Sampling Technique and Minimization of Inspection Errors in Leather Sorting

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ABSTRACT

Leather processing is one of the oldest industries. It involves processing of animals skins and hides for use in various products. The objectives of this study were to adopt a Sampling Plan Technique by comparison of various Sampling Plans in order to identify the best to be used in inspection process. This is to overcome human fatigue, to minimize the inspection time and to draw the Operating Characteristic Curve. A lot of 18000 pieces of wet blue goat skins for export was inspected for quality assurance to the standard quality level. These were set to be 10% & 5% for acceptable and rejects level by the supplier and customer respectively. Then various Acceptance Sampling Plans were compared then the probability of acceptance for lot quality level was evaluated using Operating Characteristic Curve. The results Showed that for quality assurance the best plan was when the lot size (N) was equal to 18000, the sample size (n) was equal to 350 and number of defects (c) was equal to 10. It is recommended that Acceptance Sampling Plan technique can be adopted by all Sudanese tanneries and related fields.

INTRODUCTION

Overview of Leather Technology:
Leather is one of the oldest industries. It involves the processing of hides and skins of animals for use in a numerous products (*Hooghiemstra "c.f".Iqbal et al, 2005*). The leather industries sector in the Sudan enjoys many characteristics. These are mainly: Availability of raw skins of required quality, suitable prices and quantities; availability of basic infrastructure for this industry; ease of marketing ready leather for local industry, and export. (COMESA, 2014).

Defects and Their Negative Impacts on Leather Quality
Common skin defects can be categorized as:

Natural Causes: The natural causes include breed; type; sex, age; nutrition and climate.
Breed and Type*:* The best quality skins have dense uniform structure and usually have surface areas that are small in proportion to their weight. Fine wool sheep breeds produce skins that are thin. These skins are the cheapest type of leather. Skins from goats in the high altitudes are poor in substance, spread and open grained.
Sex and Age: The skins from male goats and sheep will be heavy with a coarse grain. Female skins have better tensile strength. The skin structure of young animals tends to be fine, compact and have tight grain patterns. As animals grow older, the grain surface becomes tougher and coarser grain.
Nutrition*:* Poor nutrition causes the skin to produce leather which lacks elasticity and has a dead feel.
Climate
The leather originating from Animals raised in warmer climates has superior substance and smoother grain patterns. Leather from Animals rose in colder climates or at higher altitudes will be of poor substance and have a coarse grain.
Defects Due to External Parasites and Disease : External parasites and disease include.
Fungal Diseases
Ringworm is a fungal infection of the skin .If ringworm, heals it leaves no scars, but if the animal is slaughtered while still infected; the grain appears coarse at the site of the infection .*Faport (2009).*
Bacterial Diseases : Bacterial Diseases can be classified into:

a) **Dermatitis:** Dermatitis can be very destructive of the skin.
superficial grain tissues. b) **Streptothricosis:** treptothricosis causes blemishes on the
Dermatophilosis: Dermatophilosis is bacterial disease affecting the dorsal part of the c) body.
Viral Diseases: Healing of the skin affected by pox is slow and permanent scars can be left. As shown in Fig (1- A, B). (*Zelleke*, 2009).
External Parasites: External parasites include:
a) **Mites:** Mites Cause the skin disease known as mange in sheep and goats. Mange can be a major cause of downgrading skin quality at the tannery.

b) **Ticks:** Ticks can affect sheep and goat health and affect skin quality.
c) **Keds:** Keds are wingless flies' brown color. Keds can produce an allergic hypersensitivity reaction in the skin of sheep, leading to lesions known as cockle in processed skins.
d) **Lice:** There are two types of lice affect small ruminants: Biting lice and Sucking lice .Alice is another cause for Cockle in processed sheep skins.

A-Lesions seen on wet blue material

B-Converged lesions and scar areas on pickled skin
Fig. 1: Pox type disease seen on semi-processed sheep skins
Source :*(Zelleke, 2009*)

Defects Caused After Postmortem: Damages caused after the postmortem include:

a) **Cuts Gauge marks:** These damages are caused by careless use of an axe and knife during flaying.

