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Original Research Article

Development of Mathematical Models to Compare Different Approaches of Life Testing from an Economic Viewpoint

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Abstract

Life testing and acceptance sampling plans (ASPs) are two important fields of quality and reliability engineering. Designing sampling plans while the critical quality characteristic is lifetime is commonly known as reliability acceptance sampling plans (RASPs). When it is discussed, RASPs, life testing methods, and ASPs should be jointly taken into consideration, and consequently, this field attracts the attention of researchers. In this paper, two main methods for conducting life testing are investigated: failure censoring and time censoring. It is assumed that the lifetime of products follows an exponential distribution, and the quality of such items should be assessed. For the aforementioned life testing methods, mathematical models are developed to minimize the expected total costs of the test while constraints of producer and consumer risks are taken into consideration. Comparative studies and analyses are conducted to show better the performance of these two approaches of life testing from the economic point of view.

Keywords: Lifetime; Reliability; Quality characteristic; Acceptance sampling plans; Mathematical model.

1. Introduction

Acceptance sampling plans (ASPs) are considered an active field of statistical process control. It is desired to design an approach/plan to decide about the acceptance or rejection of a lot/batch. ASPs can be employed in different stages of a production system, from the import of raw materials to the factory, to work in process (WIP) products, to the finished goods which are ready to deliver to the consumers or warehouses [1], [2]. In designing ASPs, statistical characteristics and producer and consumer requirements should be incorporated, and an appropriate ASP should satisfy both consumer and producer risks. Usually, the producer desires that a lot at an acceptable quality level (AQL) be accepted with at least probability of $1-\alpha$, while α is known as the producer's risk. On the other hand, the consumer desire is that a lot at a rejectable quality level (RQL) be rejected by the plan with at least probability of $1-\beta$, while β is the consumer risk.

To meet the requirements of the producer and consumer, different ASPs are designed. Single sampling, double sampling, repetitive sampling, and sequential sampling plans are among others. Also, some researchers develop mathematical models in order to optimize the expected costs or other major criteria of the plans. In these models, satisfying the producer and consumer risks is usually considered as the constraint of the model. In other words, the model optimally determines the plan parameters in order to optimize a specific criterion of the plan subject to the producer and consumer risks [3], [4].

Another key feature of ASPs is the Operating Characteristic (OC) curves. It is a curve to determine the acceptance probability of a plan given a specific quality level. An ideal ASP should accept a lot at a quality level less than RQL with probability zero, and the acceptance probability should be one for the quality levels that are larger than AQL[5]. However, as its name indicates, it is just an ideal plan. In practice, it is desired that a plan has

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an OC curve which be as similar to the perfect OC curve as possible.

When the critical quality characteristic is lifetime, designing life tests arises as a field in reliability and quality engineering. Different life test methods are developed. Sometimes these methods are classified into time censoring and failure censoring methods. In the time censoring methods, the test is normally terminated after passing a prespecified time. In contrast, in the failure censoring, the test is terminated after observing a specified number of failures. Failure censoring and time censoring life tests are also known as censoring type II and I, respectively.

Reliability acceptance sampling plans (RASPs) is a field in the intersection of life testing and ASPs. In other words, in RASPs, the quality characteristic is lifetime, which necessitates designing life tests so that the requirements of the producer and consumer are met. As many life testing methods are destructive or lengthy, minimizing the costs of the test becomes of paramount importance. Accordingly, some researchers provide mathematical models in this regard.

In [6], a mathematical model is developed to minimize the expected total costs of a failure censoring life testing under the constraints of producer and consumer risks. The OC curve of the test is derived, and some analyses are provided. In [7], a mathematical model is developed to minimize the number of failures in an RASP, while the lifetime follows an exponential distribution. They also extended the model for the two-parameter Weibull distribution. A sampling plan for the exponential distribution is provided in [8]. It is based on the two-point approach in the OC curve, i.e., AQL and RQL, to meet the producer and consumer risks. In [9], a sampling plan under truncated life testing is provided, while the lifetime data are assumed to follow the Rama distribution. More recently, in [10], a group acceptance sampling plan is proposed under truncated life testing while the data follow a gamma Lindley distribution. A double-sampling plan for truncated life testing is developed by [11] while the lifetime of items follows a half-normal distribution.

