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**`Pilot Demonstration Project On The leather Sector –SUDAN**

**" Capacity Strengthening and Technical Assistance for Implementation of Stockholm Convention (SC) National Implementation Plans (NIPs) in African LDCs of COMESA & SADC SUB-Regions.**

WBS 104063 – 1 – 02 – 03 – 2100

WBS 104065 – 1 - 02 – 03 – 2100

**NATIONAL LEATHER TECHNOLOGY CENTER ( NLTC ) of INDUSTRIAL RESEARCH & CONSULTANCY CENTER ( IRCC ) SUDAN**

**UNIDO- Pilot Demonstration Project on Leather Sector - SUDAN**

**Al Amatong (Khartoum) Tannery & Leather Ind.Co.Ltd.**

**Phase (1)**

**November 2014 – January 2015**

**Contract No.3000023677**

**ABBREVIATIONS & ACRONYMS:-**

NIS	National Implementation Plans
SC	Stockholm Convention
POPs	Persistent Organic Pollutants
UPOPs	Unintentional Persistent Organic Pollutants
BAT/BEP	Best Available Techniques/Best Environmental Practices
PCDD	Poly Chlorinated Dibenzo para Dioxin
PCDF	Poly Chlorinated Dibenzo Furan
PCB	Poly Chlorinated BiPhenyle
PCP	Penta Chloro Phenols
NA	Not Available
ND	Not Detected
LDC's	Least Developed Countries
COMESA	Common Market for East & Sothern Africa
SADC	Sothern Africa Development Commission
Pcs	Pieces
Kg	Kilo gram

WB Wet Blue

TEQ Toxic Equivalent Quantity

**Keywords:** Leather , Tannery, Processes, POP's ,PCDD/PCDF ,Dyeing &Finishing ,Stockholm Convention ,Releases , Emissions ,TEQ.

## REQUEST

This study is prepared according to a request agreement signed by UNIDO & stakeholders of sub-contracts on Pilot Demonstration Project on Leather Sector that the NLTC of IRCC – SUDAN , as part of phase (1) at Al Amatong (Khartoum) Tannery & Leather Ind.Co.Ltd.

### **N.B.**

- All information in this study is confidential to the client.
- All prices & costs referred to in this study are those according to the documents & those prevailing at the time of preparing this study.
- Exchange rate is (1.00 \$ = 5.87 SDG).

(1.00€ = 1.24 US\$ ).

## **Feasibility Study Nov.-Dec.2014**

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**5-The estimated difference in the annual budget when using dioxin contaminated chemicals and pigments and the substitutes or alternatives chemicals that are dioxin free and cost due to technological change :**

**6-The technological change modification required as a result of the use of substitutes or alternatives chemicals and the additional cost that may be implicated due to these changes:**

**7- Baseline data on dioxin / furan releases from Al Amatong Tannery & leather factory that are useful to compare the rate of reduction of dioxin /furan emissions from leather factory before and after the introduction of the principles BAT/BEP.**

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**Comments:**

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## **Executive Summary :**

This study report is prepared in response to the request of UNIDO to identify & quantify the chemicals and companies supplying AlAmatong Leather Factory beside the potential chemicals for POP's releases and their substitutes and budget comparisons when introducing technology change & estimation for a base line data.

The report contents include introduction to the brief description of AlAmatong Leather factory and Stockholm Convention related Article (5) and annex C.

Then according to the work seven plan activities, all the results are tabulated. The approach for this study follows mainly the term of references as set by UNIDO & according to our study offer proposal submitted previously.

The multidisciplinary team applied suitable methodologies to determine & estimate the data and relevant information via questionnaire, site inspection, individual questioning taking into consideration sensitivity to prices & market value variations. The tannery management was addressed to nominate two of its technical personnel to facilitate our team mission then to meet the management to discuss the overall project objectives and importance. The team started its mission immediately after that request was received .

According to the work plan the team started its regular meetings & visits to the tannery to investigate and collect the needed data that simplify achieving the final results & study to be prepared. The tannery management & nominated technical staff were very helpful and facilitate the work of the consultants' team.

After more than two month of continuous activities, the results approached to are summarized in the following.

- AlAmatong leather factory is one of the oldest tanneries in Sudan, in spite of that it has one of the best well built infrastructure.
- The tannery deals with well reputed suppliers companies and were identified in the study.
- The tannery use most of their chemicals environmentally friendly ones specially in the dyeing & finishing processes stages and they were identified.
- The tannery lacks the in house environmental control and management, which is very clear in all production processes, can accelerate any unintentional releases & emissions of toxics.
- The need for introduction of BAT/BEP is vital & of high importance.
- The technology change is identified & financially analyzed in order to reach final stages of high quality finished leather in the tannery.
- Estimation of PCDD/PCDF is calculated according to the worst scenario of use of potential chemicals to POP's releases.



- Capacity building and training must be applied for all management and human resources in the tannery and the same field of production.

**Project Name: -**

UNIDO PILOT DEMONSTRATION PROJECT on LEATHER SECTOR -SUDAN

**Location & Name of the tannery:**

Al Amatong (Khartoum) Tannery & Leather Ind.Co.Ltd –KHARTOUM.

**Designed capacity**

6,000 Sheep & Goats Skins and 550 Cow Hides per day.

**Operational Tannery Capacity: -**

700 hides -3,000 sheep skins – 2,500 goat skins

**Available Capacity: -**

500 hides – 3,000 sheep skins – 2,500 goat skins

**Production Output: -**

For export =16,600 dozen wet blue sheep - 2,900 dozen wet blue goats -280,000 ft<sup>2</sup> wet blue hides

For local market =50,000,000 ft<sup>2</sup> cow leather.

**Introduction of BAT/BEP measures and system to reduce impact & releases of POPs (PCDD/PCDF) after identifying chemicals sources and substitutes of chemicals & needed change in technologies.**

Development of an environmentally sound management system.

### **Objectives of the Project:-**

- The principal objective of the whole project is to build countries capacity to implement the measures required to meet their obligations under Stockholm Convention, including POP's reduction measures, and improve their general capacity to achieve the sound management of chemicals.
- The specific objective of this pilot demonstration project on leather industry ,is to reduce dioxin / furan emissions through the introduction of technological change and substitution of chemicals such as chloranil that are currently in use for dyeing and alkaline extraction for finishing.
- To identify chemicals used in leather production, chemicals potential to release Dioxins/furans ,substitutes that minimize release of POP's, the companies those are currently supplying chemicals to Al Amatong tanning leather factory for dyeing and finishing & technology change and comparison in budget for annual production..