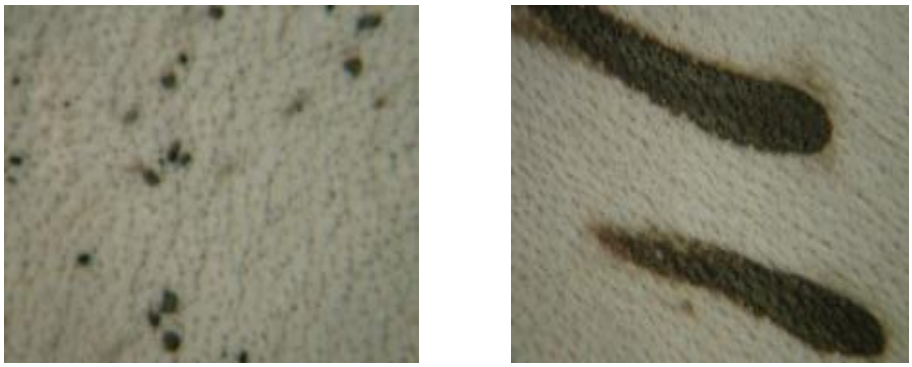
b) **Putrefactive damage:** Putrefaction is the result of bacterial growth. It starts almost immediately once the animal is dead, unless the skin is properly cured.

d) **Damage from Heat:** Heat damage may occur on hides and skins in tropical areas, when skin or hide is heated by Sun above a certain critical temperature while it is still moist.

Processing Defects: There are a number of defects that occur during the processing stages of the raw hides and skins to finished leather production.

a) **Metallic Stains:** Metallic stains are caused by nickel, iron, calcium, etc. which originate from processing chemicals usually appear brown/black on the grain surfaces of the leather as shown in Fig. (2-A, B). (*Zelleke, 2009*).

The objectives of this study were to adopt Acceptance Sampling Plan Technique by comparing various Sampling Plans in order to identify the best plan to be used in inspection process to overcome the human fatigue and to minimize the inspection time and to draw the Operating Characteristic Curves (OC).



Staining in run-off appearance Staining with a concentrated spots
A-Nickle-sulphide stains

Brown stain on grain surface Positive iron spot test

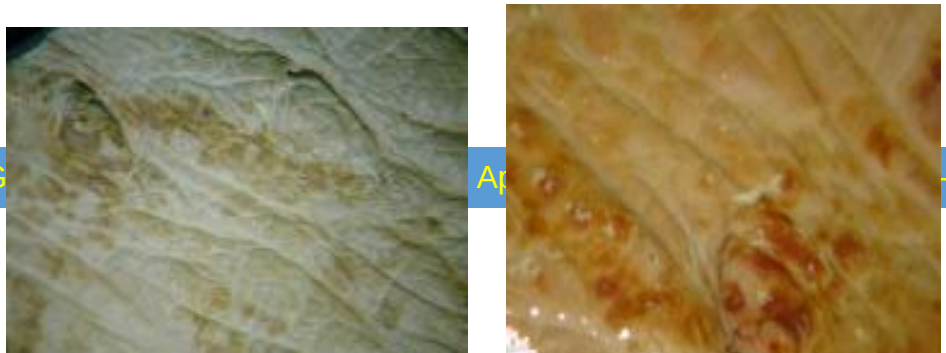


Fig. 2: B-Iron contamination
Source :(*Reddy, 2009*)

Attributes Acceptance Sampling Plan (AASP) : Attributes sampling is a procedure of the go-no go variety. It requires large sample size. . **(***Wadsworth, et al, 2004).*

Acceptance Sampling across Industries:

The following are examples of some industries using acceptance sampling plans .Sampling inspection is a well-established part of the quality control operation in many food processing plants. *(Kramer and Twing, 1984*). Acceptance Sampling is used in inspection for loose bolts within machinery. Acceptance sampling is also used extensively by other industries such as the Military, the American National Standards Institute, and the International Standards Organization (ISO) for setting various industry standards that have to be followed when manufacturing a particular product. In processing of poly vinyl chloride plastic pipes (PVC). Acceptance sampling is used to inspect for the outer diameter specification, inner diameter specification, surface defects, flexibility, compression, e before the PVC pipe can be sent to the distributors. (*Stephens, et al, 2006*).

$\bar{p} = n\bar{p}/n$ ……...……...……...…..……Eq(1)

$n = n\bar{p}/\bar{p}$ ……..…….……Eq (2)

$n\bar{p} = \bar{p} \times n$ ……..……..Eq (3)

Where:

$\bar{p}$= the average proportion defective in the process.