In [12], an accelerated acceptance sampling plan is proposed for degraded products under an inverse Gaussian distribution. The authors considered the uncertainty of the acceleration factor and used simulated and real data to show the applications of their model. To evaluate the reliability of products, [13] proposed single and double acceptance sampling plans under truncated life testing. They used percentile life as a measure of reliability. Moreover, the equations for OC curves are derived, and a mathematical model is developed to minimize the required sample size of the test. Similar research is conducted in [14]about reliability acceptance sampling plans. A nonlinear optimization model is developed in [15] to minimize the average sample number (ASN) given the constraints of producer and consumer risks. The authors used the process capability index and employed the model for circular products. In another research, the economic design of the resubmitted sampling plan is studied based on the process yield index, while the Taguchi loss function is employed [16]. More recently, in [17], a hybrid group censoring is utilized to evaluate the exponentially distributed items for step-stress accelerated life testing. In [18], a multi-stress accelerated degradation test is proposed to assess and predict the remaining useful life (RUL) of milling tools in CNC machines.

Given the literature of RASPs, the main novelties of the current research are summarized as follows:

- Development of two mathematical models to minimize the expected total costs of two approaches of life testing, including time censoring and failure censoring
- Constraints regarding producer and consumer risks are taken into consideration as constraints of the models
- Derive equations to compute the OC curve of the two approaches of life testing
- Conduct comparative studies and analyses to show the advantages/disadvantages of one approach against another from an economic point of view.

The rest of the paper is organized as follows: Section 2 provides the problem statement and introduces some basic concepts. Section 3 discusses the two approaches of life testing and their respective mathematical models. Also, the relative equations of OC curves are presented. Section 4 conducts some analyses and comparative studies. Finally, Section 5 concludes the paper.

2. Problem Statement

Consider the lifetime of an item as its critical quality characteristic. It is assumed the lifetime is a random variable denoted as t and it follows an exponential distribution with failure rate λ. In other words:

$$f(t) = \lambda e^{-\lambda t} \quad (1)$$

Assessment of the lifetime of this product is desirable. More specifically, the following hypothesis test will be conducted:

$$\begin{cases} H_0: \lambda = \lambda_0 \\ H_1: \lambda = \lambda_1 > \lambda_0 \end{cases} \quad (2)$$

The probabilities of type I and II errors are considered α and β, respectively. In the field of acceptance sampling plans, they are defined as in the following. The supplier/producer desire is that a lot at quality level $\lambda = \lambda_0$ be accepted with at least probability $1 - \alpha$. On the other hand, the consumer desires to accept a lot at quality level $\lambda = \lambda_1$ with at most probability of β. In the terminology of acceptance sampling plans, λ_0 and λ_1 are called acceptable quality level (AQL) and limiting quality level (LQL), Lot Tolerance Percent Defective (LTPD) or Rejectable Quality Level (RQL), respectively.

Also, α and β are the producer and consumer risks, respectively.

The costs of the test can be classified as in the following:

- Operational costs: these costs have a direct proportion to the duration of the test, i.e., as the test duration increases, they increase as well and vice versa. It is assumed C_1 for a time unit of the test.
- The costs of the items placed in the test: it is assumed C_2 for every item used in the test
- The costs of the failed items: the costs of every item that failed during the test are C_3.

We aim to provide mathematical models to minimize the expected total costs of the life testing while satisfying the risks of the producers and consumers. In the following two methods to conduct the life testing and assess the quality characteristic are provided. The first approach is called failure censoring or type II censoring without replacement. The second method is called time censoring or type I censoring with replacement.

The objective functions of the mathematical models of the two approaches of life testing (Equations 4 and 8 in the following) consist of three terms: operational costs of the test, the costs of items placed on the test, and the costs of failed items. The models optimize the expected total costs of the test subject to the constraints of the producer's and consumer's risks. The optimal point proposed by the models indeed provides a tradeoff among these three costs of the test.