Hence, a feasibility study report is to be prepared in order to introduce the BAT / BEP on this pilot demonstration project on leather industry following a work plan activities.

**Project Work Plan Activities:-**

No	Feasibility study in phase	NOV2014	DES2014	JAN2015
1-	Identify all chemicals used in tanning process at Al Amatong tanning & leather Ind,Co.Ltd .	██████████		
2-	Identify the companies that are currently supplying chemicals to the tannery for the purpose of dyeing & finishing.	██████████		
3-	Identify and quantify the chemicals (WT/ ton of leather products) that are potential sources of U POPs ( dioxin / furan) and the other POPs chemicals releases in the tanning process.	██████████		
4-	Identify & quantify the chemicals substitutes (WT/ton of leather product) that minimize the use of POPs and releases in to the environment.		██████████	
5-	Estimate the difference in the annual budget when using dioxin contaminated chemicals and pigments and the substitute or alternative chemicals that are dioxin free and cost due to technological change .		██████████	
6-	Indicate the technological change modification that may be required as a result of the use of substitute or alternative chemicals and the additional cost that may be implicated due to these changes.		██████████	
7-	Facilitate the collection of baseline data on dioxin / furan releases from Al Amatong Tannery & leather factory that are useful to compare the rate of reduction of dioxin /furan emissions from leather factory before and after the introduction of the principles BAT/BEP.		██████████	
8-	Organize a workshop to validate the outcome of the feasibility study.			██████████

### **Methodology and Approach:-**

- Data base for the study both primary and secondary data are used.
- The primary data concentrated on data obtained from Al Amatong Tanning Leather factory according to a pre prepared questionnaire and individual interviews.
- Tests & analysis to estimate PCDD/PCDF emissions, chemicals & substitutes and comparing budgets before |& after technology change.
- The source of the secondary data will be obtained from references related to the subject of the project & Bank of Sudan annual reports, leather association & Ministry of Industry.

## Introduction

The tanning industry is known to be very polluting especially through effluents high in organic and inorganic dissolved and suspended solids content accompanied by propensities for high oxygen demand and containing potentially toxic metal salt residues.

In most developing countries tanning operations is a family business, carried out in small to medium scale semi-mechanized units, very frequently grouped tightly in clusters which used to be outside residential areas. Tanners in such units have no formal education and have little or no understanding of the complexities of the leather processing, their skills acquired from their elders with hardly any perception of environmental protection. Low waste technologies, generally speaking, require better skilled personnel and closer technical control than conventional processing. Thus, lack of properly trained staff at different levels remains one of the crucial constraints.

Generally leather industry is considered as one of the most promising industries if it has the key pillars that support it. These include the right high quality input of materials, appropriate machineries, well trained human resources beside the management foresight and its marketing strategies.

Sudan has a comparative advantage in production of leather products; this advantage arises from its strong raw materials base, long and rich tradition of leather craftsmanship and availability of cheap labor.

Leather business constitutes crucial economic sources in Sudan as leather exports top industrial export and come second to live animal exports. Among Arab and African countries Sudan leads in camel's resources, come the sixth in respect of sheep and goats and the seventh to cattle.

**Stockholm Convention \*(4,6):**

The SC was adopted & put into practice by UNEP was on May ,22<sup>nd</sup> 2001.It decided that POP's emissions regulations are needed to be addressed globally for the sake of future safety. The purpose statement of the agreement is " To protect human health & the environment from POP's ".

Since 2004 nearly 179 countries are compliance with SC after recognizing POP's toxicity & its potential for long range transport, low solubility but with high lipid solubility ie.bioaccumulation & biomagnification and semi volatility. Sudan signed this on 23/05/2001 & ratified on 29/08/2006.

Hence what is called dirty dozen are classified as POP's main potential for emissions.

Also toolkit was introduced for identification & quantification of the releases of Dioxins & Furans and other UPOP's under article (5) of the SC on POP's and Annex C.

The essential aims of the SC are the followings:

- Elimination of dangerous POP's commencing with the dirty dozen.
- Support the transition to the safer substitutes & alternatives.
- To target any other potential additional POP's for action such as HBC,SCCP,C & penta chloro phenols..
- Clean up of stockpiles & equipments that could contain POP's.
- Work all together for POP's free future.
- Establishing an effective logo & institutional controls on all such chemicals.

The following summarizes the range of PCDD/PCDF concentrations reported in the literature for biocides and chemicals used in the production of dyestuffs \*(7,11):

**Concentrations of PCDD/PCDF in biocides and dye pigments/dyestuffs**

<b>Chemical Country or use</b>	<b>Concentration</b>	<b>(ng I-TEQ/kg)</b>	<b>Remark</b>
<b><u>Biocides</u></b>			
• PCP Pentachlorophenol	China, Europe, USA	800,000–4,445,000	Different production processes
• PCP-Na Sodium salt of Pentachlorophenol	China, Europe, USA	500–3,374,000	Different production processes
• CNP Chloronitrofen	Japan	400/300,000	Old/new technology
<b><u>Dye pigments/starting materials/dye</u></b>			
• Chloranil	Starting material for production of dioxazine Dyes	100–3,065,000	Different production processes
• Carbazole violet	Dye pigment	211,000	
• Blue 106	Dioxazine dye	19,502–56,428	

Section VI,\*(11).

### **Al Amatong Tanning and Leather Industry Co.Ltd \*(1,2).**

There are about 27 tanneries in Sudan most of them in Khartoum state one of these is Al Amatong Tanning Leather factory for dyeing and finished leather. Most of the tanneries come under the small & medium-scale sector. As most of the units are either under single proprietorship or partnership form of the organization. Skins &hides are brought from slaughter houses in Khartoum state, agencies of skins and hides and from different states of Sudan.

The tannery was established 1959 as Khartoum tannery and started its production 1962 through development cooperation between Sudan & former Yugoslavia.

Since 2000 the national pension fund & national social insurance jointly formed a private company to manage and run the tannery production , which started again in 2001 .