$n\bar{p}$ = average number of defective per sample.

n = number of items.

MATERIALS AND METHODS

Materials : Wet blue (w/b) goat skins are material under study.

Methods: The experimental works were carried out in Afrohide tannery which is located in industrial area in Omdurman. The methods used in sampling are presented below:

Attribute Acceptance Sampling Plan (AASP)

A container of 18000 pcs. w/b goat skins was to be inspected. Chinese buyer wants assurance that lots with 5% defective will be rejected less than 5% of the times. On other hand Afrohide tannery wants the assurance that lots with 2% defects will not pass inspection more than 10% of the time.

Method of designing of an AASP was as follow:

A value for defect (c), starting from 0 (zero) was chosen then it was coupled with the probability of acceptance (Pa) for both, supplier and customer, and n$\bar{p}$ was got from the chart. And (n) for both side was calculated from Eq(2) n = n$\bar{p}/\bar{p}$, and they were compared; if they were not equal another value of (c) was taken. The results are shown in table (1). (n) For supplier and costumer were plotted against (c) as shown in Fig (3). The point of intersection of two curves (n, c) was got. And probabilities for both sides were found from chart and compared to their acceptance probabilities. Then construction of an O C curve for the plan was done by using scattered values of n$\bar{p}$, the corresponding probability of acceptance was got from chart for each value of n$\bar{p}$Then $\bar{p}$ was got from equation Eq(3) $n\bar{p} = \bar{p} \times n$. the results are shown in table (2).and the curve was adjusted to get the best curve as shown in Fig (4).

RERSULTS AND DISCUSSIONS

The Sampling Plan results and OC curve are shown and discussed below.

Interpretation of AASP : In the table (1) columns 2, 4 illustrate average number of defective per sample (n$\bar{p}$).column 3 and 5 represent sample size (n) calculated from Eq(2). $n = n\bar{p}/\bar{p}$. There are eleven plans in this table. i.e. when c = 0, (n) for supplier is 3. (n) For customer is 59. Raw 9 and 10 represent answer for overall plan. But choosing the best answer within these two plans, the following methods are used.

Plotting (c) versus (n) : (c) is plotted versus (n)of supplier and customer as shown in Fig. (3).The red curve represents customer. The green curve is supplier curve. The two curves coincide at the points (9,300) - (10,350), this range of points suggests the solution of the plan. In order to choose the best plan, the probabilities for supplier and customer are calculated and compared to those probabilities of acceptance (Pa) set.

Calculations of Average Number of Defective per Sample ($n\bar{p}$)

Supplier Side

a) For plan n = 300; c= 9. From equation (1), $\bar{p} = n\bar{p}/n$, n$\bar{p}$ = 300×.02 = 6 Coupling c and n$\bar{p}$, the probability of acceptance (Pa) was found from the chart to be 0.93. If it is compared to 0.9, it is better than what the supplier wants.

b) For the plan n = 350; c = 10; the (Pa) is 0.It is exactly what the supplier wants.

Customer Side

a) For plan n = 300; c = 9; $\bar{p}$ = 0.05, (Pa) was found to be 0.06, and it is not satisfactory for customer if compared to 0.05

b) For plan n = 350; c = 10; $\bar{p}$ =.05, (Pa) from the chart was to be 0.04. This is better than .05 the probability the customer wants. So the plan, n=350, c=10 is better than the plan n = 300, c = 9.

Plotting Operating Characteristic Curve (O CC)

Fig (4) is characteristic operating curve (O C C), which is plotted and adjusted from data in table (2) by using Microsoft Excel, X-axis is % of items that are defective in a lot .Y-axis is (Pa) of accepting a lot. For the AQL of p = .02 = 2% defects, (pa) of a lot = 0.92 this yield a risk of 1-0.92= 0.08, or 8% which is less than 10% level desired by the supplier. On other hand for LTPD of 0.05 or 5% the risk is .03 or 3% which is well under the 5% sought of customer. So the best plan is (N =18000pcs, n = 350 pcs, c =10)

Table (1): Different Attributes acceptance sampling plans

Acceptance number of defects	Supplier side Pr_s =0.90		Consumer side Pr_c=0.05	
(C)	$n\bar{p}$	n = ($n\bar{p}$/0.02)	$n\bar{p}$	n= ($n\bar{p}$/.05)
0	0.05	3	2.95	59
1	0.52	26	4.65	93
2	1.15	56	6.70	134
3	1.75	88	7.52	151
4	2.40	120	9.00	180
5	3.10	155	10.50	210
6	3.90	195	11.60	210
7	4.63	232	13.20	232
8	5.40	270	14.50	290
9	6.25	313	15.70	314
10	7.00	350	17.00	340
11	7.70	385	18.00	360

* This table shows the values of defects taken arbitrarily in order to find the number of defects at which sample sizes for supplier and consumer coincide or nearby coincide.

