ADEQUATE INSPECTION FOR DEFECTIVE PRODUCTS IN PHOTOGRAPHY SECTOR AND DETERMINING INSPECTOR RELIABILITY BY USING JURAN - MELSHEIMER PLAN

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Abstract:

General inspector errors may consist of accepting defective units of product or rejecting good units of product. It can be said that the human element in the inspection process is the inspector himself, who contributes to inspection errors. Besides some other errors like use of wrong spesifications, wrong measuring instrument, improper filling of documents etc., in some cases the effects of inspector errors are so extensive that there is need for measuring the extent of errors with a plan for measuring inspectors' accuracy and control the effectiveness of inspectors. Under this plan the check inspector re-examines the inspected product both the accepted and rejected units. Although the check inspector also makes errors, these have only a secondary effect on the inspector's accuracy. In this paper, determining inspector reliability by using the Juran - Melsheimer plan is explained with the help of a problem from the photography sector.
(Key words: inspection, inspection errors, inspector errors, measures of inspector accuracy)

1. Introduction

The Turkish photography sector's existence depends mostly on imports. Lately, photography equipment importers and manufacturers are announcing that they have prolonged the warranty period for their products from 1 year to 3 years. There are also some importers who say they are willing to replace a defective product with a new one. These kinds of companies, who claim that they will definitely-if not at first try, at least with a second try-satisfy their consumer with a fully-functioning product, are in a way also implying that not everything is being fully done in their companies about processes and acceptance control. In today's world, where technology advances speedily, and where most products are being used professionally, it can easily be said that even if a product does not complete its technological life cycle within 3 years, it will get old. However, there are various and numerous products used professionally like slide machines, flashes, studio flash kits that require repairing or replacement not within 3 years but at first use. These complications give rise to a never-ending cycle of, "embarrassed merchants because of their defective product versus unhappy consumers who are not able to use the equipment effectively, or at all." The relationship between companies and customers does not become a lasting one. Apart from importers, the same problem also applies to the production process for the few manufacturers in the same sector.

As we all know, some semi-products or products are far from fulfilling their expected performance satisfactorily during the production and distribution procedures. This situation is accepted and is trying to be kept within pre-determined ranges. During the process of establishing quality definitions, these kinds of "deteriorated" materials and products have to be kept separate from ones that perform their functions at a determined level of excellency. The required inspection services for these kinds of products must be confirmed before they leave the last loop of the production-distribution chain and reach the final-real customer. Yet, there are some cases where - although quite unwillingly- the customer in a sense becomes the inspection point. The unwilling and obliged customer then, fulfills his/her inspection duty by returning the product -which has shown some malfunction during its first uses- back to the system.

Some precautions must be taken in order for the defected products to be somehow held back within the process, before they "escape" the production phase. Possible ways to re-include defected products to the system by repairing them should be sought. The probability that defected and sound products get mixed up always constitutes a risk. Defected semi-products or products, should be prevented from reaching the next phase during production and distribution stages.

In some cases, a product that has shown malfunction for some reason is repaired and starts functioning effectively again.

Semi-products or products which can be returned to the system by repairing -when economically and technically possible- should be kept separate from sound products within determined quality standards, during their production process or during their life stages; and the technological life stage of sound products should not be endangered by attempting to repair them.

In the photography sector, consumers usually invest thousands of dollars in relatively small sized material and equipment. This applies for a vast range of products starting from semi-professional cameras used by individuals to take family pictures, all the way to laboratory machines used for developing and printing these kinds

of pictures. The minimization in size of this type of material and equipment can only be accomplished through very elaborate engineering expertise and making good use of computer technology. Therefore, intermediaries who provide this type of materials and equipment should perform the necessary inspection services along with the other expected services to satisfy the customers, who invest thousands and ten-thousands of dollars in these products. This situation becomes even more valid for the photography sector, where materials are often imported and where most of the local producers' businesses involve the assembling of the imported pieces. Due to the fact that there is a certain process involving the import of goods, a customer who will have to return to the merchant with a defected product will inevitably become quite concerned. Although the legal repairing period is at the most 30 days, the rightfully concerned consumer, will have to wait approximately 90 days for the piece required for the repairing of his/her defected equipment to arrive. Considering the fact that some repair facilities find it sufficient to simply repair the malfunction mentioned by the customer -and do not show any concern to control any other parts of the equipment which may contain some other probable malfunction- it can be said that the unlucky customer is bound to be chronically unsatisfied.

