2.4726	0.7539	0.4023
0.78	0.0000	0.0000	0.0000	0.0000	4.4771	2.4771	0.7550	0.4030
0.80	0.0000	0.0000	0.0000	0.0000	4.4797	2.4797	0.7555	0.4035
0.82	0.0000	0.0000	0.0000	0.0000	4.4917	2.4917	0.7583	0.4055
0.84	0.0000	0.0000	0.0000	0.0000	4.4976	2.4976	0.7596	0.4064
0.86	0.0000	0.0000	0.0000	0.0000	4.5134	2.5134	0.7632	0.4091
0.88	0.0000	0.0000	0.0000	0.0000	4.5166	2.5166	0.7639	0.4096
0.90	0.0000	0.0000	0.0000	0.0000	4.5218	2.5218	0.7651	0.4105

For simulation study $\bar{Z}$ and R charts constants WS_U, WS_L of the WSD method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.8 gives $\bar{Z}$ and R charts constants of the WSD method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at $\alpha = 0.05$ level of significance.

Table 1.8 $\bar{Z}$ and R charts constants WS_L and WS_U of the WSD method for NovEPR distribution at $\alpha = 0.05$ level of significance

	WSL				WSU			
PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.0000	0.0000	0.0000	0.0000	4.5298	2.5298	0.7669	0.4118
0.52	0.0000	0.0000	0.0000	0.0000	4.5324	2.5324	0.7675	0.4122
0.54	0.0000	0.0000	0.0000	0.0000	4.5413	2.5413	0.7695	0.4137
0.56	0.0000	0.0000	0.0000	0.0000	4.5422	2.5422	0.7697	0.4138
0.58	0.0000	0.0000	0.0000	0.0000	4.5546	2.5546	0.7725	0.4159
0.60	0.0000	0.0000	0.0000	0.0000	4.5681	2.5681	0.7756	0.4181
0.62	0.0000	0.0000	0.0000	0.0000	4.5793	2.5793	0.7781	0.4200
0.64	0.0000	0.0000	0.0000	0.0000	4.5976	2.5976	0.7823	0.4230
0.66	0.0000	0.0000	0.0000	0.0000	4.6001	2.6001	0.7829	0.4234

0.68	0.0000	0.0000	0.0000	0.0000	4.6015	2.6015	0.7832	0.4236
0.70	0.0000	0.0000	0.0000	0.0000	4.6095	2.6095	0.7850	0.4250
0.72	0.0000	0.0000	0.0000	0.0000	4.6212	2.6212	0.7877	0.4269
0.74	0.0000	0.0000	0.0000	0.0000	4.6258	2.6258	0.7887	0.4277
0.76	0.0000	0.0000	0.0000	0.0000	4.6331	2.6331	0.7904	0.4289
0.78	0.0000	0.0000	0.0000	0.0000	4.6366	2.6366	0.7912	0.4294
0.80	0.0000	0.0000	0.0000	0.0000	4.6528	2.6528	0.7948	0.4321
0.82	0.0000	0.0000	0.0000	0.0000	4.6789	2.6789	0.8007	0.4364
0.84	0.0000	0.0000	0.0000	0.0000	4.6801	2.6801	0.8010	0.4366
0.86	0.0000	0.0000	0.0000	0.0000	4.6845	2.6845	0.8020	0.4374
0.88	0.0000	0.0000	0.0000	0.0000	4.6923	2.6923	0.8038	0.4387
0.90	0.0000	0.0000	0.0000	0.0000	4.6933	2.6933	0.8040	0.4388

For simulation study $\bar{Z}$ and R charts constants WS_U, WS_L of the WSD method for the selected combinations of m = (3,5,7,9) and P_Z are obtained by Table 1.9 gives $\bar{Z}$ and R charts constants of the WSD method based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times at α = 0.1 level of significance.

Table 1.9 $\bar{Z}$ and R charts constants WS_L and WS_U of the WSD method for NovEPR distribution at α = 0.1 level of significance