Where:

*$Pr_s = 0.9$: Supplier's probability that a lot with 2% defects will pass inspection.

* Pr_c=0.05: consumer's probability of rejecting a lot with 5%defects.

* $n\bar{p}$: average number of defective per sample.

*$n\bar{p}/.02$: sample size (n) for supplier.

* $n\bar{p}/0.05$: sample size (n) for consumer.

* 0.02&0.05: the average proportion defectives in the process.

Table (2): Data for construction OC Curve

Average number of defective per sample($n\bar{p}$)	the average proportion defective in the process ($\bar{p}$)	Probability of Acceptance(pa)
1.0	0.29	0.9990
2.0	0.57	0.9980
4.0	1.14	0.9950
6.0	1.71	0.9500
8.0	2.29	0.8000
10.0	2.86	0.7000

12.0	3.43	0.3500
14.0	4.0	0.1500
16.0	4.57	0.0170
18	5.14	0.0130
20	5.71	0.0100
22	6.29	0.0015

* The values of $n\bar{p}$in the table are taken arbitrarily.
* The values of Probability of acceptance (pa) are got from chart by coupling the values of $n\bar{p}$ with the corresponding values of Acceptance number of defects (c) in table (1).
* $\bar{p}$: is calculated from equation $\bar{p}= n\bar{p}*100/350$

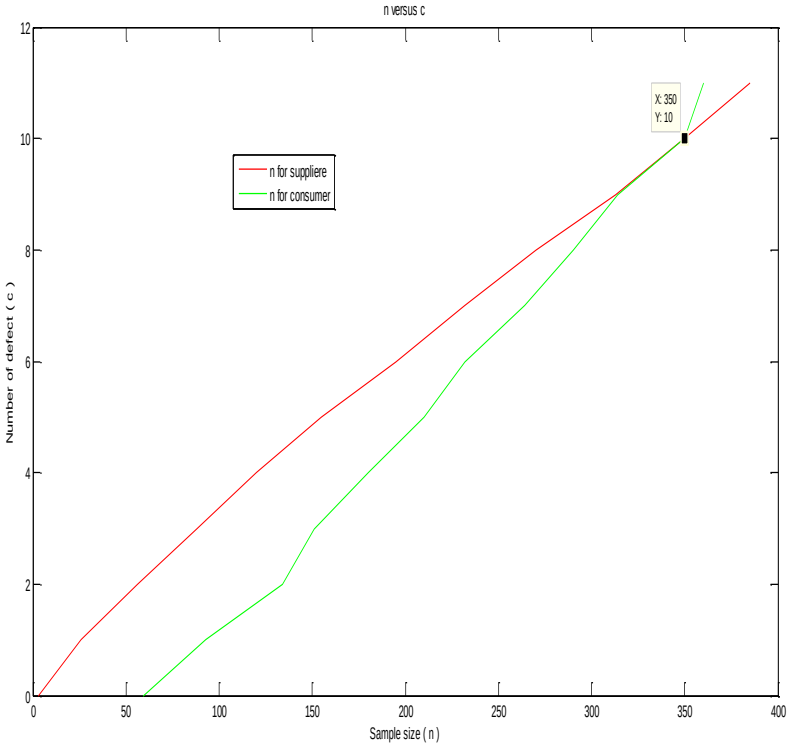


Fig. (3): Sample size (n) for supplier and customer versus number of defects (c)
*The red curve represents supplier's sample size (n) versus defects number (c).
* The green curve represents customer's sample size (n) versus number of defects (c) .
* The two curves intersect at the points (9,300) , (10,350)

