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On Quick Switching System with Different Sampling Plans using Fuzzy Neutrosophic Weighted Poisson Distribution

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Abstract: The present study provides a new sampling inspection approach to costly and destructive testing that involves the concept of neutrosophic and fuzzy logic in a quick switching system with a normal SSP and a tightened DSP as a reference plan using weighted poisson distribution as a baseline. It includes the neutrosophic and fuzzy weighted poisson distribution associations of this approach, along with normal and tightened acceptance numbers using OC functions, and OC curves using R programming. It strongly focuses on a new sampling approach that uses fuzzy logic for effectively dealing with inconsistent and uncertain terms. And Also, these sets can be used to enhance the adaptability and flexibility of quick switching sampling. Neutrosophic consists of three terms: truthiness (t), indeterminacy (i), and falsity (f), which refer to different scenarios. The efficacy of the updated system has been evaluated through comparison of its results to the existing one. Costly and destructive testing using neutrosophic and fuzzy logic in a QSS with a normal SSP and a tightened DSP as a reference plan. The purpose of this research is to address the limitations associated with standard sampling techniques for continuous manufacturing process measurement. This focuses on the challenges with identifying uncertainties-related defects and highlights the fields involving fuzzy logic and neutrosophic theory have not been completely integrated into appropriate sampling techniques. This new approach improves the accuracy of quality control decision-making and significantly decreases the sample sizes involved. This provides an effective approach to improve quality monitoring across manufacturing scenarios.

Keywords: Neutrosophic logic, fuzzy set theory, statistical quality control, quick switching system, weighted poisson distribution, single sampling plan, double sampling plan.

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1. Introduction

The present continuous manufacturing quality evaluation approaches find a challenge to maintain the variability and uncertainty in defects assessment, especially with costly and destructive testing. Variations in quality control can results in the fixed methods employed in standard sample techniques, that have a tendency to modify to the changing nature of manufacturing procedures. As inaccurate assessments of quality may contribute to significant economic losses and risk the integrity of goods, it is essential than it be solved. When a provider can regularly detect weaknesses, it will grow less effective and lose the confidence consumers have in domains where reliability is important. So, in modern extremely difficult manufacturing environment, the growth of further adaptable and reliable methods for sampling is essential. Quick Switching Systems (QSS) are advanced attribute-acceptance sampling methods that goal at improving the accuracy of sampling based on the process quality levels. Dodge (1967) proposed QSS, that includes normal and tightened inspections plans. Romboski (1969) modified QSS with types that included QSS (n, cN, cT) and QSS (n, kn, c0), each modified for specific quality control requirements. Soundararajan and Arumainayagam (1990a, 1990b) developed QSS-r (n;cN,cT) and QSS-r (n;kn,c0) for r = 2 and 3, establishing various types of attribute different possibilities for predicting various operating conditions. Tightened plans are used for lesser quality levels that require high normal of quality, while normal plans are used for greater quality levels for reducing sample numbers and preserve the detection of errors.

The weighted poisson distribution (WPD) increases defect control through providing various significance levels to defects due to their importance, compared to the normal Poisson model, that accepts each mistake the same. This approach is particularly effective for industries which work with second-quality lots or have a significant number of manufacturing defects. Industries may prioritize resources by prioritizing errors depending on their effect, along with the objective of increasing overall quality of goods and consumer satisfaction. This method is particularly effective in industries switching to zero defects manufacturing methodologies, since it provides a more structured procedure for resolving quality problems simultaneously reducing managerial effectiveness and resource allocation.

Radhakrishna Rao (1977) established the weighted poisson distribution (WPD) as a fundamental distribution for designing sampling methods. Sudeswari (2002) developed sampling schemes constructed on the WPD methods concept and emphasized its implementation in plan construction. Radhakrishnan and Mohana Priya (2008) indicated that sampling plans utilizing the WPD possess a higher acceptance probability and require a smaller number of sample sizes that methods based on the Poisson distribution, and this helps consumers as well as producers through improving the effectiveness of resources. Arumainayagam and Vennila (2017) evaluated a QSS to a NSSP and a tightened TDSP, that provides a more effective approach. It follows that investigated QSS using different sampling plans in 2018, then implemented QSS with a zero-one acceptance number have studied in 2019. Furthermore, Arumainayagam and Vennila (2020) assessed QSS incorporating weighted poisson distribution with single and double sampling plans as reference plan, expanding its utility in quality control strategies and studied the QSS with DSP as reference plan (QSDSS) across various quality regions (2021). In 2022, they studied QSS using SSP and DSP based on MIL-STD-105D. For the purpose to investigate the relationships between nine criteria, Victor Christianto (2024) did studies using Single-Valued Neutrosophic Sets (SVNSs) combined with the DEMATEL strategy. In accordance with professional evaluations, a clear relationship matrix was developed, highlighting that factor 1 had a small affect and criteria 5 had the most impact. The above approach reduced the uncertainty of the evaluation procedure significantly. Mai Mohamad (2024) has studied the SVTNSs-LMAW-RAWEC methods for selecting drone materials, identifying carbon fiber-reinforced polymer as the best option. The approach effectively manages uncertainty but has limitations with zero elements in the decision matrix. Future work will expand the analysis to more criteria and alternatives. The use of fuzzy logic and neutrosophic concepts, however, aren't sufficiently frequently included into investigations that presently be found, but evidence it may significantly enhance the quality of decision-making processes.