The daily working capacity was 700 hides and 6,000 skins of sheep & goats with human resources total no. 134 from which 74 of them are not on daily basis.

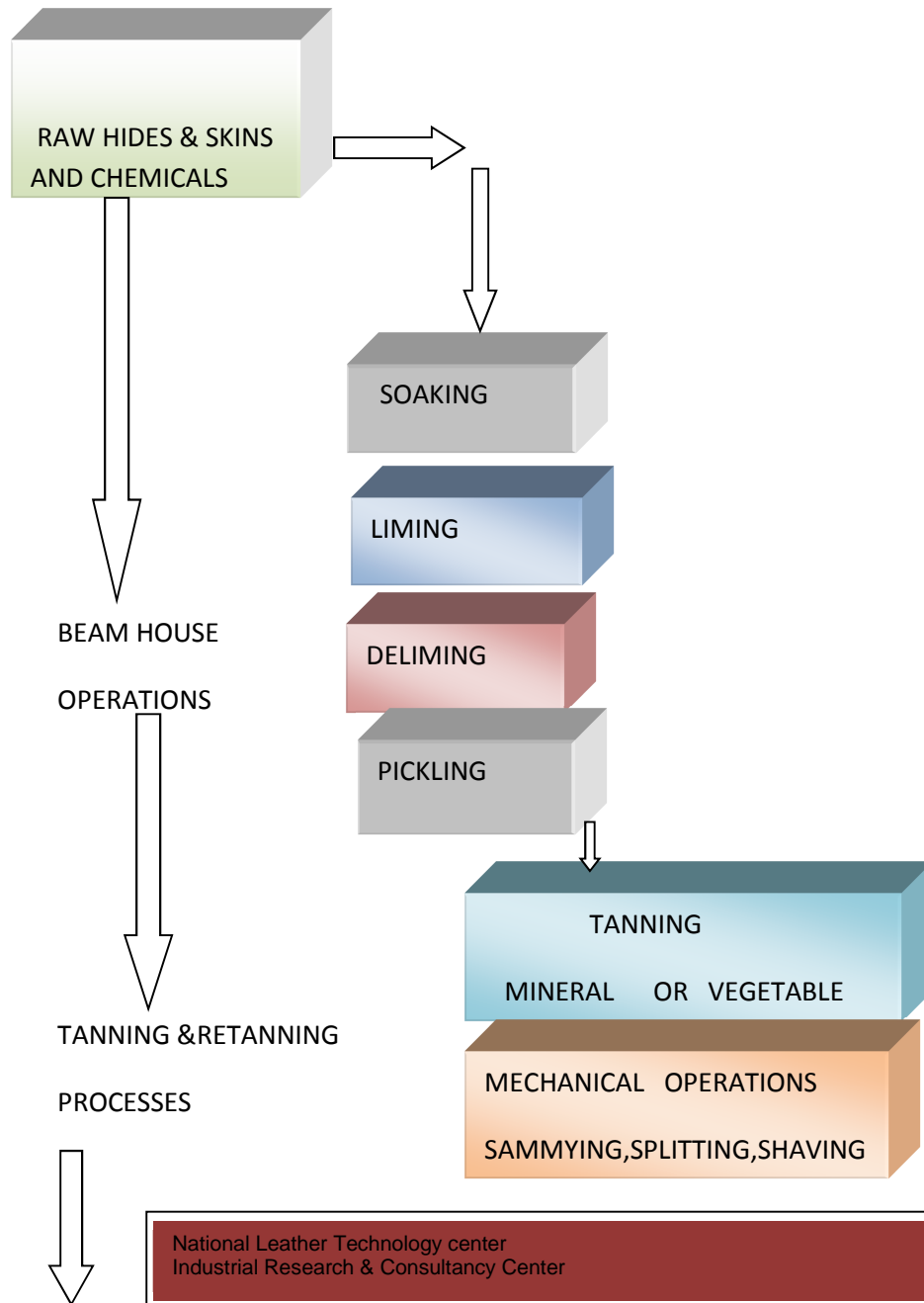
2004 installed a small leather goods unit to produce garments, hand bags, belts and wallets from its produced leather.

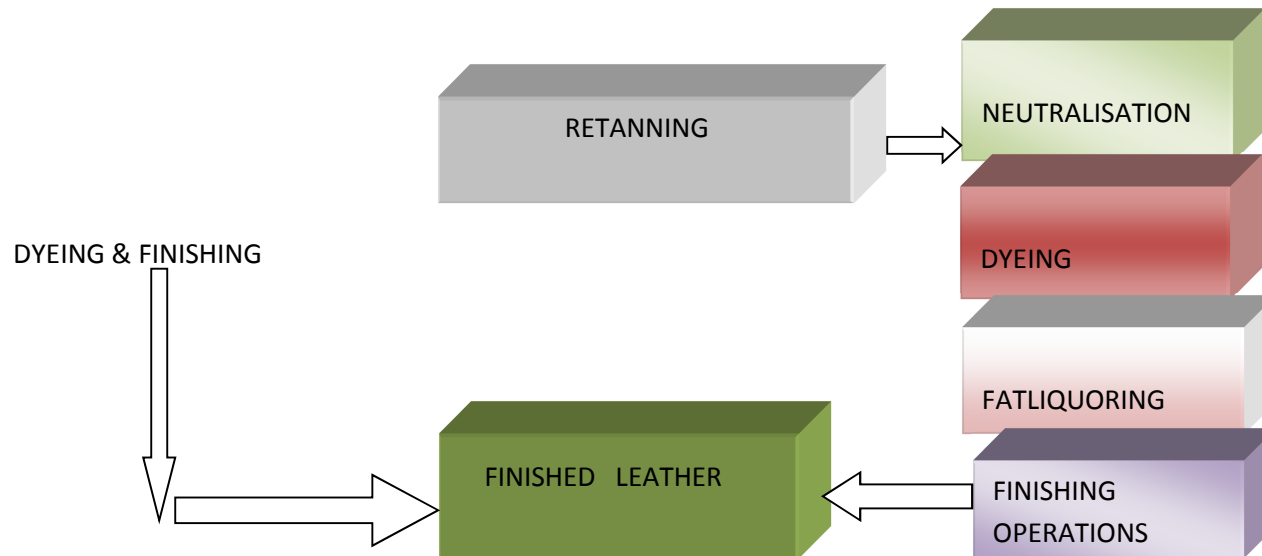
The management has a plan for rehabilitation of the tannery to increase the production of high quality finished leather of about 1000 pcs of bovine hides and 10,000 pcs of goats and sheep skins.