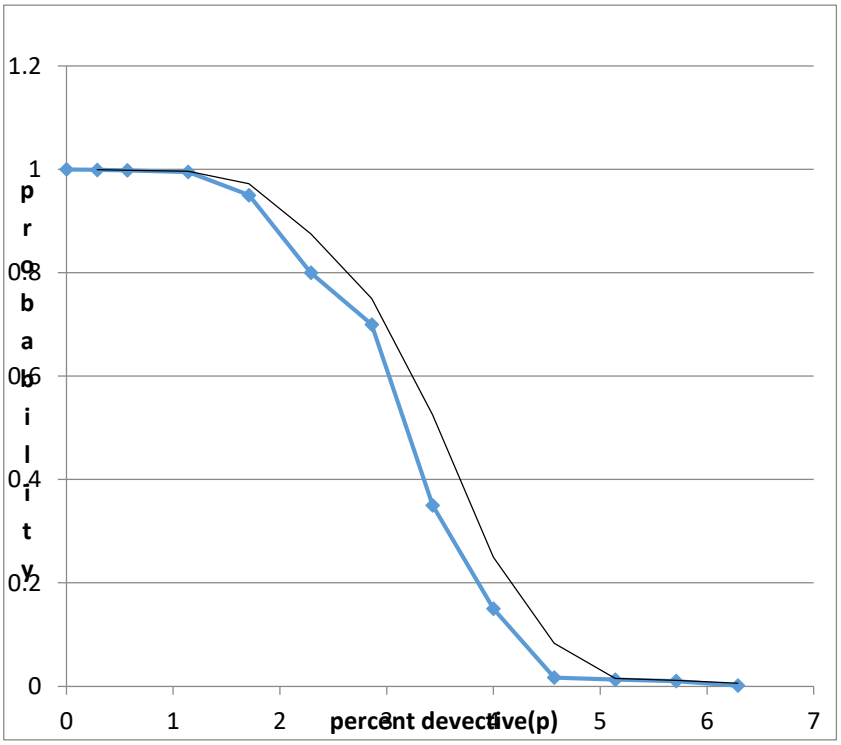


Fig. (4): Operating Characteristic Curve (OCC)

CONCLUSION

This study was carried out to adopt Acceptance Sampling Plan Technique by comparing various Sampling Plans in order to identify the best plan to be used in inspection process to overcome the human fatigue and to minimize the inspection time. The wet blue goat skins which were tanned in Afrohide tannery, Omdurman, the industrial area were the core of the study. For outgoing wet blue goat skins, different sampling plans were designed and the best plan was adopted for both customer and producer. The adapted plan was evaluated with its Operating Characteristic Curve. It was found that the best plan is (N equal to 18000pcs, n equal to 350 pcs and c equal to 10 pcs) .The minimization of inspection cost by using Acceptance Sampling Plan can be adopted by all Sudanese tanneries and related fields.

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ملخص البحث

تعتبر عمليات صناعة الجلود واحدة من أقدم الصناعات. حيث تعتمد على معالجة جلود الحيوانات لاستخدامها في العديد من المنتجات.. إن أهداف هذه الدراسة هي تقليل زمن الفرز والجهد البشري للحد من الأخطاء البشرية في فرز الجلود. والأهداف المحددة هي اعتماد خطة قبول اخذ بالعينات ومقارنة عدة خطط للقبول بالعينات من أجل اعتماد أفضلها. تم فرز الجلود باستخدام خطة القبول بالعينات لضمان جودة الدفعة الصادرة من جلود الماعز الزرقاء اللينة المدبوغة بالكروم (18000 قطعة)، و تم تحديد مستوى الجودة المقبولة ومستوى الجودة المرفوضة ليكونا 10٪ و 5٪ من قبل المورد والمشتري على التوالي. وبعد ذلك تمت مقارنة خطط القبول بالعينات وتم تقييم احتمال القبول لمستوى الجودة باستخدام منحنى التشغيل المميز. وكانت النتائج على النحو **التالي:** وعند تطبيق خطة القبول بالعينات. وجد أن أفضل خطة هي عندما يكون حجم الدفعة (N) تعادل 18000 قطعة وحجم العينة (n) تعادل 350 قطعة وعدد الجلود المرفوضة (c) تعادل 10 وعليه نوصي أن تعتمد خطة قبول اخذ بالعينات, والمخططات البيانية لضبط جودة العملية في كافة المدابغ السودانية.