It is quite clear that the number of unsatisfied customers will decline if the products' needs for repair are diminished by proper inspection activities. From a merchant's point of view, the best way to accomplish this economically is by "doing it right the first time instead of having to repair it or improve it." So the situation is not just limited with the acceptance inspection performed by the importing company, it is also a matter of precautions that must be taken during the production process. With this in mind, the circumstances under which the product will become insufficient and not meet the needs of the customer should be clearly defined for the requested goods from the company. Once an adequate inspection system has been established, it should be applicable to all units of the business - meaning both in services and in the products themselves. The system may work under the business' total responsibility. The employees must continue performing their duties according to the planned strategy. The strategy should be one which aims at minimizing customer dissatisfaction and which is based on doing it right the first time instead of having to repair things.

In the photography sector -apart from Istanbul, where a first and second-hand market is well-established- production and repairing facilities are far from applying the above-mentioned strategies. This causes local production to perish before it has even had a chance to flourish. The widespread assumption about locally produced equipment offered to the sector's professionals is, "Yes, local products are cheaper but they will surely show some malfunction within one year, and when they do you are on your own. If a local product costs 1 monetary unit, an imported products costs 4 times as much. Yet, the imported product functions properly without causing any problems for at least 5 years." These kinds of consumer claims are mostly rightful with respect to the consumers' past experiences. Considering both the companies' and the consumers' insight on their own future in this sector, it is necessary to take some precautions; companies must establish some service standards and consumers must behave more consciously in order to make use of the rights they have. For example, a new strategy should be adopted in repairing facilities serving the photography sector in which: the kind of work required on equipment showing malfunction, who's responsibility it is to do the repair, and what kind of results are expected after the repairing, should clearly be pre-defined. Records should be kept, where the reason for the malfunction, the kind of work that has been performed on the equipment, and the extent to which corrective activities have been effective should be clearly expressed and noted down. The information assembled from these records will make it possible to improve imported whole or semi-products in compliance with Turkey's conditions. For example, a French Company selling products in Turkey sent a repair team from Istanbul to one of the smaller provinces, where the team discovered that the local voltage used was below the tolerable level. This brought up the need to increase the tolerable level of voltage for multiple flash products manufactured for Turkey.

2. Determining the malfunction

The case described above is an example of how a customer having paid thousands of dollars for a studio flash kit has played the role of an inspection point. Though the problem concerning tolerable level of voltage -which is actually an expected problem in our country's conditions- could have been pre-determined. Apart from this, another reason why consumers experience bigger and smaller problems alike is because they are not informed enough to use this high-tech equipment effectively and therefore do not have enough command over them. In the end, both the customer and the client are unsatisfied. Since photography chemicals are poisonous and hazardous to the environment, malfunctions caused by misusages due to lack of knowledge not only harm the individual user but also the country's nature.

If we return to the operations of the companies in the photography sector, we can easily claim that if there is a malfunction in a certain product it will either be detected before it is sold by an inspector, or after it is sold by a customer who was unable to use it effectively. Once the malfunction has been detected, the company should be totally responsible for the repairing of the product, which has been returned to the system. If somehow the malfunction is caused by some unforeseen production error, sold products should be recollected from customers for repairing.

Companies must establish a system where they can determine all of their customers' repairing requests for each product that they sell. Malfunctioning (or defected) products should be distinguished from the ones that function properly by the use of special marks, labels or some other conventional method.

In our photography sector, which is based on imports, the following situations should be examined when a semi-product or whole product has been determined as malfunctioning or defective:

a) It can probably be repaired within the company's own facilities,

b) It can be repaired within the company's own facilities,

c) Repairing is not possible in any sub-department, it must be sent back to the manufacturer for repair,

d) Repairing is not possible, cost of transportation for sending it back to the manufacturer is too high, the product can be disposed of,

e) Repairing is not possible even if the product is sent back to the manufacturer; therefore it can be disposed of.

Another distinction must be made apart from determining a product to be malfunctioning or defective:

a) simple problems that require repairing,

b) serious problems that require repairing.

Serious problems that require repairing imply that either one or more of the following kinds of defects exist:

a) a defect which totally affects the usage of the product,

b) a defect which affects the efficient use of the product,

c) a defect occurring regularly and preventing the product to function reliably,

d) a defect making it impossible to change some parts of the product even though it is compatible,

e) defects having to do with appearance, weight and/or volume which cause difficulty in usage,

f) defects having to do with reliability in usage. Simple problems that require repairing are not the kind which cause functioning problems like the above-mentioned. However they are problems which contradict with the design quality of the product.