3. Two approaches to conduct the life testing and their respective mathematical models

First, a failure censoring method is described, and its mathematical model is derived. Also, an equation to compute the acceptance probability of a lot under a desired quality level is derived. This equation is employed to display the OC curve. In the second subsection, the second approach for conducting the test is explained. It is time censoring or type I censoring. Its mathematical model and equation to derive the OC curve are also provided.

3.1 Type II/Failure censoring and its mathematical model

It is assumed that n items are randomly selected and put in the test concurrently. The test continues until r items fail ($r \leq n$). During the test, the failure timepoints of every item are recorded, which eventually form the following ordered statistics: $t_{(1)}, t_{(2)}, \ldots, t_{(r)}$. Accordingly, the following statistic is computed:

$$W = \sum_{j=1}^{r} t_{(j)} + (n-r)t_{(r)} \qquad (3)$$

It is well discussed in [19] that $2\lambda w$ follows a chi-square distribution with $2r$ degrees of freedom which is denoted as: $2\lambda w \sim \chi^2_{2r}$. Accordingly, the following approach is used to assess the quality of items: if $\frac{r}{w} \leq k$, the lot is accepted, and otherwise it is rejected, which means the lot does not meet the quality criteria. The value of k is critical and is determined by the model as discussed in the following.

A model to minimize the expected total costs (ETC) of the test is derived in [6]as in the following:

$$\begin{aligned} &\textbf{\textit{Minimize}}\ ETC(n,r,k) = \frac{C_1}{\lambda}\sum_{j=0}^{r-1}\frac{1}{n-j} + nC_2 + rC_3 \\ &\textbf{\textit{Subject to}}:\quad P\left(\chi^2_{2r} \leq \frac{2\lambda_0 r}{k}\right) \leq \alpha \\ &P\left(\chi^2_{2r} \geq \frac{2\lambda_1 r}{k}\right) \leq \beta \\ &n \geq r, k > 0 \end{aligned} \qquad (4)$$

The objective function minimizes the total costs of the test. It encompasses three terms. As the test averagely takes $\frac{1}{\lambda}\sum_{j=0}^{r-1}\frac{1}{n-1}$ time unit to terminate, the first term computes the operational costs of the test. The second and third terms are the costs of items placed on the test and the costs of the failed items, respectively. The first and the second constraints are the risks of the producer and the consumer, respectively. Decision variables of the model are $r, n,$ and k. In other words, the model determines these variables so that the total costs of the test are minimized.

As the sample size (n) increases, the expected time to terminate the test decreases, and consequently, the operational costs of the test (the first term of the objective function) decrease. On the other hand, increasing sample size leads to an increase in the costs of the items placed on the test and the costs of the failed items (the second and third terms of the objective function). Hence, a tradeoff is necessary among these three terms of the objective function in order to minimize the expected total costs of the test. For more discussion in this regard, the interested reader is referred to [6].

Equation 4 is a non-linear mixed integer mathematical model, i.e., k is a continuous variable, while n and r are integer and discrete variables. This type of model is difficult to optimize, especially given its non-linear constraints. Thus, by discretizing the continuous variables in reasonable intervals, a grid search algorithm is provided in MATLAB software.

According to the rule of this approach, for a lot at quality level λ, the probability of acceptance is computed using the following equation [6]:

$$\pi_a(\lambda) = P\left(\chi^2_{2r} \geq \frac{2\lambda r}{k}\right) \qquad (5)$$

In other words, this equation provides the OC curve of the plan.

3.2 Type I/Time censoring and its mathematical model

In this test, n items are randomly selected and simultaneously put in the test. During the test, once a fails, it is replaced with a new one. The test continues until a predetermined time as t_0. Having finished the test, the total number of failed items is enumerated. If it is less than or equal to a critical number as *r*, the lot is accepted, and otherwise it is rejected. Accordingly, during the test, there are always *n* items. Let us define $N(t_0)$ as a random variable denoting the number of failed items during the test. It follows a Poisson distribution with rate $n\lambda$. Hence, the probability of observing r failures during the test can be computed as follows:

$$p(N(t_0) = r) = \frac{e^{-\lambda n t_0}(n\lambda t_0)^r}{r!} \qquad r = 0,1,2,\ldots \tag{6}$$