The tannery has around 12,000 dozens of wet blue for export monthly and 250,000 ft<sup>2</sup> of hides too , while 25 -40% of the production is finished for local market needs .



### Leather Production Operations & Processes :





### Post tanning processes \*(8):

#### Retanning

The retanning process is performed to improve the leather characteristics and the re-wetting properties of the hides necessary to facilitate and optimize the subsequent dyeing process. A wide variety of chemicals may be used for the re-tannage of leather, including vegetable tanning extracts, syntans, aldehydes, resins, and mineral tanning agents.

#### Dyeing

Dyeing is performed to produce colors in hides/skins. Typical dyestuffs include water-based acid dyes. Basic and reactive dyes are less commonly used. A wide range of dyestuff is available with different characteristics and physic-chemical resistances such as to light, PVC migration sweat migration, among others.

Some dye stuff which are originally Chloranil, {2, 3, 5, 6-Tetrachloro-2, 5-cyclohexadiene-1, 4-dione (*p*-chloranil)}, is the precursor for the production of dioxazine dyes (for cotton, leather, and synthetics) and other chemicals (*e.g.*, seeds and fungicides). Synthesis of pigments is from reaction of chloranil (or other halogenated benzoquinones) with aromatic amines to diarylaminochloroquinones and oxidative cyclization in high-boiling solvents, such as *o*-dichlorobenzene, in the presence of acylchlorides or sulfuric acid. Depending on the production process, *p*-chloranil can contain high contamination with PCDD/PCDF.

### **Fat liquoring**

Fat liquoring is the process by which leathers are lubricated to achieve product-specific characteristics and to re-establish the fat content lost in the previous procedures. The oils used may be of animal or vegetable origin, or may be synthetic products based on mineral oils. Stuffing is an old technique used mainly for heavier vegetable-tanned leather. Sammed leathers are treated in a drum with a mixture of molten fat. The retanned, dyed, and fatliquored leathers are then acidified by formic acid for fixation and usually washed before being aged to allow the fat to migrate from the surface to the inside of the pelt.

### **Drying**

The objective of drying is to dry the leather while optimizing leather quality. Drying techniques include sammying, setting, centrifuging, hang drying, vacuum drying, toggle drying, paste drying, and over drying. Sammying and setting are used to reduce the moisture content mechanically before implementing another drying technique. After drying, the leather may be referred to as 'crust', which is a tradable and storable intermediate product.

### **Finishing Operations**

Finishing operations are important to enhance the appearance of the leather and provide the performance characteristics expected in the finished leather with respect to color, gloss, feel, flex, and adhesion as well as other properties including stretch-ability, break, light-and perspiration fastness, water vapor permeability, and water resistance. Finishing operations can be divided into mechanical finishing processes and surface coat applications.

## 1) All chemicals used in tanning process at Al Amatong tanning & leather Ind,Co.Ltd .:

### Supply & Demand Analysis:-

The market supply consists of local production and imports.

Chemicals Used in the Tannery According to the Processes, are Shown in the Following Table (1):

No.	Process Stage	Chemical Specification	Chemicals used in the tannery leather production processes	Origin	Remarks
1.	Soaking	Wetting & soaking agent	√	Zschimmer & Schwarz	Local agent
2.		Lime	√	Egypt	
3.		Preservatives	(0.2%) BAC,wet Blue Fungicide	Rock Chemie Spain	
4.		Sodium Sulfide	√	Rock Chemie	
5.		Degreasing &wetting agent	(1.25%) √	Local,Zschimmer & Schwarz	Local agent
6.		Ammonium sulphate	√	Rock Chemie	
7.		Bating agent	Orbon	Rock Chemie	
8.		Sodium chloride	√	Local	
9.		Sulphuric acid	√	Local	

10.	Tanning & retanning	Basic chromium sulphate	√ (5%)	India Rock Chemie	
11..		Formic acid	√	Rock Chemie	
12.		Vegetable tannins	Acacia Nilotica(Garad) Mimosa	Local India	
13.		Sodium formate	√	Rock Chemie	
14.		Sodium bicarbonate	√	Rock Chemie	
15..		Syntans	ROS, RR7	Roch Chemie	Rockytan.Ros.R7(Mixed 5 items )
16.	Dyeing & finishing	Fatliquors	Oil-Plyrassol,Oil-X Pellasstol .Oil-XR Pellasstol	Zschimmer& Schwarz	Local agent
17.		Pigments	√	Stahl	
18.		Dye stuff	SU 8255,SU 8260	Turkey Stahl Spain	
19.		Season wax	Thinner, Liquid Dye, Dye Lacquer	Local Nile Co., Stahl	
20.		Binders	PU1120	Verbo	
21.		Fillers	AR055,AR 146,YM9602,KR 9585	Verbo, Stahl	

In order to assess the market demand the approach and methodology will be taking into account:

- a) Demand includes local consumption & export.
- b) The consumers of finished leather produced by Al Amatong Tanning Leather factory during 2013 and 2014 are individuals, companies and from different state of Sudan.

Table (2) **Local Consumption of Dyed & Finished Leather**  
(2013-2014) pcs/annum

Year	Consumption (pcs )
2013	28,771.25
2014	26,750

Source: Khartoum (Al Amatong)

### **Export:-**

Al Amatong Tanning Leather factory export wet blue to India, Pakistan, China, and Italy and locally to Saria Company for shoes, Kordofan state, small workshops and factories and to all states of Sudan. The following table shows the export of wet blue during 2013&2014 in pieces.