The purpose of an inspection activity is to evaluate gathered information about the semi-product or whole product in order to decide whether to:

a) reject,

b) accept, or

c) inspect 100% the incoming consignment.

The application of 100% inspection for valuable imported goods that show the need to undergo inspection is made possible by the number of functions that need inspection. If there are any defects/damages in products that have been assembled locally, the people or unit responsible for this can also be determined. If probable difficulties are to be avoided and if the inspection activity is meant to be successful and fully implemented the following points should be determined:

a) factors which constitute the quality standard should fully be determined and written down,

b) all probable defects should be grouped into categories,

c) the person who is authorized to make decisions and undertake responsibility for the detection of defected goods should be determined,

d) the administrative ways of how to solve situations causing disagreements due to their complex nature should be determined.
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3. The inspector's purpose

The inspector's defined duty is to decide upon the product's compatibility to its design quality. It is the inspector's duty to pick out and select half-products, whole products or consignment of goods that show unacceptable characteristics. This way related departments can be warned and can take the necessary preventive steps. However, to prevent various kinds of complications that may occur during the realization of these activities,

a) sampling,

b) inspection methods should be well-known,

c) the measuring device,

d) record-keeping systems, should both be used properly.

If any complication is to occur within the above-mentioned activities, "inspection errors" will arise due to misinformed decisions. As a result, a sound or well-functioning product may be evaluated as defected or damaged whereas an acceptable consignment of goods may be rejected. This is usually the case for the photography sector, where products have high unit prices because of the advanced engineering, computer-aided design and micro-electronic technology they contain.

There is always a probability for inspectors to make wrong decisions.

a) Deviating the actual situation due to some personal benefit: This is done intentionally to provide some sort of personal benefit or to willingly put the company into a worse state. During the acceptance inspection, the inspector may decide to accept a consignment although it is of unacceptable nature because of some personal benefit provided from the seller. Sometimes these kinds of decisions may be taken by upper rank

management, in which case the inspector may not be able to object even if he/she does not want to be an accomplice. In areas where performance appraisal and extra payment per unit of goods is applied, the inspector may choose to ignore the existence of a defected product thinking of the bonus payment he/she will otherwise not receive. This kind of ignorance may also be caused by some sort of emotional attachment to the company. Although the photography market in Turkey is not too large, it would be quite appropriate to take some preventive steps against this kind of behaviour aimed at acquiring certain personal benefits.

b)   Some other reasons for the inspector to intentionally make wrong decisions are: wanting to complete the inspection as quickly as possible; trying to avoid 100% inspection; deviating from objective observations; accepting some goods -that do not fit the determined quality standards and exceed the limits- with, for example the assumption that the range of tolerance is too narrow; not wanting to be a problem-maker; and wanting to avoid the necessary procedures for rejected consignments. The acceptance of consignments that have not exceeded but are very close to the rejection level is an often-occurring incident. The fact that materials come from abroad in the photography sector leads to a postponing of problems, which in turn may deteriorate the function of inspection. The troublesome process of importing also has some effect on this.

4. Producer – consumer relationship

Due to the reasons listed above, the following situations are within certain probability, the sort of mistakes caused by the inspector's wrong decisions:
a) the rejection of an acceptable consignment,
b) the acceptance of a consignment that should be rejected.

These situations are also called consumer and producer's risks, and expressed symbolically as: alpha, α; beta, $\beta = 1 - \alpha$. In case the company's management is not being scrupulous enough about the rejection of an acceptable consignment during acceptance inspection, it will make it easier for the inspectors to decide on rejecting the consignment.

In situations where acceptance sampling is applied, a relationship is established between the producer and consumer. The producer's aim is to have all acceptable consignments accepted, and the consumer's aim is to have all unacceptable consignments rejected. The Ideal Operating Characteristics Curve is a vertical line, which means that both the producer's and the consumer's wishes are fulfilled. In order to create this curve the application of 100% inspection is absolutely necessary. In other words, when a sampling is done, it will spontaneously reveal the probabilities for the acceptance of consignments that should actually be rejected versus the rejection of consignments that should actually be accepted.

The producer's risk is essentially the probability of rejecting a consignment that supplies the necessary quality standards. This probability -generally known to be 5%- can vary between 0.1% and 10%.
For example if
$\alpha = 0.05$m then,
$\beta = 1 - \alpha = 1 - 0.05 = 0.95$
The numeric representation of an acceptable consignment related to the producer's risk -in other words the rate of defected products in a consignment of good quality that may possibly be rejected- is defined as the Acceptable Quality Level (AQL), which actually implies the acceptable rate of defected products.