	WSL				WSU			
PZ	n = 3	n = 5	n = 7	n = 9	n = 3	n = 5	n = 7	n = 9
0.50	0.0000	0.0000	0.0000	0.0000	4.7023	2.7023	0.8061	0.4403
0.52	0.0000	0.0000	0.0000	0.0000	4.7171	2.7171	0.8094	0.4428
0.54	0.0000	0.0000	0.0000	0.0000	4.7393	2.7393	0.8144	0.4464
0.56	0.0000	0.0000	0.0000	0.0000	4.7484	2.7484	0.8165	0.4479
0.58	0.0000	0.0000	0.0000	0.0000	4.7600	2.7600	0.8191	0.4499
0.60	0.0000	0.0000	0.0000	0.0000	4.7708	2.7708	0.8216	0.4516
0.62	0.0000	0.0000	0.0000	0.0000	4.7763	2.7763	0.8229	0.4526
0.64	0.0000	0.0000	0.0000	0.0000	4.7778	2.7778	0.8232	0.4528
0.66	0.0000	0.0000	0.0000	0.0000	4.7789	2.7789	0.8234	0.4530
0.68	0.0000	0.0000	0.0000	0.0000	4.7948	2.7948	0.8270	0.4556
0.70	0.0000	0.0000	0.0000	0.0000	4.8005	2.8005	0.8283	0.4566
0.72	0.0000	0.0000	0.0000	0.0000	4.8272	2.8272	0.8344	0.4610
0.74	0.0000	0.0000	0.0000	0.0000	4.8274	2.8274	0.8344	0.4610
0.76	0.0000	0.0000	0.0000	0.0000	4.8328	2.8328	0.8357	0.4619
0.78	0.0000	0.0000	0.0000	0.0000	4.8480	2.8480	0.8391	0.4644
0.80	0.0000	0.0000	0.0000	0.0000	4.8490	2.8490	0.8393	0.4646
0.82	0.0000	0.0000	0.0000	0.0000	4.8526	2.8526	0.8402	0.4652
0.84	0.0000	0.0000	0.0000	0.0000	4.8621	2.8621	0.8423	0.4668
0.86	0.0000	0.0000	0.0000	0.0000	4.8712	2.8712	0.8444	0.4683
0.88	0.0000	0.0000	0.0000	0.0000	4.8878	2.8878	0.8481	0.4710
0.90	0.0000	0.0000	0.0000	0.0000	4.9048	2.9048	0.8520	0.4738

For simulation study $\bar{Z}$ and R charts of type I risks of SC, WSD, WV and Shewhart charts for n = 3 for NovEPR distribution based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times.

Table 1.10 $\bar{Z}$ and R charts e type I risks of SC, W SD, W V and Shewhart charts for n = 3 for NovEPR distribution

	Type I Risk, n =3							
	$\bar{Z}$				R			
K3	WV	WSD	SC	Shewhart	WV	WSD	SC	Shewhart
0.5000	0.0107	0.0107	0.0105	0.0125	0.0106	0.0105	0.0103	0.0141
0.6000	0.0119	0.0113	0.0109	0.0125	0.0108	0.0107	0.0105	0.0147
0.7000	0.0130	0.0117	0.0120	0.0131	0.0115	0.0116	0.0116	0.0148
0.8000	0.0132	0.0120	0.0125	0.0146	0.0115	0.0120	0.0122	0.0151
0.9000	0.0132	0.0121	0.0128	0.0151	0.0118	0.0123	0.0126	0.0151
1.0000	0.0146	0.0123	0.0131	0.0152	0.0134	0.0127	0.0126	0.0151
1.1000	0.0147	0.0125	0.0134	0.0153	0.0140	0.0139	0.0129	0.0152
1.2000	0.0152	0.0142	0.0134	0.0155	0.0147	0.0143	0.0131	0.0154
1.3000	0.0157	0.0144	0.0137	0.0157	0.0149	0.0146	0.0137	0.0157
1.4000	0.0164	0.0144	0.0137	0.0164	0.0159	0.0150	0.0155	0.0160
1.5000	0.0176	0.0145	0.0139	0.0179	0.0166	0.0156	0.0162	0.0167
1.6000	0.0178	0.0149	0.0147	0.0180	0.0178	0.0161	0.0166	0.0174
1.7000	0.0179	0.0151	0.0149	0.0180	0.0180	0.0161	0.0176	0.0179
1.8000	0.0179	0.0165	0.0151	0.0178	0.0181	0.0163	0.0177	0.0180
1.9000	0.0180	0.0166	0.0153	0.0180	0.0183	0.0168	0.0178	0.0186
2.0000	0.0183	0.0171	0.0170	0.0185	0.0184	0.0171	0.0178	0.0190
2.1000	0.0184	0.0172	0.0171	0.0185	0.0184	0.0176	0.0186	0.0191
2.2000	0.0188	0.0173	0.0179	0.0187	0.0187	0.0178	0.0187	0.0195
2.3000	0.0189	0.0191	0.0188	0.0188	0.0192	0.0187	0.0187	0.0197
2.4000	0.0190	0.0192	0.0200	0.0202	0.0192	0.0189	0.0187	0.0201
2.5000	0.0196	0.0192	0.0202	0.0202	0.0194	0.0199	0.0190	0.0203

For simulation study $\bar{Z}$ and R charts of type I risks of SC, WSD, WV and Shewhart charts for n = 7 for NovEPR distribution based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times.