To evaluate a lot, the number of failures is compared with *r*. It means that if $N(t_0) \le r$, the lot is accepted, which is equivalent to acceptance of the null hypothesis, and otherwise the lot is rejected. According to the relations of Poisson, Erlang, and Chi-square distribution, the following equation can be derived:

$$p[N(t_0) \le r] = p(x^2_{2r+2} \ge 2n\lambda t_0) \tag{7}$$

Finally, the following mathematical model minimizes the expected total costs of the test:

$$\textbf{Minimize } ETC(n, r, t_0) = C_3 n\lambda t_0 + C_2 n(1 + \lambda t_0) + C_1 t_0 \tag{8}$$

$$\textit{subject to} \quad p(x^2_{2r+2} > 2nt_0\lambda_0) \ge 1 - \alpha$$
$$p(x^2_{2r+2} > 2nt_0\lambda_1) \le \beta$$
$$n, r \in INTEGER, t_0 > 0$$

Like Equation 4, Equation 8 is also a mixed integer non-linear mathematical model. Again, a grid search algorithm is developed in MATLAB software to optimize this model.

Decision variables of the model are n, *r,* and t_0. The first and second constraints guarantee the producer and consumer risks. The model optimally determines the decision variables to minimize the costs of the test. Finally, the following equation is employed to derive the OC curve of this test:

$$\pi_a(t, n|\lambda) = p[N(t_0) \le r] = 1 - \sum_{j=r+1}^{\infty} \frac{e^{-\lambda n t_0}(n\lambda t_0)^j}{j!} = P(\chi^2_{2r+2} \ge 2n\lambda t_0) \tag{9}$$

It should be recalled that two approaches are discussed to conduct the life testing. The first is failure censoring (type II censoring), while the failed items are not replaced during the test. The second is time censoring or type I censoring, while the failed items are replaced with new ones during the test. In the proposed approach of type I censoring, *n* items are placed on the test, and once an item fails, it is replaced with a new one. Hence, the total number of items during the test remains fixed, and the stochastic process describing the number of failed items during a specified interval forms a stochastic Poisson process with rate $n\lambda$ [20].

4. Numerical Examples and Analyses

In the following, some examples and analyses are provided to show the applications of the models and equations. The data of the example are presented in Table 1. Accordingly, for this example, the producer and consumer risks are 0.01 and 0.05, respectively. The costs for every failed item are 5, and the cost for any item used during the test is 75. Also, for an hour of test, the operational cost is 10. Acceptable quality level and rejectable quality level are considered 0.001 and 0.002, respectively.

Table 1. Data of the example

C_1	C_2	C_3	α	β	λ_0	λ_1
10	**75**	**5**	**0.01**	**0.05**	**0.001**	**0.002**

For the type II censoring (failure censoring) approach without replacement, Table 2 shows the results. For type I censoring (time censoring) with replacement, Table 3 displays the results. It is worth noting that in the mathematical models derived for both life testing methods, a value should be specified for λ. As it is common in the literature of ASP and RASP, the models are solved under three different values of λ, including λ_0, λ_1 and $0.5(\lambda_0 + \lambda_1)$ as shown in both tables. For example, given the value of λ_1, for the failure censoring, it is necessary to place 70 items simultaneously, and the test continues until observing 36 failed items. During the test, the failure time of any of the items is recorded, and accordingly, Equation 3 is computed. If $\frac{r}{w} = \frac{36}{w} \le 0.0016$, the lot is accepted, and otherwise it is rejected. For the same value of λ, if time censoring is employed, it is required to place 54 items on the test and terminate the test after passing 420 hours. If the number of failed items during the test is less than or equal to 34, the lot is accepted; otherwise, it is rejected. As Tables 2 and 3 show, the optimal costs of the failure censoring and time censoring under λ_1 are 9000 and 11881, respectively. It means that for this level of quality, the failure censoring is a better approach from an economic point of view, as it leads to 32% savings in the costs. For the quality level λ_0, however, the time censoring test leads to less expected cost, and at quality level $0.5(\lambda_0 + \lambda_1)$, the failure censoring provides a better result.