Consumer risk implies accepting an unsatisfactory consignment, and its value generally is 0.10. The 10% value here refers to the acceptance probability of a bad quality consignment. Therefore, contrary to the producer's risk, there is no need to make any conversion.

In order to minimize inspectors' mistakes, the following preventive measures can be taken:
a) keeping appropriate records of inspectors in order to determine who performed the inspection,
b) having upper-rank management qualified to evaluate and approve the inspection results,
c) applying a second inspection under certain circumstances,
d) reviewing previous records for specific analysis,
e) using performance appraisal for the inspectors with respect to customer complaints.

Yet, no matter how many preventive measures are taken, it is impossible to suggest that there will be no defected pieces in a consignment. Therefore, the rate of acceptable defected goods, allowed both by the seller and the customer must be determined.

5. Determining inspector reliability by using Juran – Melsheimer plan

Even if all of the preventive measures listed above are taken, the big duty that falls upon the inspector is also a tough one. The inspector is responsible for systematically controlling the product to see if it is within the desired routine standards or not. Yet, in some cases the customer performs this task.

If the inspector is to perform his/her duty properly and yield reliable results, then his/her responsibility should be to inspect the material in terms of its description.

The Juran-Melsheimer Plan is used to determine the inspectors' reliability. Once the effectiveness rate of the company is measured, it is multiplied with the inspector's reliability coefficient and hereby the new rate for the company is found.

Considering that,

d = number of defects reported by the inspector,

k = number of products that are actually sound but rejected by the inspector,

(d – k) = the real number of defects detected by the inspector,

b = number of defected products overlooked by the inspector,

(d – k + b) = the actual number of defects in the product,

The Correctly Defined Rate of Defects is expressed with the following formula:

[(d – k) / (d – k + b)]

In professional photograph shootings correct exposure metering is the first step for properly exposed ready to develop photographs. Since slide films are used to obtain the desired image quality and color distinction, correct exposure metering becomes especially important. Reversal colour films have a more narrow tolerance value compared to standard films. When professional slide films are used, the fact that the image distinction by exposure is narrowed down to +/- 0.5 exposure tolerance value makes correct exposure metering even more important.

The inner-built exposure metering system found in single lens reflex cameras, is a reflective metering system which measures the light -after some of it has been absorbed by the subject of the picture- that reflects on the camera itself and its light meter. Lately professional photographers still choose to work with manual exposure meters for incident metering, although inner-built exposure metering systems have become more reliable than they were in the past. The main reason for this choice is because misadjustments created by the different tones of the reflective surface can be avoided by using manual exposure meters. Manual exposure meters can usually continuously measure the level of light as well as the intensity of momentary flash lighting in studio shootings. While pin type, continuous light-measuring manual exposure meters are preferred by amateurs, digital-screened professional types of exposure meters can measure incident light from flash heads.

Let us assume that 135 professional manual exposure meters of brand "A" that can read 3 and 5 degrees and have a spot metering system for both incident and reflective metering, are being inspected to control if they yield any results within the tolerated levels. Let us say that light measurements are being done from a stable distance for white, black, and medium gray toned areas reflecting from human complexion. Then, let us say the same readings are in turn being done for incident metering.

If,

d = 135 defected products,

k = 15 sound products,

b = 30 malfunctioning products

in the distinction made by the inspector, then the real number of defected light meters will be

(d – k) = (135 – 15) = 120

The Correctly Defined Lightmeter Rate will be equal to:

[(135 – 15) / (135 - 15 + 30)] = (120 / 150) = 0.80

meaning 80%. The b= 30 malfunctioning products in the example, is the number of defected products which the first inspector overlooked, and which came up in the second inspection performed by another inspector supervising the first one.

In real life the inspector is continuously busy with the inspection of goods. As a result, the d, k, and b values obtained from the inspections accumulate in the company's records while days, weeks and months go by.

For example:

Products; Total Numbers Inspected; d; b; k,

Projection Timer; 2.500; 25; 0; 0,

Kelvinmeter; 125; 8; 0; 3,

Hand Held Lightmeter; 375; 13; 0; 3,

Compact Camera; 12.500; 25; 0; 10,

Dark Room Thermometer; 4.000; 45; 0; 5,

Total Number of Products Inspected; 19.500; 116; 0; 21,

The rate of reliability can be reached by using the total value:

[d / (d + b)] = [116 / (116 + 21)] = 0.8467 = % 84.67

The products listed in the example above may refer to the same product being inspected on different dates or they can be different products as well. Since the important point here is to determine the inspector's reliability, the rates for d, b, and k may be taken as a total even if the products are different. However, the question that needs attention is revealed by how much time is spent for different products. In other words, the inspector's performance may be evaluated as "excellent" for a certain product, but the inspection of that particular product may have taken a very short time. This will in turn imply that the inspector's "excellent" performance was of a very short-lasting kind. The same inspector's effectiveness and reliability may be evaluated as "weak" for another product. If the inspection for this kind of product takes up a considerable amount of the inspector's time, this will imply that he/she is working

longer hours at a lower reliability rate. So it would be quite useful to enlarge the tasks included in the evaluation. The time spent for each task may be taken as a measurement for the enlargement.