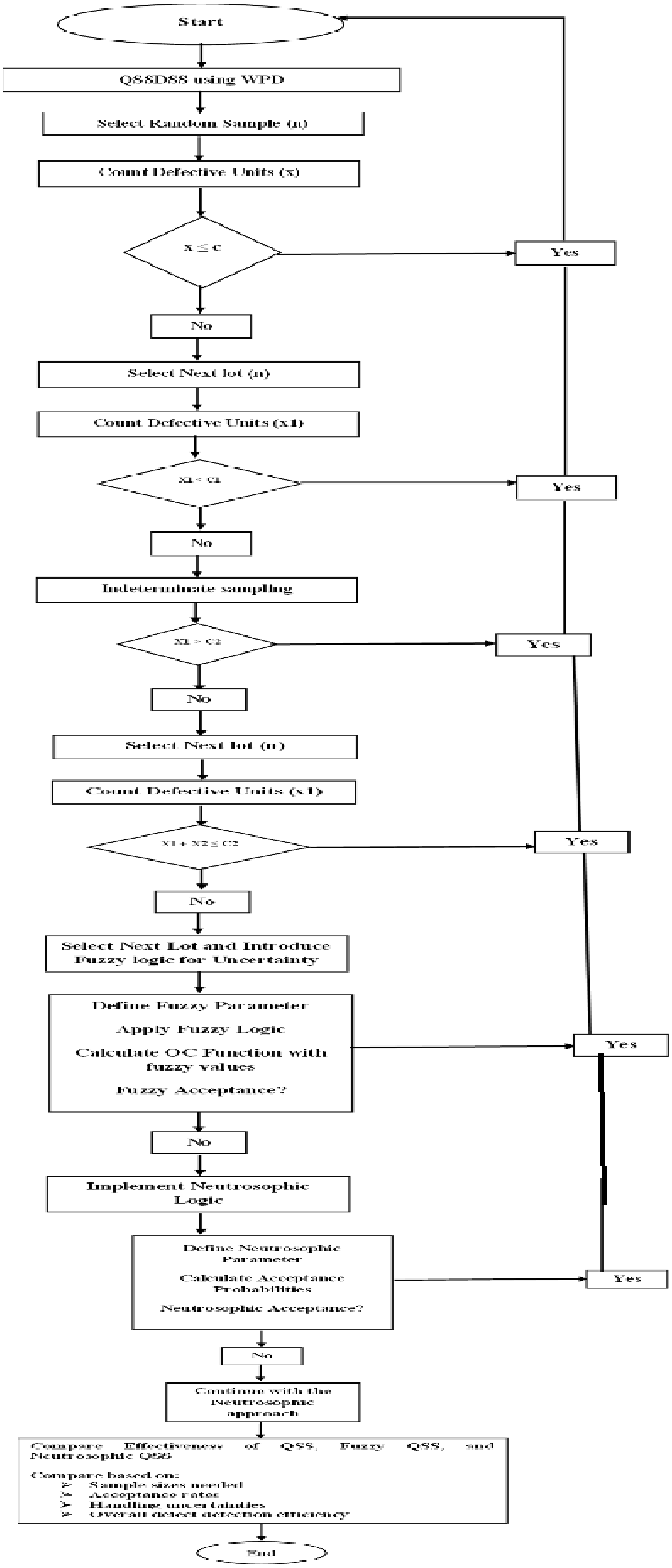
Most of the studies have already been done to rewrite sampling techniques with fuzzy logic is used to identify uncertainty. In normal sampling plans, the product's defective proportion is presented as a specific number. However, there could be significant uncertainty in applications in real life. Conventional logic evaluates reports by providing two absolute values: 0 and 1. The above concept is unable to replicate uncertainty in both natural and engineering scenarios. The most significant difference between classical logic and fuzzy logic is the application of the term "membership" to describe uncertainties. The method of fuzzy logic uses a membership function ((x)) and a variable that is continuous (x) within the [0,1] range in a space (X) as the uncertainty level. The first equation explains a basic fuzzy set and also if there is a lot of uncertainty, the membership value is higher, and both directions.

This article baselines an innovative sampling inspection framework that integrates a normal single sampling plan (n; c) and a tightened double sampling plan (n; c1, c2) using the assumption of a Weighted Poisson distribution (WPD). This mixture system is termed as the Weighted Poisson Distribution-Quick Switching Single Double Sampling System (WPD-QSSDSS) (n; c; c1, c), where n=n1=n2. This work was already done by Arumainayagam and Vennila (2020). The condition c1=0, c, c1 > c2 is utilized to enhance protective measures in quality control processes. This approach is particular in that it combines Fuzzy logic with professional Neutrosophic basic concepts to effectively deal with uncertainty, fuzzy thoughts, and unpredictability that comes with parameter estimate. The use of fuzzy logic enables the system to change to uncertain conditions with different types of certainty in parameter values, maximizing reliable decision-making throughout sampling inspections when conventional methods have difficulty using insufficient or inaccurate information.

According to Aslam (2019), the acceptance sampling plan using attribute and variable that proposed an updated attribute sampling plan that find lot accepted or rejected, and unspecified chances of the Neutrosophic Binomial distribution and interval method using different acceptance number. Uma and Nandhitha (2022) examined the impact of Neutrosophic sets on Acceptance Sampling plans using attribute sampling plans. Uma and Nandhitha (2023) assessed QSS utilizing Neutrosophic Poisson Distribution with corresponding OC curve, and relevant tables were designed.

Neutrosophic sets were a type of fuzzy sets containing three phrases: membership (truthiness), non-membership (falsity), and uncertainty. Applying arbitrary terms and solving multiple sets provides neutrosophic logic equivalent to logical theory. As a result, it gives excellent outcomes for predicting uncertainty that relates to scenarios with beings. A few studies have been claimed to have invented sample plans using neutrosophic sets, but none of them contain along with uncertainty terms and unreliable information that in an identical give structure and description. From the literature, the term uncertainty is minimized through applying a few assumptions and investigating acceptance sampling plans constructed using neutrosophic sets. The primary aim of this work is to formulate a QSS that utilizes neutrosophic weighted poisson distribution using QSS with normal SSP and tightened DSP as reference plan.