Table 2. The results for type II censoring

Decision Variables / Different Values of Lambda	*r*	*n*	*k*	*ETC*
λ_0	36	89	0.0016	12000
λ_1	36	70	0.0016	9000
$0.5(\lambda_0 + \lambda_1)$	36	77	0.0016	10119

Table 3. The results for type I censoring

Decision Variables / Different Values of Lambda	r	n	t_0	ETC
λ_0	34	54	420	10066
λ_1	34	54	420	11881
$0.5(\lambda_0+\lambda_1)$	34	54	420	10973

Comparison of Tables 2 and 3 shows that one of the main factors affecting the performance of one approach of life testing against another is the quality of the assumed lot, which is indeed represented by λ. Thus, to have a better insight into the comparison of these two methods of life testing, Figure 1 displays the ETC of the two tests for different levels of a lot's quality. It cannot be concluded that one approach is uniformly better than the other. Indeed, the trends of the two methods with changes of λ are completely different. For the failure censoring, as λ increases from 0.001 to 0.002, ETC decreases, while for the time censoring, the trend is increasing. Consequently, for $\lambda < 0.0013$, the time censoring test yields lower costs. Generally speaking, it can be concluded that for the lots with a high-quality level, the time censoring method provides better results. On the other hand, if the quality level of the received lot is poor, it is recommended to use the failure censoring method.

From a managerial implications point of view, these results show that for a supplier with high quality levels, it is recommended to employ time censoring in order to evaluate the quality of the received lots/batches. In contrast, if a supplier is new or producers/manufacturers are not sure about the quality of what they received, it is better to apply the failure censoring in order to decrease the expected total costs of the test. Moreover, for a time censoring test, the analyst has more control over the time to end the test, while for the proposed failure censoring, the analyst can specify the number of failed items to terminate the test.

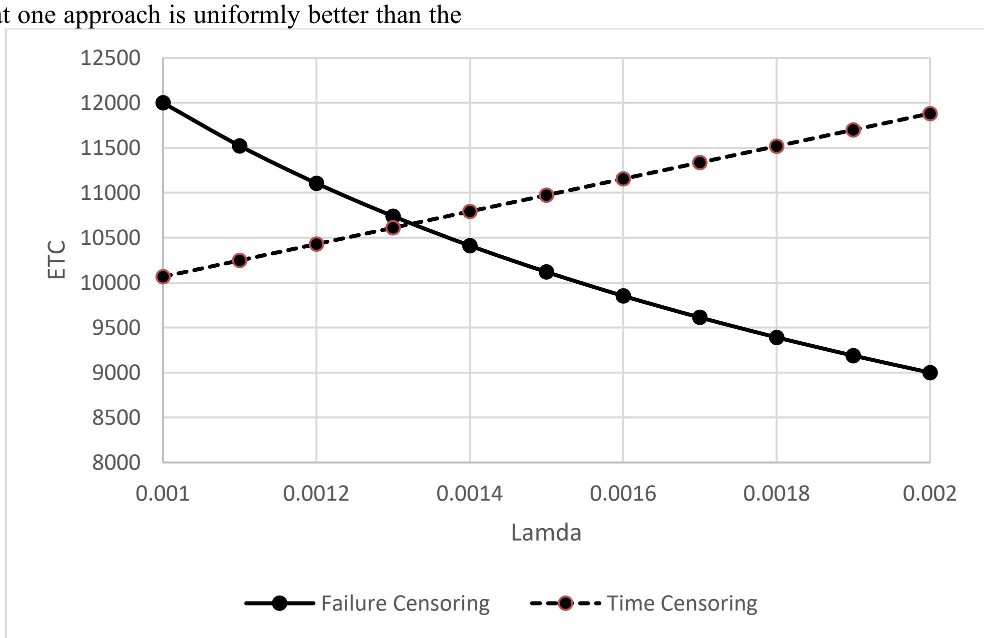

Figure 1. Comparison of the expected total costs (ETC) of the failure censoring and time censoring for different quality levels of a lot

According to Equations 5 and 9, the OC curves are plotted and shown in Figure 2. There is a little difference between the two curves. It seems that the probability of acceptance of the lot is larger under failure censoring for all quality levels. For example, at quality level 0.0015, the probabilities of acceptance are 0.54 and 0.63 for time and failure censoring, respectively.