Table 1.11 $\bar{Z}$ and R charts e type I risks of SC, W SD, W V and Shewhart charts for n = 7 for NovEPR distribution

	Type I Risk, n =3							
	$\bar{Z}$				R			
K3	WV	WSD	SC	Shewhart	WV	WSD	SC	Shewhart
0.5000	0.0105	0.0105	0.0106	0.0134	0.0125	0.0127	0.0104	0.0109
0.6000	0.0106	0.0101	0.0110	0.0137	0.0128	0.0129	0.0105	0.0110
0.7000	0.0110	0.0122	0.0110	0.0143	0.0134	0.0130	0.0106	0.0113
0.8000	0.0116	0.0120	0.0115	0.0145	0.0135	0.0133	0.0119	0.0113
0.9000	0.0121	0.0126	0.0115	0.0146	0.0136	0.0136	0.0122	0.0131
1.0000	0.0122	0.0137	0.0120	0.0156	0.0142	0.0140	0.0130	0.0131
1.1000	0.0138	0.0137	0.0122	0.0162	0.0145	0.0145	0.0132	0.0131

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1.2000	0.0143	0.0149	0.0131	0.0163	0.0146	0.0149	0.0136	0.0134
1.3000	0.0144	0.0149	0.0135	0.0163	0.0150	0.0152	0.0143	0.0136
1.4000	0.0145	0.0156	0.0142	0.0167	0.0154	0.0155	0.0145	0.0138
1.5000	0.0146	0.0162	0.0144	0.0169	0.0159	0.0157	0.0149	0.0145
1.6000	0.0151	0.0162	0.0144	0.0169	0.0159	0.0159	0.0155	0.0156
1.7000	0.0157	0.0163	0.0145	0.0170	0.0159	0.0163	0.0156	0.0169
1.8000	0.0160	0.0165	0.0157	0.0171	0.0161	0.0175	0.0158	0.0179
1.9000	0.0162	0.0166	0.0163	0.0175	0.0164	0.0176	0.0160	0.0180
2.0000	0.0166	0.0167	0.0166	0.0177	0.0167	0.0180	0.0174	0.0182
2.1000	0.0168	0.0168	0.0174	0.0179	0.0178	0.0188	0.0184	0.0185
2.2000	0.0171	0.0176	0.0187	0.0182	0.0179	0.0190	0.0186	0.0190
2.3000	0.0185	0.0184	0.0190	0.0185	0.0181	0.0192	0.0187	0.0199
2.4000	0.0191	0.0188	0.0192	0.0197	0.0183	0.0193	0.0198	0.0200
2.5000	0.0202	0.0193	0.0199	0.0201	0.0186	0.0194	0.0202	0.0204

For simulation study $\bar{Z}$ and R charts of type I risks of SC, WSD, WV and Shewhart charts for n = 9 for NovEPR distribution based on Newton-Raphson iteration method was used for parameter combinations and the process was repeated 10,000 times.

Table 1.12 $\bar{Z}$ and R charts e type I risks of SC, W SD, W V and Shewhart charts for n = 9 for NovEPR distribution

	Type I Risk, n =3							
	$\bar{Z}$				R			
K3	WV	WSD	SC	Shewhart	WV	WSD	SC	Shewhart
0.5000	0.0109	0.0107	0.0104	0.0124	0.0109	0.0110	0.0124	0.0126
0.6000	0.0112	0.0108	0.0110	0.0134	0.0111	0.0110	0.0128	0.0127
0.7000	0.0123	0.0108	0.0113	0.0136	0.0120	0.0110	0.0129	0.0130
0.8000	0.0128	0.0110	0.0118	0.0137	0.0123	0.0114	0.0134	0.0138
0.9000	0.0128	0.0117	0.0119	0.0137	0.0129	0.0122	0.0141	0.0140
1.0000	0.0131	0.0118	0.0133	0.0138	0.0137	0.0125	0.0142	0.0142
1.1000	0.0131	0.0125	0.0139	0.0145	0.0139	0.0136	0.0148	0.0152
1.2000	0.0133	0.0126	0.0140	0.0149	0.0145	0.0146	0.0150	0.0153
1.3000	0.0145	0.0135	0.0143	0.0161	0.0146	0.0150	0.0151	0.0156
1.4000	0.0145	0.0144	0.0154	0.0162	0.0152	0.0150	0.0151	0.0169
1.5000	0.0153	0.0149	0.0157	0.0163	0.0153	0.0160	0.0154	0.0164
1.6000	0.0154	0.0149	0.0158	0.0172	0.0156	0.0161	0.0155	0.0169
1.7000	0.0155	0.0149	0.0164	0.0176	0.0157	0.0161	0.0156	0.0170
1.8000	0.0169	0.0167	0.0165	0.0182	0.0160	0.0181	0.0156	0.0185
1.9000	0.0170	0.0169	0.0168	0.0190	0.0164	0.0182	0.0161	0.0189
2.0000	0.0174	0.0170	0.0170	0.0190	0.0168	0.0182	0.0165	0.0184
2.1000	0.0176	0.0171	0.0181	0.0192	0.0179	0.0184	0.0165	0.0194
2.2000	0.0185	0.0178	0.0183	0.0199	0.0182	0.0188	0.0171	0.0200
2.3000	0.0188	0.0189	0.0184	0.0200	0.0188	0.0194	0.0187	0.0203
2.4000	0.0193	0.0195	0.0186	0.0203	0.0197	0.0197	0.0188	0.0202
2.5000	0.0194	0.0195	0.0186	0.0203	0.0202	0.0201	0.0194	0.0218