Table (3) **Total Export of Wet Blue**  
**2013&2014 (pcs)**

Year wet blue	Quantity (pcs) 2013	Quantity (pcs) 2014	Quantity Ton/2013	Quantity Ton/2014	Average Cost US \$		Remark
					2013	2014	
Sheep	290,974	205,241	727.435	513.102.5	1,212,391.67	855,391.67	70.536%
Goat	361,800	34,800	615.060	59.160	1,145,700	110,200	09.619%
Cow	14,000	9,480	140.000	94.800	277,200	187,704	67,714%
Total			1,482,495	667,062.5	2,635,291.67	1,153,295.67	43.76%

Source: Khartoum (Al Amatong)

Table (4 ) shows the total production of wet blue and dyeing & finished leather by different types of hides and skins ( sheep, goat & cow) and this represent wet blue while local market represent dyeing and finished leather for years 2013 & 2014 in pieces.

Year Quantities & Weight Classification	2013						2014					
	(pcs)	Ton	(pcs)	Ton	(pcs)	Ton	(pcs)	Ton	(pcs)	Ton	(pcs)	Ton
Hide& skin type	Sheep	Sheep	Goat	Goat	Cow	Cow	Sheep	Sheep	Goat	Goat	Cow	Cow
STD	61,200		14,400		-		34,812		-			
V/VI	142,800		338,400		-		85,229		-			
X	73,824		4,800		-		63,600		16,800			
XX	13,150		4,200		-		21,600		18,000			
Total Quantity (Skins)	<u>290,974</u>	727.435	<u>361,800</u>	615.060			<u>205,241</u>	<u>513.102,5</u>	<u>34,800</u>	59.160		
A	-				4,200						2,844	
B	-				4,900						3,318	
C	-				4,900						3,318	
Total Quantity ( Cow					<u>14,000</u>	<u>14.000</u>					<u>9,480</u>	94.800



Hides)												
Local market					28,771.25						26,750	

Source: Khartoum (Al Amatong)

Table of projected production ( 5 )

Year	2015			2016		
Type of Leather	Sheep ( pcs/year)	Goats (pcs/year)	Cow (ft <sup>2</sup> /year)	Sheep ( pcs/year)	Goats (pcs/year)	Cow (ft <sup>2</sup> /year)
Total Quantity	900,000	750,000	4,620,000	1,950,000	1,050,000	6,600,000
Export Quantity	71,250 (Dozen) (61.29%)	59,375(Dozen) (61.29%)	2,541,000 (55%)	-	-	-
Local Market Quantity	45,000 (pcs) (38.71%)	37,500 (pcs) (38.71%)	2,079,000 (45%)	(135,625) 9,750,000 (ft <sup>2</sup> /year) (100%)	5,250,000 (ft <sup>2</sup> /year) (100%)	6,600,000 (100%)

## **2)Companies identified as suppliers of chemicals for dyeing & finishing to Al Amatong Tanning Leather factory:-**

The following table shows the companies supplying Al Amatong Tanning Leather factory by chemicals for dyeing and finishing which are supplied from Turkey, Istahl and other are locally brought from Nile company for paints and Almohandis paints company during 2013and 2014 in kg.

Table (6) **Companies supplying chemicals to Al Amatong Tanning Leather factory of dyeing and finishing during 2013and 2014(kg)**

Company	Type of chemicals	Quantity(kg) 2013	Quantity(kg) 2014
Verbo –Turkey	AR 055	2,350	4,200.0
Turkey	PU 1120	3,000	600.0
VERBO- Turkey	AR 146	-	1,800.0
Istahl	Pigments	-	3,380.0
VERBO- Turkey	YM 9602	-	1,700.0
VERBO- Turkey	KR 9585	-	-
Stahl	Water Lacquer	-	-
Stahl	SU 8250	-	1,020.0
Stahl	Su 8255	-	1,200.0

Locally (Nile)	THINNER	4,140	3,108.0
VERBO- Turkey	Liquid dye	150	320.0
Zschimmer & Schwarz	Fatliquors		

Source: Khartoum (Al Amatong)

**3)List of chemicals (WT/ ton of leather products) that are potential sources of U POPs ( dioxin / furan) and the other POPs chemicals releases in the tanning process Table (7) :**

Type of chemicals	Quantity(kg) 2014	Potential Chemicals Wt/Ton Leather Product 2014	
AR 055	4,200.0		
PU 1120	600.0		
AR 146	1,800.0		
pigments	3,380.0		
YM 9602	1,700.0		
SU 8250	1,020.0		
Su 8255	1,200.0		
THINNER	3,108.0		
Dye Stuff	1,500.0		
Biocides	420.0		
Liquid Dye	320.0		
Total	5,620.0		0.21 10 <sup>5</sup>

**4)The List of chemicals substitutes(WT/ton of leather product )that minimize the use of POPs and releases into the environment :**

AlAmatong leather factory has a large area of more than 23,000 m<sup>2</sup> & annual consumption of chemicals in the dyeing & finishing processes are as tabulated in the following table (8) with the assumption of using 2014 as a reference year:

Type of used chemicals	Quantity(Kg) 2014	Quantity (Kg)/Kg hide or skin) 2015	Type of substitute chemicals	Quantity (Ton)/Year	Remarks
AR 055	4,200.0	5.7		63,612	
PU 1120	600.0	4.6		51,336	
AR 146	1,800.0	4.6		51,336	
Pigments	3,380.0	3.9	√	43,524	
YM 9602	1,700.0	3.9		43,524	
KR 9585	-	2.3		25,668	
Water Lacquer	-	3.1	√	34,596	
SU 8250	1,020.0	7.1		79,236	
Su 8255	1,200.0	8.8		98,208	

THINNER	3,108.0	18.4		205,344	
Liquid dye	320.0	4.6	√	51,336	
Dyes	1,500.0	16.6	√ Natural dyes free of PCP's & PCB's, no azo dyes		
Biocides	420.0		√ <ul style="list-style-type: none"> <li>• 2ThioCyanoMethylThioBenzothiazolo- (TCMTB ; CAS Registry No. 21564-17-0);</li> <li>• <i>o</i>-phenylphenol (oPP; CAS Registry No. 90-43-7);</li> <li>• 2-<i>n</i>-octyl-4-isothiazolin-3-one (OIT; CAS Registry No. 26530-26-1).</li> </ul>		

**5)The estimated difference in the annual budget when using dioxin contaminated chemicals and pigments and the substitutes or alternatives chemicals that are dioxin free and cost due to technological change :**

Raw Costs (700, 3,000&2,500) =167,000 SDG

(Hides= quantity\* 110, Sheep skins= quantity\* 20, Goat skins= quantity\* 12).