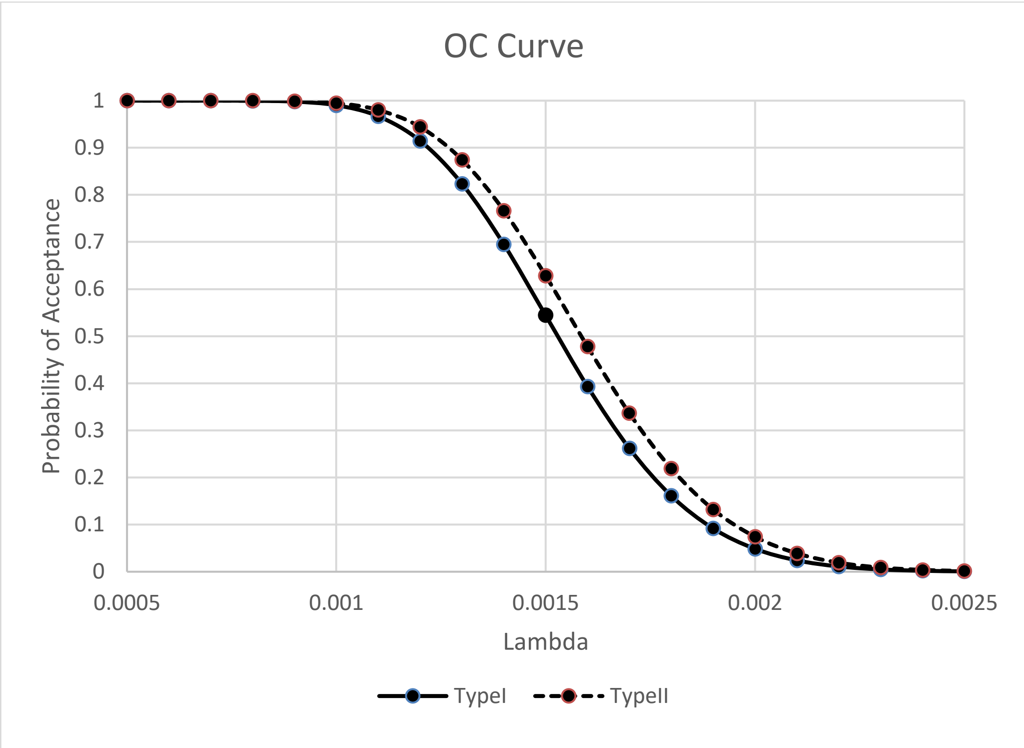

Figure 2. The Operating Characteristic (OC) curve of the two tests

In the following, some analyses are provided to show the effects of changing the test parameters. One of the key factors in the ASPs is consumer and producer risks, i.e., α and β. Table 4 provides some insights in this regard. Different results can be inferred from this table. First, as the level of α or β increases, the *ETC* significantly decreases. For example, for $\alpha = 0.01, \beta = 0.01$, the time censoring and failure censoring life testing lead to *ETC* of 13546 and 11865, respectively. If we set $\beta = 0.05$, for the same level of producer risk, *ETC* becomes 10973 and 10119 for the time censoring and failure censoring, respectively. Also, increasing the producer/consumer risks decreases the values of decision variables of the test, i.e., $n, r,$ and t_0.

Table 4. Analyzes the effects of the producer and consumer risks

α	β	Time/failure censoring	n	r	K or t_0	*ETC*
0.01	0.01	Failure censoring	92	47	0.0015	11865
		Time censoring	68	45	465	13546
	0.05	Failure censoring	77	36	0.0016	10119
		Time censoring	54	34	420	10973
	0.1	Failure censoring	68	30	0.0016	9091
		Time censoring	51	29	365	9710
0.05	0.01	Failure censoring	73	33	0.0014	9613
		Time censoring	55	32	435	11348
	0.05	Failure censoring	59	24	0.0015	7987
		Time censoring	48	23	340	8960
	0.1	Failure censoring	51	19	0.0015	6988
		Time censoring	42	18	295	7588