The aim of this study is to fill in the gaps that are identified with an extensive structure which integrates effective sample addresses using fuzzy logic and neutrosophic approaches. A significant number of current sampling techniques present the inaccurate a proportion as a constant amount, not considering the variability inherent in practical applications. The present research proposes a Quick Switching System (QSS) using normal Single Sampling Plans (SSP) and tightened Double Sampling Plans (DSP) as reference plans, based on the Neutrosophic Weighted Poisson Distribution (NWPD). The main objective of the effort is to provide a systematic way for managing uncertainty in quality assessments through the combination of different approaches.



Flowchart 1: QSS, Fuzzy logic and Neutrosophic logic with single double sampling plan using weighted distribution as reference plan

The use of Neutrosophic logic expands this model through allowing an additional level of uncertainty, however along with the two main ones, which is essential to managing concerns that improve across fuzzy limits. This combination optimizes the ability of the system for dealing with difficult processes in factories by optimizing sample sizes and checking processes with the WPD method using the QSSDSS using fuzzy logic and neutrosophic set. It enhances the stability and flexibility of quality assurance methods, but additionally, it deals with occurrences with significant data uncertainty and variability. It highlights that Neutrosophic concepts utilize Fuzzy logic to address concerns deeper in the scenario of attribute determine and the sampling process assessments.

This study provides the Weighted Poisson Distribution Quick Switching Single Double Sampling System (WPD-QSSDSS), an innovative technique which increases reliability and minimizes the sample sizes required for effective quality control. The use of fuzzy logic was incorporated in this new method to deal with uncertainty in factor forecasts to improve accurate decision-making processes. In the end, this study contributes to improve manufacturing quality control methods, ensuring that high standards are continuously satisfied.

2. Weighted Poisson Distribution using QSSDSS

The present study uses WPD-QSSDSS (n; c; c1; c2) under the assumption of WPD. The conditions for the applications are given below

i. A continuous manufacturing method includes evaluating many successive in batches.
ii. Every batch will be expected to be nearly identical in quality.
iii. The batches are examined in the manner during which they were manufactured.
iv. Quality is determined through the proportion of defects.

Operating Procedure

Step 1: Choose a random sample of size n in a lot and check the no. of defective units x.
- (i) if x ≤ c, accept the lot and continue step 1for the next lot.
- (ii) if x > c, reject the lot and continue step 2 for the next lot.

Step 2: Choose a random sample of size n in the next lot and check the no. of defectives x1.
- (i) if x1 ≤ c1, accept the lot and continue step 1 for the next batch.
- (ii) if x1 > c2, reject the lot and continue step 2 for the next batch.
- (iii) Select a second random sample of size n in the same batch if c1 < x1 ≤ c2 and check the no.of defectives x2.
- (iv) if x1+x2 ≤ c2, accept the lot and continue step 1 for the next batch.
- (v) if x1+x2 > c2, reject the lot and step 2 for the next batch.

OC Function

The OC function of WPD-QSSDSS (n; c; c1, c2) based on Romboski's (1969) is given below

$$P_a = \frac{P_T}{(1 - P_N) + P_T} \qquad \text{------(1)}$$

Where,
PN - the proportion of lots are accepted using a normal SSP (n, c).
PT -the proportion of lots are accepted using a tightened DSP (n, c1, c2).

The PN and PT of the WP model is given below

$$P_N = \sum_{x=1}^{c} e^{-np} np^{x-1} / x - 1! \quad \left.\vphantom{\begin{matrix}a\\a\\a\\a\end{matrix}}\right\}$$

$$P_T = \left(\sum_{x=1}^{c_1} e^{-np} np^{x-1}/(x-1)! + \left(\sum_{x=c_1+1}^{c_2} e^{-np} np^{x-1}/(x-1)! * \sum_{x=1}^{c_2-(c_1+1)} e^{-np} np^{x-1}/(x-1)!\right)\right)$$

-----(2)

Properties of the WPD-QSSDSS

Figures 1 indicate the WPD with QSSDSS's normal, tightened, and composite OC curves, and the WPD-QSSDSS. It shows that tightened curves of OC are nearer to the composite OC curve with large values of p than SSP/DSP OC curves are at lower p values. The combined OC curve is less costly than its their respective normal and tightened curves for OC when the values of the normal SSP are stable and the acceptance levels of the tightened DSP are allowed to decrease. They indicate that the OC curve's discriminatory effectiveness improves as the tightening increases deeper.