Total estimated budget 2015 per day = 167,000+50,566.2+8,748.4+2,597.6= 228,912.2 SDG/Day

Total estimated annual budget 2015 = 68,673,660 SDG = **11,699,090.29 US\$**

The finished production in 2015 equals 45% of the total production in AlAmatong Tannery.

Thus the total estimated budget 2016 for production of raw (1000, 6,500 &3,500) = **25,997,978.42 US\$**

The estimated change in budget = **14,298,888.13 US\$**

## **6) The technological change modification required as a result of the use of substitutes or alternatives chemicals and the additional cost that may be implicated due to these changes:**

### **Technology Change :**

AlAmatong Leather Factory is utilizing different technologies in its production of Wet Blue & finished products. These technologies vary from Italian, German, Spanish, Turkish, Indian, Greece, English, Yugoslavian, Czechs, Romanian, Dutch & some locally made ones (Appendix b), \*(3,6):

- The working machineries in use in the dyeing and finishing stage include, Dry shaving, staking, buffing, re-dusting, smooth rotary ironing, spray units, sammying, settings out, annual toggling, stand press, automatic measuring and others that are out of work such as the automatic toggling conveyor, glazing and the automatic spray unit.
- The vacuum dry m/c needs maintenance.
- Thus, in housekeeping control and management needs organization & all the scrap that hinder smooth working stages are to be taken away. Although the tannery is well established but renovation is needed & is highly recommended when introducing new clean technologies & chemical substitutes for any poly chlorinated phenyls in order to reduce toxic POP's emissions.

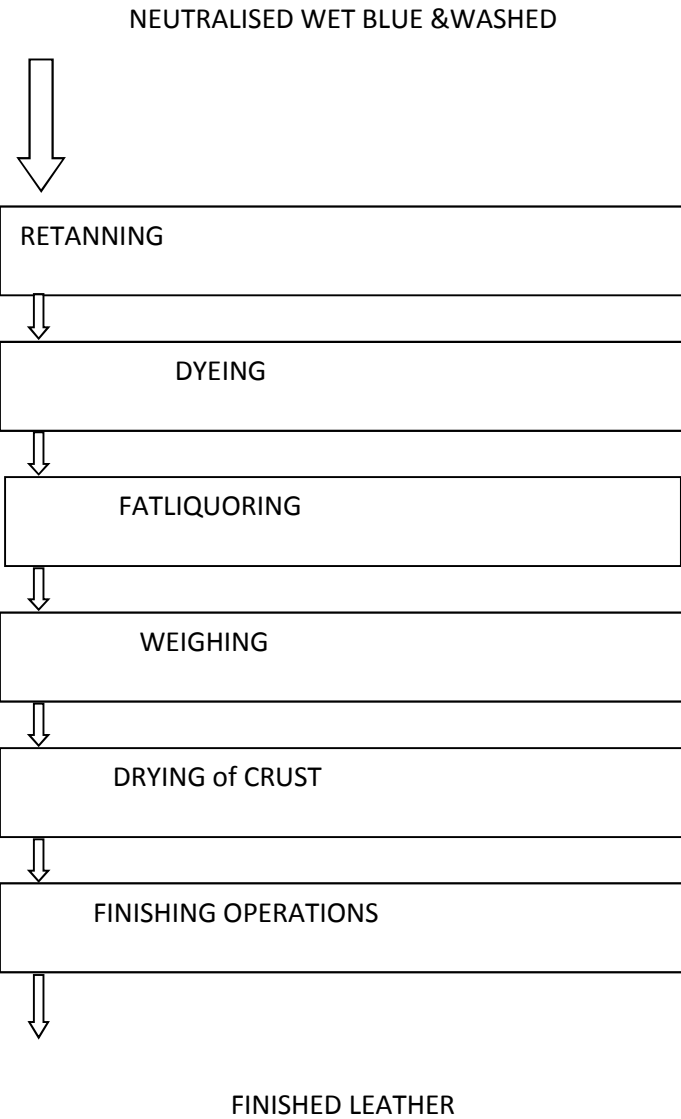
The need for technology change and alternative chemicals are expected to add effectiveness of processes and higher quality of production beside cost saving through efficiency of machineries and time & energy saving.

- One of the most important changes needed is to introduce some Polyethylene drums and roller coating technologies which can eliminate & save use of materials uses in coloring and coating stages beside time consuming when compared with actual manual used procedure.
- Biocides are also recommended to be substituted with free chlorine ones. The alternative to chlorinated biocide such as (Penta Chloro Phenols) is (2ThiocyanoMethylThioBenzothiazolo) that are free of PCP's.
- The dye stuff contaminated with chloranil such as dioxazino or phthalocyanine is recommended to be prohibited in the coloring stage. Hence its safer to use either natural dyes or any other that has high color fastness inputs. We need also to recommend material with free poly chlorinated phenyls (PCP) which achieve more working rate & production.



- Substitutes for solvent base finishing materials that are water base ones.
- Hence, we have to expose the technical personnel & labors to some training in quality management and clean technologies beside the impact of POP's releases when using potential chemical materials for POP's emissions.
- Needs for baseline information about POP's releases is essential for no quantitative information on discharges of PCDD/PCDF into the environment is available due to lack of reliable analytical data.

**FLOW DIAGRAM OF DYEING & FINISHING PROCESSES**



The required machineries to be introduced for improvement of production with reduction to any PCDD/PCDF releases are as follow \*(9,10,12):

1	PolyPropylene drum of 3.5*3.5 & 2.5*2 m capacity	€ 35,000		
2	2 Balances of one & 5 Tons load.	1,500		
3	Automatic hanging toggling of 100 m length.	9,500		
4	Shaving M/C for hides 1,800mm	45,000		
5	Rotary Hydraulic Ironing & embossing press M/C.	52,000		
6	Roller coating M/C.	65,000		
7	Automatic spraying unit 2,200 mm	36,000		
8	Polishing M/C.	15,000		
9	Rotary Hides Staking M/C	78,000		
10	Glazing M/C.	2,500		
11	Compressor 30 HP	<u>1,200</u>		
12	Stainless Drum 2.5*2 m (loading capacity:1,700kg)		<u>15,000 US\$</u>	
<b>Total</b>				<b><u>437,468 US\$</u></b>

$$\begin{aligned}
 \text{Total machineries cost} &= \underline{340,700 * 1.24 + 15,000} = \mathbf{(422,468 + 15,000)} = \mathbf{437,468 \text{ US\$}} \\
 \text{Installation \& training of personnel} &= 437,468 * 20 + 75,000 = 87,494 + 75,000 = \mathbf{162,494 \text{ US\$}} \\
 \text{Hence total machineries, installation \& training} &= \mathbf{599,962 \text{ US\$} \approx 600,000 \text{ US\$}}
 \end{aligned}$$

The use of auto-roller coating M/C technology with use of free PCP materials , replacing the manual coating which can eliminate & save material used for coloring coating& painting. It also save time consumption & increase production rate.