α	β	Time/failure censoring	n	r	K or t_0	*ETC*
0.1	0.01	Failure censoring	62	26	0.0013	8365
		Time censoring	48	25	410	10063
	0.05	Failure censoring	50	18	0.0014	6778
		Time censoring	44	17	290	7732
	0.1	Failure censoring	44	15	0.0015	6115
		Time censoring	38	14	265	6709

In the following, some analyses are conducted to show the parameter effects of the life testing. Table 5 displays the impact of a change in AQL and RQL. The general impression obtained from this table is that as the difference between AQL and RQL becomes wider, the values of n and r decrease, which consequently decreases the *ETC* of the test. Finally, the effects of cost parameters, i.e., C_1, C_2 and C_3 are thoroughly investigated in [6].

Table 5. Analyzing the effects of $\boldsymbol{\lambda_0}$ and $\boldsymbol{\lambda_1}$

$\boldsymbol{\alpha = 0.01;\ \beta = 0.05;\ C_1 = 10;\ C_2 = 75;\ C_3 = 5}$

λ_0	λ_1	*n*	*r*	*k*	*ETC*
0.001	0.002	77	36	0.0016	10119
	0.0025	51	21	0.0018	6923
	0.003	41	16	0.002	5589
0.002	0.003	135	100	0.0026	15971
	0.0035	83	53	0.0028	10125
	0.004	60	35	0.0031	7554
0.003	0.005	87	63	0.0041	10022
	0.006	54	35	0.0046	6508

5. Conclusion

In this paper, a comparison of two approaches to conduct life testing is investigated from the economic point of view. The first approach was failure censoring, and the second was time censoring. The item's lifetime is assumed to follow an exponential distribution. To this end, mathematical models are developed for the two approaches. The models provide the optimal life testing and sampling plan to minimize the expected total costs of the test. Thus, the objective function of the models is to reduce the costs of the tests, and producer and consumer risks are taken into consideration as constraints of the models. Equations to compute the OC curves are also provided. Finally, some analyses and comparative studies are conducted. The results show that it cannot be claimed that one approach monotonically surpasses the other approach. The decision regarding the appropriateness of one approach over another depends on many factors, for example, the mean quality level of the lots/batches.

6. References

[1] D. Montgomery, *Introduction to Statistical Quality Control*, 6th ed. Hoboken, New Jersey: John Wiley & Sons, 2009.

[2] H. Rasay, F. Naderkhani, and A. M. Golmohammadi, “Designing variable sampling plans based on lifetime performance index under failure censoring reliability tests,” *Quality Engineering*, vol. 32, no. 3, pp. 354–370, 2020, https://doi.org/10.1080/08982112.2020.1754426.

[3] M. S. Fallahnezhad and S. Seifi, “Designing optimal double-sampling plan based on process capability index,” *Communications in Statistics- Theory and Methods*, vol. 46, no. 13, pp. 6624-6634, 2017, https://doi.org/10.1080/03610926.2015.1132325

[4] H. Rasay and F. Naderkhani, “Designing a reliability quick switching sampling plan based on the lifetime performance index,” in *IEEE International Conference of Prognastic and Health Management*, pp. 1–7, 2020, http://dx.doi.org/10.1109/ICPHM49022.2020.9187035.

[5] H. Rasay and E. Alinezhad, “Developing an adaptable sequential probability ratio test applicable for lifetime analysis of different continuous distributions,” *Quality Technology and Quantitative Management*, vol. 19, no. 4, pp. 511–530, 2022, https://doi.org/10.1080/16843703.2021.2020954.

[6] Hasan Rasay & Amir-Mohammad Golmohammadi2, “Developing a Constrained Mathematical Model to Optimize the Expected Total Costs of Life Testing,” *International Journal of Industrial Engineering and Production Research*, vol. 32, no. 2, pp. 1–11, 2021, http://dx.doi.org/10.22068/ijiepr.32.2.1.

[7] C. Wu, M. Shu, and Y. Chang, “Variable-sampling plans based on lifetime-performance index under exponential distribution with censoring and its extensions,” *Applied Mathematical Modelling*, vol. 55, pp. 81–93, 2018, https://doi.org/10.1016/j.apm.2017.10.027.