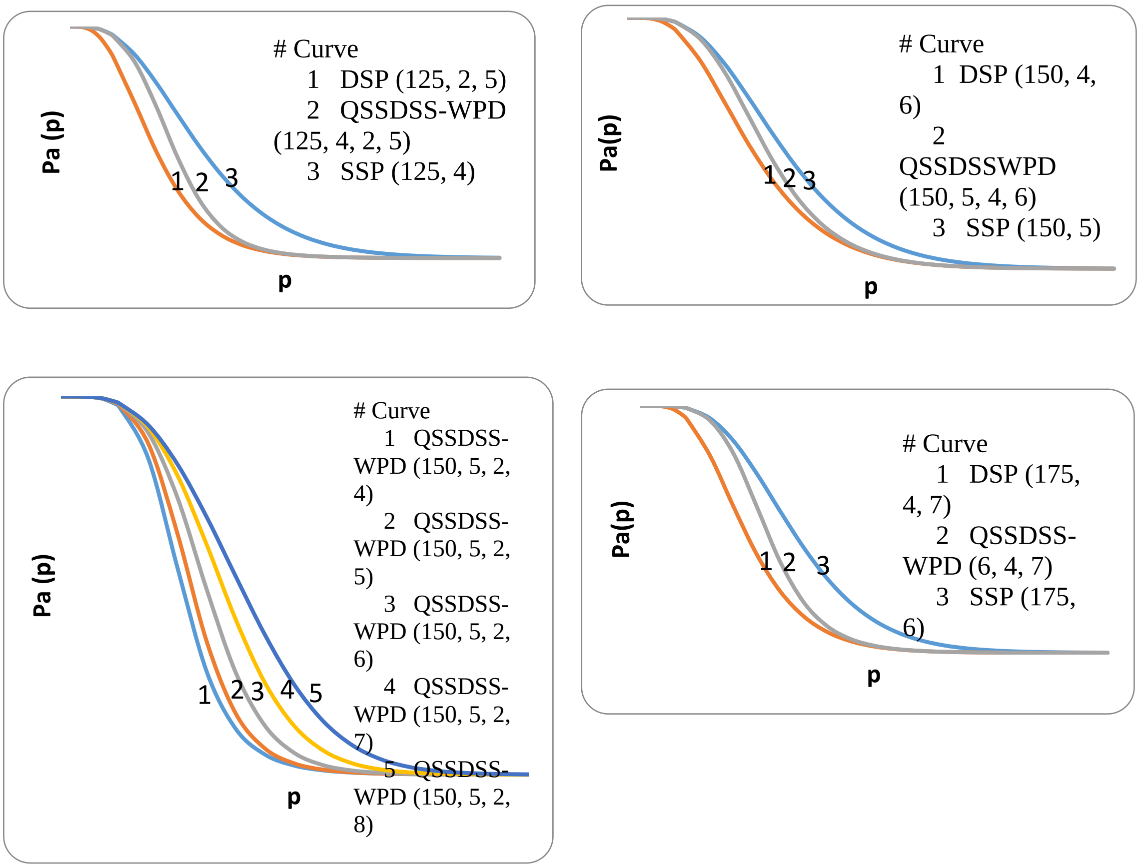


Figure 1: OC function of WPD QSSDSS

Comparison of systems and plans matched by OR

Table 2 provides the appropriate SSP, DSP, and WPD-QSSDSS values (n, c, c1, c2). Table 2 provides five sets of values. Cameron (1952) and Duncan (1986) produced SSP and DSP values, accordingly. The WPD-QSSDSS values were taken from Table (4), which follows. Effectiveness is investigated among SSP, DSP, and WPD-QSSDSS. The method used for determining effectiveness is as outlined below:

*E1=np0.95 of SSP / np0.95 of WPD-QSSDSS
*E2=np0.95 of DSP / np0.95 of WPD-QSSDSS

According to the table, a significantly smaller sample size is needed for the WPD-QSSDSS than for SSP and DSP.

TABLE 1: MatchingOperating Ratio of Single Sampling Plan, Double Sampling Plan and QSSDSS-WPD

Single sampling plan			Double sampling Plan				QSSDSS-WPD					*E1	*E2
c	OR	np 0.95	a1	a2	OR	np 0.95	c	c1	c2	OR	np 0.95		
10	2.67	4.654	4	11	2.67	4.292	9	4	8	2.67	3.122	1.2111	1.1010
12	2.94	6.234	4	13	2.91	5.565	9	2	6	2.93	3.145	2.3455	1.5433
13	2.13	7.654	4	13	2.14	6.181	10	1	7	2.11	3.876	2.1232	1.3547
14	2.10	9.468	4	17	2.09	8.019	10	2	4	2.10	3.755	2.5555	1.6985
15	2.07	10.120	4	18	2.09	9.123	8	1	5	2.09	3.663	2.6628	1.9280

Fuzzy Set Theory and Acceptance Sampling Plan:

The use of fuzzy measurements combination theory and acceptance sampling methods plays an essential part in solving the inherent uncertainty of assessing quality as simple standards are inadequate. The Fuzzy Set Theory provides a more detailed assessment of membership in sets, along with greater flexibility in the identification of boundaries. This flexibility is most beneficial for acceptance sampling, as requirements may be modified using sets of fuzzy values which successfully indicate the various quality characteristics of examined goods. In manufacturing, for scenario, the concept of fuzzy sets allows acceptance sampling plans for taking into consideration multiple levels of acceptance or divergence in quality requirements, instead of simple categories that include success or failures. The dynamic approach ensures that quality assurance processes could effectively deal with practical applications complications, allowing for better understanding and accurate acceptance decisions which take advantage of the uncertain characteristic of measurements of quality.

The idea of fuzzy sets enhances acceptance of sampling methods by integrating ideas from specialists in the field and a variety of ideas. This conceptual structure provides for the flexible modification of acceptance or rejection criteria for sampling sets, taking advantage of multiple characteristics of quality that result from different components and factors. Establishments which accept the concept of fuzzy sets may enhance the accuracy of their quality management frameworks. It is achieved by providing a review of levels in the quality of the product instead of straightforward good or bad decisions.

Further, the concept of fuzzy sets provides efficient allocation of resources in quality management plans. It means that monitoring activities focus on what could have the most of an effect, if it involves identifying and rectifying minor deviations with requirements and keeping the highest possible standards of quality in significant domains. The dynamic method certainly increases the success rate of inspections, but it also allows manufacturers to react more quickly to shifting economic and commercial circumstances.

Eventually, which includes the theory of fuzzy sets into acceptance sampling methods provides a strong basis of solving the various challenges associated with quality control. In allowing the unpredictability and difficulties associated with practical problems evaluation of quality, this approach increases an organization's overall quality control plans, permitting continual improvement and reliability in the delivery of products and services.