Actual daily production (2014) of raw hides & skins is estimated = 20 Tons

Assumption of raw weights as follows:

Hide =15 Kg, sheep = 2.5 Kg & goat = 1.7 Kg

Hence the annual total production = 6,000 Tons.

40% of the annual production is finished for local uses= 2,400 Tons

The tannery's plan for production of 2015 to reach 45% for local market before reaching 100% in 2016.

The proposed future production after introduction of new technologies & chemicals alternatives.

The production capacity = 1,000 pcs of hides/day

10,000 pcs of skins /day

If 6,500 are sheep skins & 3,500 are goat skins the total daily production of the tannery =  $15+16.25+5.95 =$   
**37.2 Tons**

Thus the annual tannery production = **11,160 Tons**

Assuming all production is finished ( 100% ) ,

**907.2 Ton** of chemicals are needed for total production in 2016,

then the total finished product area = **21,600,000** ft<sup>2</sup>

**Total revenue** = 156,000,000 SDP = **26,575,809 US\$**

**Annual profit (577,830.58)US\$**

**7) Baseline data on dioxin / furan releases from Al Amatong Tannery & leather factory that are useful to compare the rate of reduction of dioxin /furan emissions from leather factory before and after the introduction of the principles BAT/BEP :**

**Introduction of BAT/BEP \*(7,10,11,12):**

The good management practices in any production facility must take into consideration the human resources awareness training, education, handling of materials and good storage & machineries technologies operations. Its advised to use most effective and advanced activities to limit, prevent or reduce releases of any toxic PCDD/PCDF through introduction of clean described processes available techniques that can lead to less achievable release levels.

Hence, introduce environmental control measures according to strategies.

- Automation helps to avoid many obstacles and waste of materials, thus automatic dosing and dispersing adding to that the improved knowledge of inputs & outputs material balance of any process.
- Economical benefits for a tannery for each 1,000,000 ft<sup>2</sup> of leather finished by using the revolutionary roller finishing system while was supposed to consume 42,000 Kg of chemicals, are as follows:-

Saving of input 21,000 Kg of chemical product (3 gm/ ft<sup>2</sup>) instead of ( 12-14 gm/ ft<sup>2</sup>) **50%**

Saving energy (electric power) of 5,980 kWh **80%**

Saving of 31,400 liters of washing water **95%**

Saving of 58,200,000 liters of compressed air **95%**

Saving for the cleaning, stocking and disposal of the sludge (mud) produced from 21,000 Kg of dispersed chemical product **100%**, & the cost for the disposal of the sludge produced by the dispersed chemical product.

- **907.2 Ton** of chemicals are needed for total production in 2016.

Well equipped laboratory is needed for physical & chemical control for color fastness and for monitoring of other properties & specifications of leather products, chemicals and control of waste water and air stream condition.

Good basic control of housekeeping & safety improvement must be advocated to be implemented & applied at the tannery.

According to expected dioxin furan releases from AlAmatong Tannery & Leather Factory using the PCDD/PCDF Toolkit (5)\* & its emission factor for leather ,the estimation is as follows taking also into consideration that in air releases are negligible while in water and residues could be high.

Table (9)

Classification	Emission Factors – µg TEQ/T					
	Air	Water	Land	Product	Residue	
Upper Limit	Not Available (NA)	Not Detected (ND)	Not Available (NA)	1,000	Not Detected (ND)	
Lower Limit	(NA)	(ND)	(NA)	100	(ND)	

Hence, the estimated source strength PCDD/PCDF releases per year = Emission Factor (EF) \*Activity Rate (T /Year) = (Unit) TEQ Releases /Year

Activity rate of 2013 = 459.459,98 Ton /year

Activity rate of 2014 = 529.749,51 Ton /year

Hence, the following are the estimations of releases in 2013 & 2014 which may be due to inefficient, bad housekeeping and other environmental miss control conditions since they are using high quality of chemicals in their crust and finishing stages :-

Table (10)

Limit Release of PCDD/PCDF	2013 µg TEQ	2014 µg TEQ
The upper limit	459,459.98	529,749.51
The lower limit	45,946	52,974.59

### **Tests analysis report**

The samples are: waste water, Dyestuff and finishing materials.

Table (11)

Sample	Test	Results
waste water	Temp.	31 °C
	pH	
	Chloride	
	R.T	48 H



Table (12)

	Hydroxide group	Benzene Ring
Green	√	√
Red	√	√
Broun	√	√
Dark brown	√	√
Black	√	√

The analysis of Hydroxide group and benzene ring because it's the main hydrocarbons to form dioxins and furan.

The analysis of chloride is needed later, because it's the main substitute in dioxin and furan formula.

The PH, temperature and Retention time are the conditions of formation of dioxin and Furan, thus further work is to be investigated such as follows:-

1. Analysis of finishing materials (e, g Binders, Pigments, Biocides).
2. Determination of Dioxins and Furan.

Equipments needed for such test analysis are the following:

- Infra fed instrument.
- Thermometer.
- pH meter.
- HPLC high resolution& mass spectrophotometer.

**Conclusion:****Comments & Recommendations :****Comments:**

- AlAmatong Leather Factory deals with well reputed companies both in its machineries & chemicals supply internally or externally.
- The tannery management & technical personnel has little awareness about some toxic chemicals & releases.
- Storage & handling of chemicals is unsafe and poorly managed.
- The tannery has an ample area for upgrading its processes, machineries & equipments which is needed for more effective high quality production.
- Recommendations are crucial for mitigation of any toxic or hazardous releases or wastes through inefficient technologies that are of negative impact to the environment.
- Estimated intervention is 599,962 US\$ adding to that water treatment plant job and the local component for premises rehabilitation.