[8] M. Aslam, M. Azam, and C.-H. Jun, “A new sampling plan under the exponential distribution,” *Communications in Statistics- Theory and Methods*, vol. 46, no. 2, pp. 644–652, 2017, https://doi.org/10.1080/03610926.2014.1002936.

[9] A. Al-Omari, A. Al-Nasser, and E. Ciavolino, “Acceptance sampling plans based on truncated life tests for Rama distribution,” *International Journal of Quality*

& Reliability Management, vol. 36, no. 7, pp. 1181–1191, 2019, https://doi.org/10.1108/IJQRM-04-2018-0107.

[10] A. I. Al-Omari and M. T. Ismail, "Group Acceptance Sampling Plans Based on Truncated Life Tests for Gamma Lindley Distribution with Real Data Application," *Lobachevskii Journal of Mathematics*, vol. 45, no. 2, pp. 578–590, 2024, https://doi.org/10.1134/S1995080224600225.

[11] H. Tripathi, A. Kiapour, and M. N. Qomi, "Optimal time truncated double acceptance sampling plan for generalized half normal distribution," *Life Cycle Reliability and Safety Engineering*, vol. 13, no. 2, pp. 173–180, Jun. 2024, https://doi.org/10.1007/s41872-024-00256-8.

[12] H. Zheng, J. Yang, and Y. Zhao, "Accelerated acceptance sampling plan for degraded products based on inverse Gaussian process considering the acceleration factor uncertainty," *Computers and Industrial Engineering*, vol. 203, 2025, Art. no. 111052, https://doi.org/10.1016/j.cie.2025.111052.

[13] C.-W. Wu, T.-C. Wang, and R.-H. Chen, "Development of acceptance sampling plans under time-truncated life test for verifying product reliability using Weibull-percentile lifetimes," *Reliability Engineering and System Safety*, vol. 261, 2025, Art. no. 111062, https://doi.org/10.1016/j.ress.2025.111062.

[14] H. Zheng, J. Yang, H. Xu, and Y. Zhao, "Reliability acceptance sampling plan for degraded products subject to Wiener process with unit heterogeneity," *Reliability Engineering and System Safety*, vol. 229, 2023, Art. no. 108877, https://doi.org/10.1016/j.ress.2022.108877.

[15] A. Banihashemi, C.-W. Wu, and A. Amiri, "Analytical modeling of acceptance sampling plan with functional process capability index for circular profiles," *International Journal of Production Economics*, 2025, Art. no. 109622, https://doi.org/10.1016/j.ijpe.2025.109622.

[16] A. Banihashemi, M. S. Fallah Nezhad, and A. Amiri, "A new approach in the economic design of acceptance sampling plans based on process yield index and Taguchi loss function," *Computers & Industrial Engineering*, vol. 159, 2021, Art. no. 107155, https://doi.org/10.1016/j.cie.2021.107155.

[17] M. H. Ling, E. Cramer, and S. J. Bae, "Statistical inference and optimal design for step-stress accelerated life testing with hybrid group censoring for non-destructive one-shot devices," *Reliability Engineering & System Safety*, vol. 265, part B, 2026, Art. no. 111506, https://doi.org/10.1016/j.ress.2025.111506.

[18] C. Che, M. Wang, X. Gao, Z. Liu, Y. Zhang, and J. Peng, "A statistical inference method for predicting the remaining useful life of milling tools based on multi-stress accelerated degradation test," *Reliability Engineering & System Safety*, 2025, Art. no. 111541, https://doi.org/10.1016/j.ress.2025.111541.

[19] C. Wu, M. Shu, and Y. Chang, "Variable-sampling plans based on lifetime-performance index under exponential distribution with censoring and its extensions," *Applied Mathematical Modeling*, vol. 55, pp. 81–93, 2018, https://doi.org/10.1016/j.apm.2017.10.027.

[20] Fatemeh Molaie, Hiwa Farughi, and Hasan Rasay, "Reliability Acceptance Sampling plans Considering Optimization of the Costs," M.S. thesis, Department of Industrial Engineering, University of Kurdistan, 2022, (in Persian).