Fuzzy QSSDSS:

The Operating characteristic function of WPD-QSSDSS based on the equation (1), In a manufacture process must be inspected using lots with the large size of N such that the probability of defective items is not known specifically. The parameter of fuzzy number $\tilde{p}$ as follows:

$$\tilde{p} = (a_1, a_2, a_3), p \in \tilde{p}[1], q \in \tilde{q}[1], p + q = 1 \qquad \text{------}(3)$$
$$\tilde{\lambda} = \widetilde{np} = (nl_i, na_2 + nl_i, na_3 + nl_i) \qquad \text{------}(4)$$

l_i in the domain of $[0, 1 - a_3]$, the OC function is plotted using fuzzy probability. Fuzzy logic with normal SSP and tightened DSP (n, c, c1, c2). The normal SSP using fuzzy logic is given below:

$$\tilde{P}_N = \left\{\sum_{x=1}^{c} \frac{e^{-\lambda}\lambda^{x-1}}{(x-1)!} | \lambda \in \tilde{\lambda}[a]\right\} = \left[min\left\{\sum_{x=1}^{c} \frac{e^{-\lambda}\lambda^{x-1}}{(x-1)!} | \lambda \in \tilde{\lambda}[a]\right\}, max\left\{\sum_{x=1}^{c} \frac{e^{-\lambda}\lambda^{x-1}}{(x-1)!} | \lambda \in \tilde{\lambda}[a]\right\}\right] \qquad \text{------}(5)$$

The tightened DSP using fuzzy logic is given below:

$$\tilde{P}_T = \tilde{P}^I{}_a + \tilde{P}^{II}{}_a = \left\{\sum_{x=1}^{c_1} \frac{e^{-np}np^{x-1}}{(x-1)!} | \lambda_1 \in \tilde{\lambda}[a]\right\} + \left(\left(\sum_{x=c_1+1}^{c_2} e^{-np}np^{x-1}/(x-1)! * \sum_{x=1}^{c_2-(c_1+1)} e^{-np}np^{x-1}/(x-1)! \, | \lambda_1 \in \tilde{\lambda}[a]\right)\right) \qquad \text{-------}(6)$$

Properties of FWPD-QSSDSS

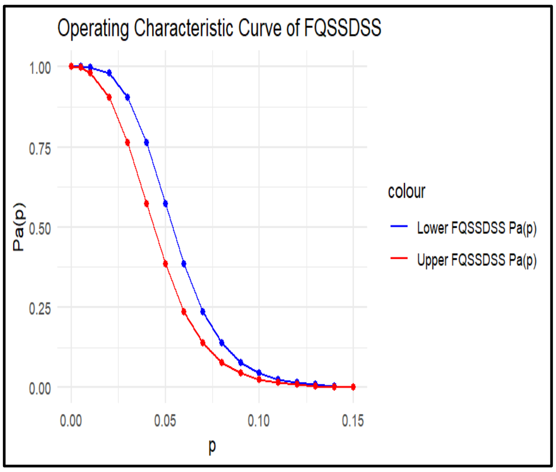
Table -2 indicates the data of OC curve of QSSDSS with fuzzy logic using R programming. It shows the effectiveness of a quality control sampling that combines fuzzy logic and QSS using normal SSP and tightening DSP.

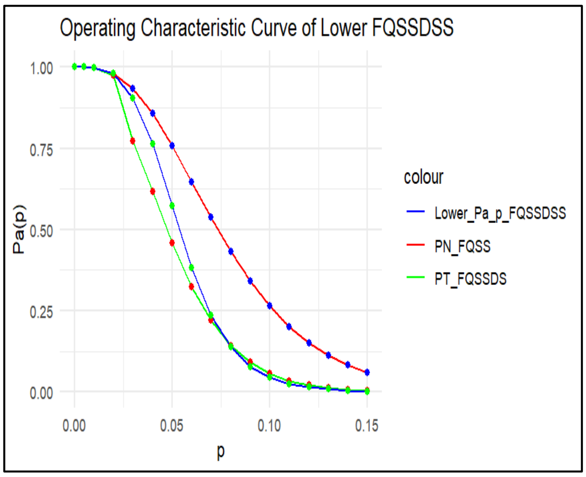
Table 2: Operating Characteristics Function for WPD-QSSDSS using fuzzy logic

p Lower	p Upper	Lower P_N FQSS	Upper P_N FQSS	Lower P_T FQSS	Upper P_T FQSS	Lower Pa(p) FQSSDSS	Upper Pa(p) FQSSDSS
0	0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.005	0.01	1.0000	0.9982	1.0000	0.9985	1.0000	0.9982
0.01	0.02	0.9982	0.9810	0.9985	0.9754	0.9982	0.9793

0.02	0.03	0.9810	0.9344	0.9754	0.9005	0.9793	0.9037
0.03	0.04	0.9344	0.8571	0.7723	0.6157	0.9037	0.7629
0.04	0.05	0.8571	0.7576	0.6157	0.4599	0.7629	0.5728
0.05	0.06	0.7576	0.6472	0.4599	0.3250	0.5728	0.3835
0.06	0.07	0.6472	0.5366	0.3250	0.2195	0.3835	0.2357
0.07	0.08	0.5366	0.4335	0.2195	0.1429	0.2357	0.1375
0.08	0.09	0.4335	0.3423	0.1429	0.0903	0.1375	0.0782
0.09	0.10	0.3423	0.2650	0.0903	0.0558	0.0782	0.0441
0.10	0.11	0.2650	0.2017	0.0558	0.0339	0.0441	0.0249
0.11	0.12	0.2017	0.1512	0.0339	0.0204	0.0249	0.0142
0.12	0.13	0.1512	0.1118	0.0204	0.0122	0.0142	0.0082
0.13	0.14	0.1118	0.0818	0.0122	0.0073	0.0082	0.0047
0.14	0.15	0.0818	0.0591	0.0073	0.0043	0.0047	0.0003
0.15	0.16	0.0591	0.0424	0.0043	0.0003	0.0003	0.0000

Using R programming Figure 2 was plotted. It indicates that the OC curve of fuzzy logic using QSSDSS. of probability of accepting a lot improves for increasing levels of nonconformity. This method accurately assesses lot with normal SSP and shifted to Tightened DSP for further analysis when defects increase. This approach maximizes goods, increases manufacturing, and produces appropriate quality-control decisions.