Products and Enlargement (Weight) Factors
Projection Timer; % 45,
Kelvinmeter; % 5,
Hand Held Lightmeter; % 15,
Compact Camera; % 5,
Darkroom Thermometer; % 30,
Total; % 100,
The rate of reliability can be reached by using the total value:
$[(d_i - k_i) / (d_i – k_i + b_i)]$
The rate of inspector's reliability found with this formula can be applied to the example above and the following values can be calculated for various products:
$[d / (d + b)] = [25 / (25 + 0)] = 1.00 = \% 100$,
$[d / (d + b)] = [8 / (8 + 3)] = 0.7273 = \% 72.73$,
$[d / (d + b)] = [13 / (13 + 3)] = 0.8125 = \% 81.25$,
$[d / (d + b)] = [25 / (25 + 10)] = 0.7143 = \% 71.43$,
$[d / (d + b)] = [45 / (45 + 5)] = 0.90 = \% 90$.
If the inspected products were equivalent in nature, we would have expected our inspector's reliability rate to be the same as the one calculated previously. However once we have included the enlargement factors, the new rate of reliability for the inspector is calculated as:
$\{[100 (0.45)] + [72.73 (0.05)] + [81.25 (0.15)] + [71.43 (0.05)] + [90 (0.30)]\}$
$= 45 + 3.64 + 12.19 + 3.57 + 27 = \% 91.40$
Another complication which arises with respect to this matter is when there is a large number of defected goods in a pile which the inspector may have observed or overlooked. For example, let us assume that there are 2500 units in a pile, and that all of them are defected. In case the inspector has observed all of the defected goods and if we choose to calculate his/her rate of reliability using the formula for more than one product, given that:
$d = 116$,
d new $= 2500$,
d total $= 116 + 2500 = 2616$ defected products
$b = 21$,
b new $= 2500$,
b total $= 21 + 2500 = 2521$
then,
$[(d - k) / (d - k + b)] = [2616 + (2616 + 2521)] = 0.5093$
If the inspector had overlooked the defected pile, then the result would be:
$(116 / 2616) = 0.0443 = \% 4.43$
The effect of only one single pile of goods should not be so drastic for the inspector's rate of reliability.
There is also the possibility that the supervisor who controls the inspector may make mistakes. For example, if we assume that the reliability rate of the particular supervisor is 80%, the number of presumably defected goods he/she is likely to detect will be $[(21) . (0.80)] = 17$. In this case the rate of reliability will be calculated as
$(116 / 133) = 0.8722 = \% 87.22$
which will lead to a situation where % 87.22 > % 84.67.
When k -the number of goods rejected by the inspector although they are in fact sound- is small there is a possibility that it can also be neglected. In some cases, instead of using the rate of reliability for the inspector, his/her rate of making mistakes can also be used. Given that n is the total number of inspected goods, the rate of Rejected Sound Products can be determined with the following formula:
$[k / (n - d - b + k)]$

6. Conclusion

As explained above, the inspector's reliability and the rate of properly inspected goods actually express the same thing. It is possible to use the inspector's rate of correct detection as an element of extra payment per unit system. Clearly coincidence will play an important role in the supervising of the inspector's performance. In practice, the number of supervisors used for controlling the inspector varies according to the nature of the job. Different ratios like 1 supervisor for 4 inspectors, 2 for 20, 35 to 100 supervisors for one inspector, or 50 for one are used regularly.

Clearly, the inspector should be held responsible for his/her duty. However an inspector making wrong decisions due to incorrect instructions, or one who has to perform his/her duty using a measuring device that has not been properly calibrated should not be held responsible for erroneous results. It can be decided whether 100% inspection is necessary or not. If the purpose of the inspection is defined as 'detecting defected products that do not comply with specific quality standards', then this will also mean that it cannot be used to increase the standards of

the products that do comply with the design quality. If the latter is also going to be the purpose of the inspection, then the whole matter must be dealt with initiating from product design.

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