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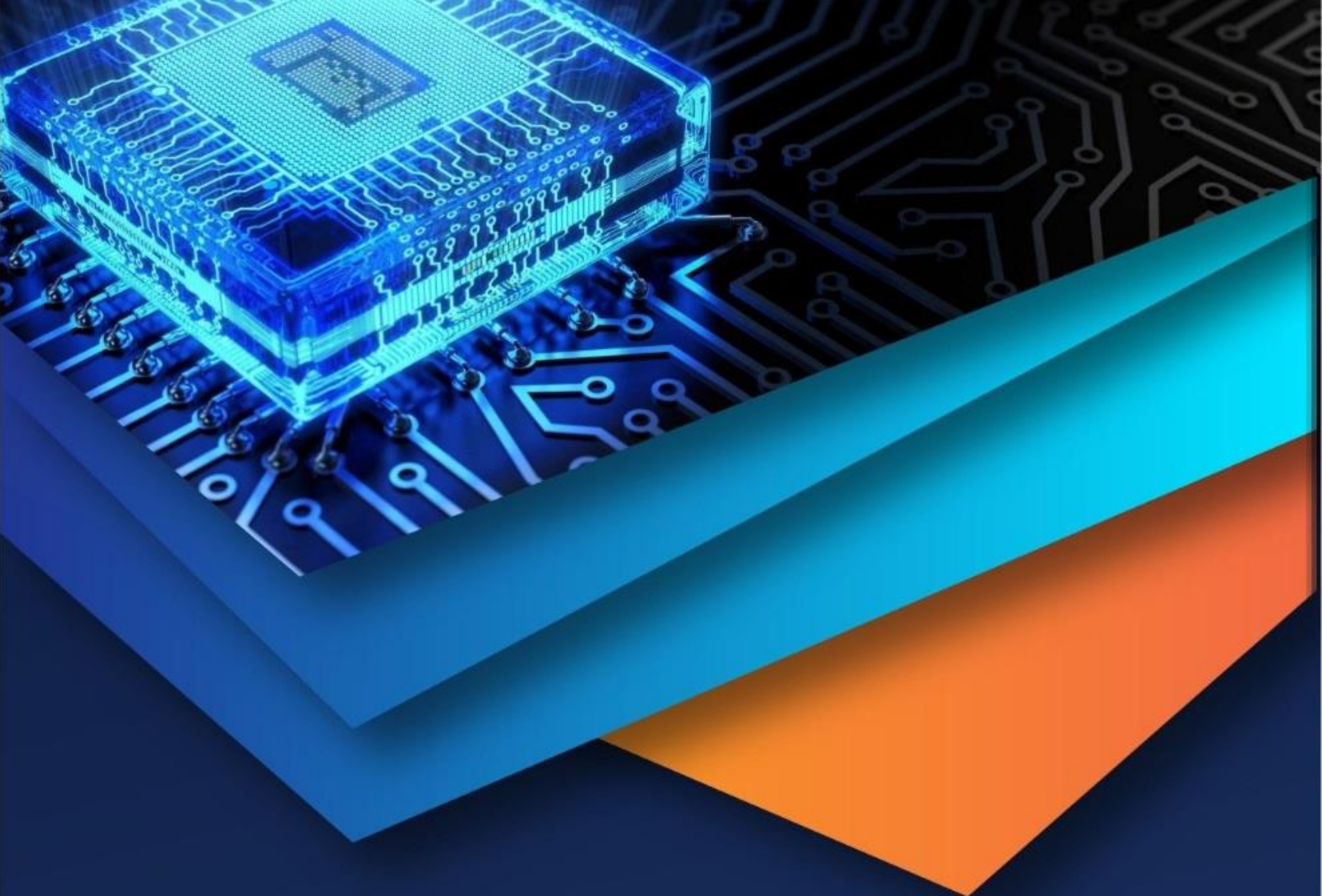

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