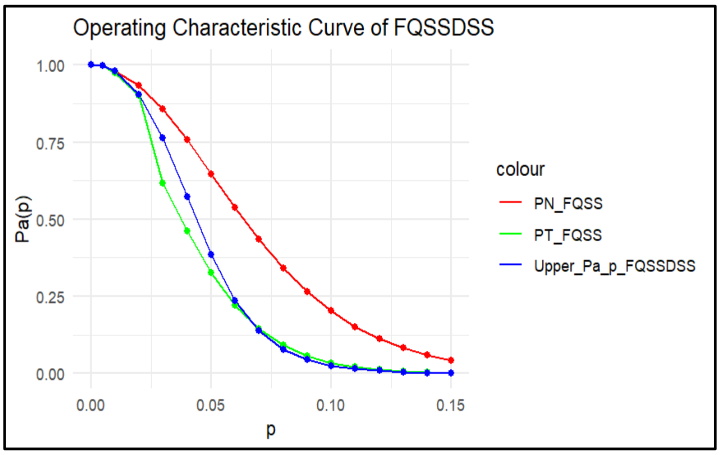


Figure 2: OC curve for WPD-QSSDSS with fuzzy logic

Neutrosophic Weighted Poisson Quick Switching Single Double Sampling Plan (NWPD-QSSDSS)

The combination of the neutrosophic concept with quick switching sampling (QSS), which incorporates both a normal SSP (NSSP) and a tightened DSP (TDSP) with WPD, is an effective approach for bettering manufacturing quality monitoring. Neutrosophic, it accepts the indeterminacies of decision-making, gives an outline for managing uncertainty and challenges that may appear in evaluating acceptance or defect of items. The above framework has been further improved by QSS, that continuously modifications the sample's perform based on the initial decisions. From the beginning, an NSSP evaluates a sample in the entire batch using specified criteria to find out whether it satisfies the requirements for quality. Since the conclusions are unsatisfactory (i.e., the number of nonconformities approaches the acceptability level), a TDSP is performed. It requires a deeper assessment prior to making an end focus. This flexible technique further assures that the highest standards requirements are fulfilled, however it also minimizes the monitoring process by giving useful input through real-time quality tests. It will prove particularly useful in industries were quick response to shifting manufacturing environments and uncertainty are essential for maintaining consistency and customer satisfaction.

OC Function of NWPD-QSSDSS

The neutrosophic based on quick switching single double sampling plan using weighted poisson distribution is a baseline. According to Smarandache (2010), the normalization is given by

$$t + I + f = 1 \qquad \text{------(7)}$$

where, t = truth of a statement; I = indeterminacy of a statement; f = falsehood of a statement similarly, we consider,

$$\text{PtN} + \text{PIN} + \text{PfN} = 1 \qquad \text{------(8)}$$

where, PtN = Probability of acceptance; PIN = Probability of indeterminacy; PfN = probability of rejection

The Operating characteristic function of WPD-QSSDSS based on the equation (1), Based on the above concept and equation (1), the equation of neutrosophic probability of acceptance, rejection probability and indeterminacy probability using the normal single sampling plan is given below

$$P_{tN} = \sum_{x=1}^{c} \frac{\lambda_F^x}{x!}\left[\sum_{i=0}^{\min(I,\ n-x)} \frac{\lambda_I^i}{i!} e^{-(\lambda_1+\lambda_F)}\right] \qquad \text{-----(9)}$$

$$P_{FN} = \sum_{x=c+1}^{c} \frac{\lambda_F^x}{x!} \left[\sum_{i=0}^{(\ n-x)} \frac{\lambda_I^i}{i!} e^{-(\lambda_1+\lambda_F)} \right] \qquad \text{-----(10)}$$

$$P_{IN} = \sum_{i=I+1}^{n} \frac{\lambda_I^i}{i!} \left[\sum_{x=1}^{\min(N,\ \ n-i)} \frac{\lambda_F^x}{x!} e^{-(\lambda_1+\lambda_F)} \right] \qquad \text{-----(11)}$$

Also, the equation of neutrosophic probability of acceptance, rejection probability and indeterminacy probability using the tightened double sampling plan is given below

$$P_{tN} = \sum_{x_1=1}^{c_1} \Bigg(\frac{\lambda_{F_1}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=0}^{\min(I_1,n_1-x_1)} \frac{\lambda_{I_1}^{i_1}}{i_1!} e^{-(\lambda_{I_1}+\lambda_{F_1})} \Bigg] \Bigg)$$

$$+ \sum_{x_1=c_1+1}^{c_2} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=0}^{\min(I_2,n_1-x_1)} \Bigg(\frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})}$$

$$* \Bigg[\sum_{x_2=1}^{c_2-x_1} \Bigg(\frac{\lambda_{F_2}^{x_2-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=0}^{\min(I_2-i_1,\ \ n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg)$$

$$+ \sum_{x_1=1}^{c_1} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=I_1+1}^{\min(I_2,\, n_1-x_1)} \Bigg(. \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})}$$

$$* \Bigg[\sum_{x_2=0}^{c_2-x_1} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=0}^{\min(I_2-i_1,\ \ n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg)$$

-----(12)

$$P_{FN} = \sum_{x_1=c_2+1}^{n_1} \Bigg(\frac{\lambda_{F_1}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=0}^{\min(\ n_1-x_1)} \frac{\lambda_{I_1}^{i_1}}{i_1!} e^{-(\lambda_{I_1}+\lambda_{F_1})} \Bigg] \Bigg)$$

$$+ \sum_{x_1=c_1+1}^{c_2} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=0}^{\min(I_2,n_1-x_1)} \Bigg(\frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})}$$

$$* \Bigg[\sum_{x_2=x_1+1}^{n_2} \Bigg(\frac{\lambda_{F_2}^{x_2-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=0}^{\min(n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg)$$

$$+ \sum_{x_1=1}^{c_1} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=I_1+1}^{\min(I_2,\, n_1-x_1)} \Bigg(. \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})}$$

$$* \Bigg[\sum_{x_2=x_1+1}^{n_2} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=0}^{\min(n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg)$$

-----(13)

$$
\begin{aligned}
P_{IN} = {} & \sum_{x_1=1}^{c_2} \Bigg(\frac{\lambda_{F_1}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=I_2+1}^{\min(n_1-x_1)} \frac{\lambda_{I_1}^{i_1}}{i_1!} e^{-(\lambda_{I_1}+\lambda_{F_1})} \Bigg] \Bigg) \\
& + \sum_{x_1=c_1+1}^{c_2} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=0}^{\min(I_2, n_1-x_1)} \Bigg(\frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \\
& * \Bigg[\sum_{x_2=1}^{c_2-x_1} \Bigg(\frac{\lambda_{F_2}^{x_2-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=I_2-i_1+1}^{\min(n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg) \\
& + \sum_{x_1=1}^{c_1} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_1=I_1+1}^{\min(I_2, n_1-x_1)} \Bigg(. \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \\
& * \Bigg[\sum_{x_2=0}^{c_2-x_1} \Bigg(\frac{\lambda_{F_2}^{x_1-1}}{(x_1-1)!} . \Bigg[\sum_{i_2=I_2-i_1+1}^{\min(I_2-i_1,\ n_2-x_2)} \frac{\lambda_{I_2}^{i_1}}{i_1!} e^{-(\lambda_{I_2}+\lambda_{F_2})} \Bigg] \Bigg) \Bigg] \Bigg) \Bigg] \Bigg)
\end{aligned}
\qquad \text{-----(14)}
$$

Properties of NWPD-QSSDSS

Table -3 indicates the data of OC curve of neutrosophic using WPD QSSDSS. Using R programming the OC function was calculated. It shows the effectiveness of a quality control sampling that combines neutrosophic and QSS using normal SSP and tightening DSP.

Table 3: Operating Characteristics Function for WPD-QSSDSS using Neutrosophic

N	n	n_1	n_2	c	c_1	c_2	I_1	I_2	Neutrosophic			Neutrosophic QSS-SSP			Neutrosophic QSS-DSP			Neutrosophic QSSDSS Pa(p)
									P(S)	P(F)	P(I)	SSP P_{IN}	SSP P_{FN}	SSP P_{IN}	DSP P_{IT}	DSP P_{FT}	DSP P_{IT}	
500	20	20	30	0	1	2	1	2	0.85	0.08	0.07	0.9607	0.0210	0.0183	0.9751	0.0133	0.0116	0.9613
500	25	25	35	1	2	3	2	3	0.88	0.07	0.05	0.9435	0.0285	0.0280	0.9132	0.0273	0.0595	0.9417
500	30	30	40	2	3	4	3	4	0.90	0.05	0.05	0.9262	0.0283	0.0456	0.9018	0.0341	0.0641	0.9244
500	35	35	45	3	4	5	4	5	0.95	0.03	0.02	0.9047	0.0392	0.0561	0.8997	0.0482	0.0521	0.9042
500	40	40	50	4	5	6	5	6	0.98	0.01	0.01	0.8621	0.0369	0.1010	0.8666	0.0005	0.1329	0.8627
1000	20	20	30	0	1	2	1	2	0.80	0.10	0.10	0.9801	0.0100	0.0100	0.9856	0.0072	0.0072	0.9802
1000	25	25	35	1	2	3	2	3	0.85	0.10	0.05	0.9753	0.0165	0.0082	0.9597	0.0134	0.0269	0.9749
1000	30	30	40	2	3	4	3	4	0.90	0.05	0.05	0.9704	0.0148	0.0148	0.9088	0.0856	0.0056	0.9685

1000	35	35	45	3	4	5	4	5	0.95	0.03	0.02	0.9656	0.0206	0.0138	0.8984	0.0916	0.0100	0.9631
1000	40	40	50	4	5	6	5	6	0.98	0.01	0.01	0.9607	0.0197	0.0196	0.8234	0.1383	0.0383	0.9544

Practical Example:

A hospital regularly purchases blood test kits from a supplier to diagnose various medical conditions. These kits can sometimes exhibit defects such as faulty reagents or inaccurate calibration, which can impact diagnostic accuracy. The hospital and supplier have agreed upon quality standards based on probabilities of non-defectiveness, indeterminacy, and defectiveness of the kits. The hospital implements a QSS based on Neutrosophic WPD to assess the quality of incoming blood test kit lots. The following steps are used:

Step 1: In QSS with normal SSP, take a random sample of size n=52 from a lot and check the no. of defective units x and number of indeterminate items 'i'

(i) if $x \leq 2$, and $i \leq I$ (1), accept the lot and repeat step 1 for next lot.
(ii) if $x > 2$, reject the lot a and continue with step 2 for the next lot.
(iii) if $x \leq 2$, $i > I$ (1), the lot is indeterminate.

Step 2: In QSS with tightened DSP, take a random sample of size n=52 from the next lot and check the no. of defectives x1 and in determinate item (i).

(i) If $x1 \leq 5$, $i \leq I$ (1), accept the lot and continue with step 1 for the next lot.
(ii) If $x1 > 3$, reject the lot and repeat step 2 for the next lot.
(iii) Choose a second random sample of size n from the same lot if $5 < x1 \leq 3$ and verify the no. of defectives x2.
(iv) If $x1+x2 \leq 3$. $i \leq I$ (1), accept the lot and continue with step 1 for the next lot.
(v) If $x1+x2 > 3$ reject the lot and repeat step 2 for the next lot.
(vi) If $x1+x2 \leq c2$, $i > I$ (1), the lot is indeterminate.

The above example indicates the quality control method includes a Quick Switching System (QSS) with a normal SSP (Step 1) and a tightened DSP (Step 2) depending on the weighted poisson distribution. It uses Neutrosophic concepts to circumstances in which the lot's quality status is not known or fuzzy. Using Neutrosophic logic, the method gives valid choices, increasing the accuracy of quality control processes for monitoring the blood test kit quality for clinical diagnostics. These strategies give a systematic method for quality control in the medical sector, including blood testing kits meeting specified defective needs for usage in clinical testing.

Table 4: Values of np tabulated against c, c1, c2 for the given values of Pa(p) for WPD-QSSDSS (n; c; c1, c2)

c	c_1	c_2	0.99	0.95	0.75	0.50	0.25	0.10	0.05	0.01
2	1	4	0.1492	0.3624	1.0178	1.7476	2.6232	3.5252	4.1328	5.4585
2	2	5	0.1493	0.3647	0.4041	1.6531	3.5478	5.1991	6.2385	8.3955
2	3	6	0.1495	0.3658	1.1553	2.3997	3.9323	5.3989	6.3623	8.4337
2	4	7	0.1499	0.3666	1.1790	2.7714	4.8028	6.5913	7.7160	10.0397

2	5	8	0.1534	0.3678	1.1865	3.1564	5.7725	7.8356	9.0817	11.5919
2	6	9	0.1593	0.3695	1.1884	3.5488	6.8018	9.0854	10.4278	13.0935
3	1	5	0.4371	0.8247	1.7463	2.6162	3.6020	4.5890	5.2392	6.6091
3	2	6	0.4376	0.8315	1.8378	2.8579	4.0113	5.1441	5.8853	7.4613
3	3	7	0.4377	0.8343	1.9214	3.1554	4.5547	5.8986	6.7760	8.6656
3	4	8	0.4387	0.8351	1.9814	3.4943	5.2358	6.8516	7.8935	10.1058
3	5	9	0.4399	0.8353	2.0150	3.8604	6.0423	7.9517	9.1470	11.6092
4	1	6	0.8243	1.3710	2.5204	3.5227	4.6237	5.7080	6.4144	7.8824
4	2	7	0.8252	1.3802	2.6022	3.7143	4.9382	6.1271	6.8940	8.4801
4	3	8	0.8256	1.3862	2.6915	3.9543	5.3396	6.6631	7.5127	9.2848
4	4	9	0.8257	1.3889	2.7742	4.2451	5.8598	7.3710	8.3389	10.3811
5	1	7	1.2799	1.9719	3.3262	4.4512	5.6607	6.8374	7.5986	9.1688
5	2	8	1.2811	1.9815	3.3962	4.6123	5.9289	7.1978	8.0102	9.6703
5	3	9	1.2819	1.9899	3.4771	4.8015	6.2352	7.6021	8.4712	10.2439
6	1	8	1.7857	2.6120	4.1540	5.3919	6.7009	7.9627	8.7746	10.4409
6	2	9	1.7871	2.6209	4.2159	5.5386	6.9514	8.3026	9.1633	10.9112
7	1	5	2.1393	2.7681	3.6294	4.2136	4.8424	5.5077	5.9771	7.0520
7	2	6	2.2011	2.8880	3.8504	4.5131	5.2332	6.0025	6.5507	7.8287
7	3	7	2.2564	3.0133	4.1114	4.8858	5.7405	6.6686	7.3394	8.9309
8	1	5	2.5744	3.2027	4.0313	4.5824	5.1715	5.7939	6.2338	7.2466
8	2	6	2.6610	3.3494	4.2739	4.8971	5.5701	6.2892	6.8034	8.0113
8	3	7	2.7460	3.2910	4.5638	5.2897	5.4539	6.9525	7.5816	9.0874
9	1	5	2.9974	3.6198	4.4195	4.9440	5.5016	6.0893	6.5049	7.4644
9	2	6	3.1083	3.7912	4.6824	5.2746	5.9107	6.5897	7.0759	8.2230
9	3	7	3.2236	3.9839	4.9995	5.6879	6.4395	7.2562	7.8503	9.2789
10	1	5	3.4086	4.0227	4.7972	5.2998	5.8317	6.3911	6.7864	7.7005
10	2	6	3.5428	4.2172	5.0798	5.6469	6.2536	6.9002	7.3634	8.4587

10	3	7	3.6876	4.4401	5.4231	6.0817	6.7978	7.5747		9.5005

Conclusion: The construction and design of Quick Switching systems QSSFP and QSSNP (n; CN, CT) involve the implementation of single sampling plans using Neutrosophic Poisson Distribution (NSPD), which integrates Neutrosophic Sets (NSs) to effectively manage uncertainty in quality assessment. Quick Switching Sampling (QSS) systems with normal SSP and tighter DSP that utilize the weighted poisson distribution as the baseline distribution and interact into fuzzy logic and neutrosophic combinations provide an adverse methodology for quality control in production. Using standard static sampling plans, QSS systems continuously shift samples intervals in response to immediate input and preliminary findings. This dynamic range additionally increases performance under shifting manufacturing circumstances, but it also optimizes sample efforts, minimizing expenses while retaining the highest standards of quality. The use of fuzzy logic improves decision-making above simple outcomes by providing for degrees of membership in acceptance criteria, solving the inherent risk in manufacturing procedures. Neutrosophic sets improve this approach through involves criteria for truth, indeterminacy, and falsity, providing an exhaustive structure for managing uncertain high-quality information effectively.

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