**Recommendations:**

- To develop an environmentally sound management system through BAT/BEP to reduce or minimize use of potential contaminated chemicals & reduce these emissions of toxic PCDD/PCDF releases, which can be replicated later in other tanneries..
- Introduction of technology proposed change in dyeing & finishing processes and mechanical operations.
- Capacity building, training, technical assistance & raising of awareness among management and workers is highly crucial.
- Suitable mechanism for sustainable monitoring & evaluation is needed in the tannery.
- Safety equipments, masks, boots, gloves and garments are important beside well ventilated work place.
- Laboratory with qualified technician for all quality control for processes operations, chemicals & products.
- A primary treatment station plant is needed for the tannery, extra follow up job.

- Rehabilitation of all premises of the tannery including the Lab, beamhouse section, tanning and retanning with concentration on introduction of recycling of lime and tanning materials & revise the whole waste water system adding to that the finishing and all other stores & the maintenance workshop.

## **References**

1. AlAmatong Manager & related technical staff individual interviews and needed documents.
2. Leather sector analytical paper for the leather industry in Sudan, National industrial Conference – 2010.
3. Environmental, Health, and Safety Guidelines, TANNING AND LEATHER FINISHING, APRIL30, 2007, WORLD BANK GROUP.
4. [www.pops.int](http://www.pops.int)
5. PCDD/PCDF Toolkit-2005-2-1\_en.pdf
6. [www.unido.org](http://www.unido.org)
7. [www.batbepguide.en.pdf](http://www.batbepguide.en.pdf) Guideline on BAT and guidance on BEP, 2006.
8. [www.wikipedia.org](http://www.wikipedia.org) , free encyclopedia.
9. [www.alibaba.com](http://www.alibaba.com)
10. [www.gemata.org](http://www.gemata.org)
11. UNEP-POPS\_BATBEP-GUIDE-08-15.English.pdf
12. [www.tannerytrade.com](http://www.tannerytrade.com)

## **Appendix:**

### **a)List of nominated Team of Consultants from NLTC of IRCC:-**

Dr.Widad Hassan Abelhalim (IRCC director) nominated the following team:-

Eng.Samia Hamid Mohamed Elamin      Head of the team

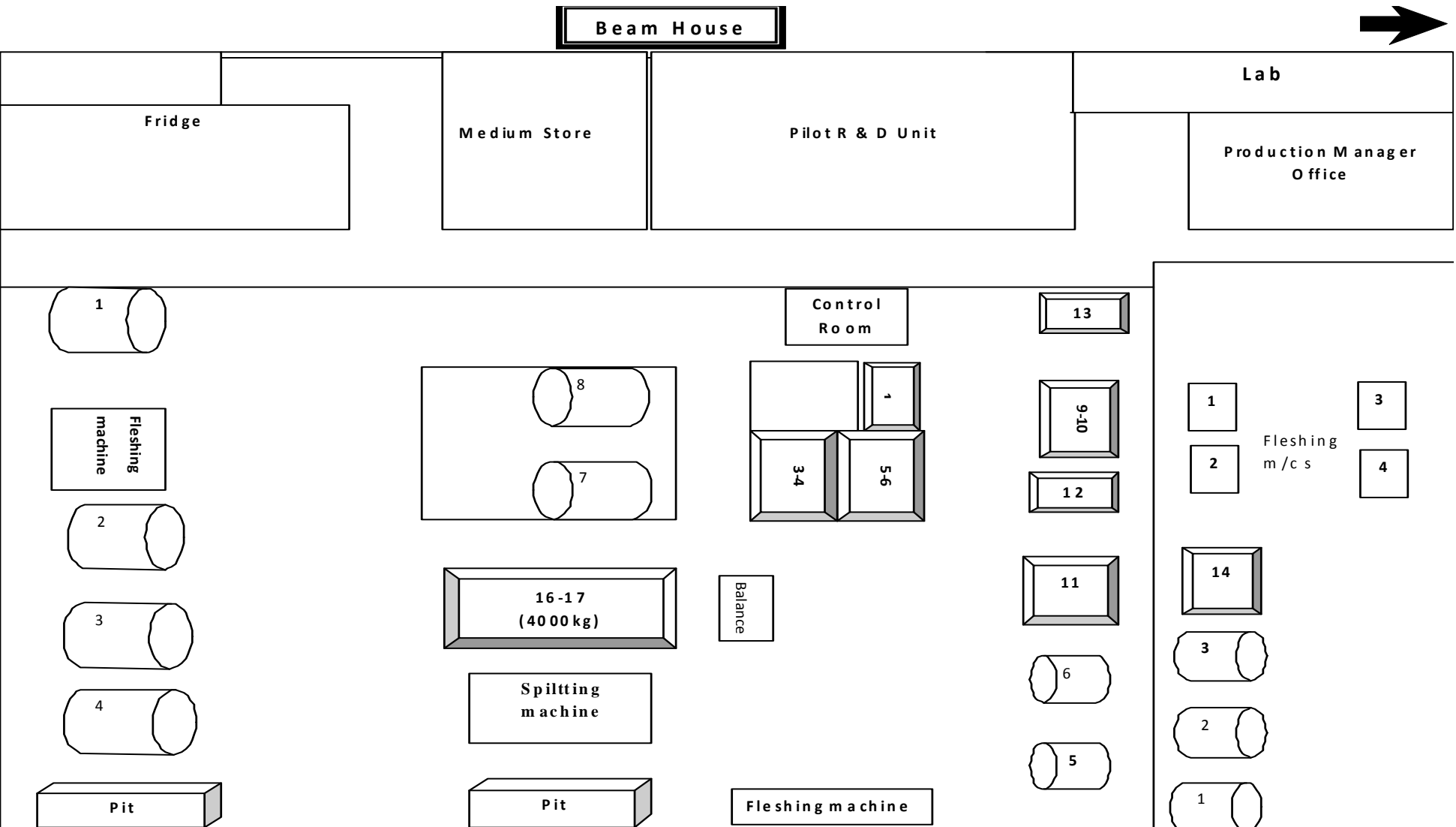
Dr.Haytham Osman Awadelkareim

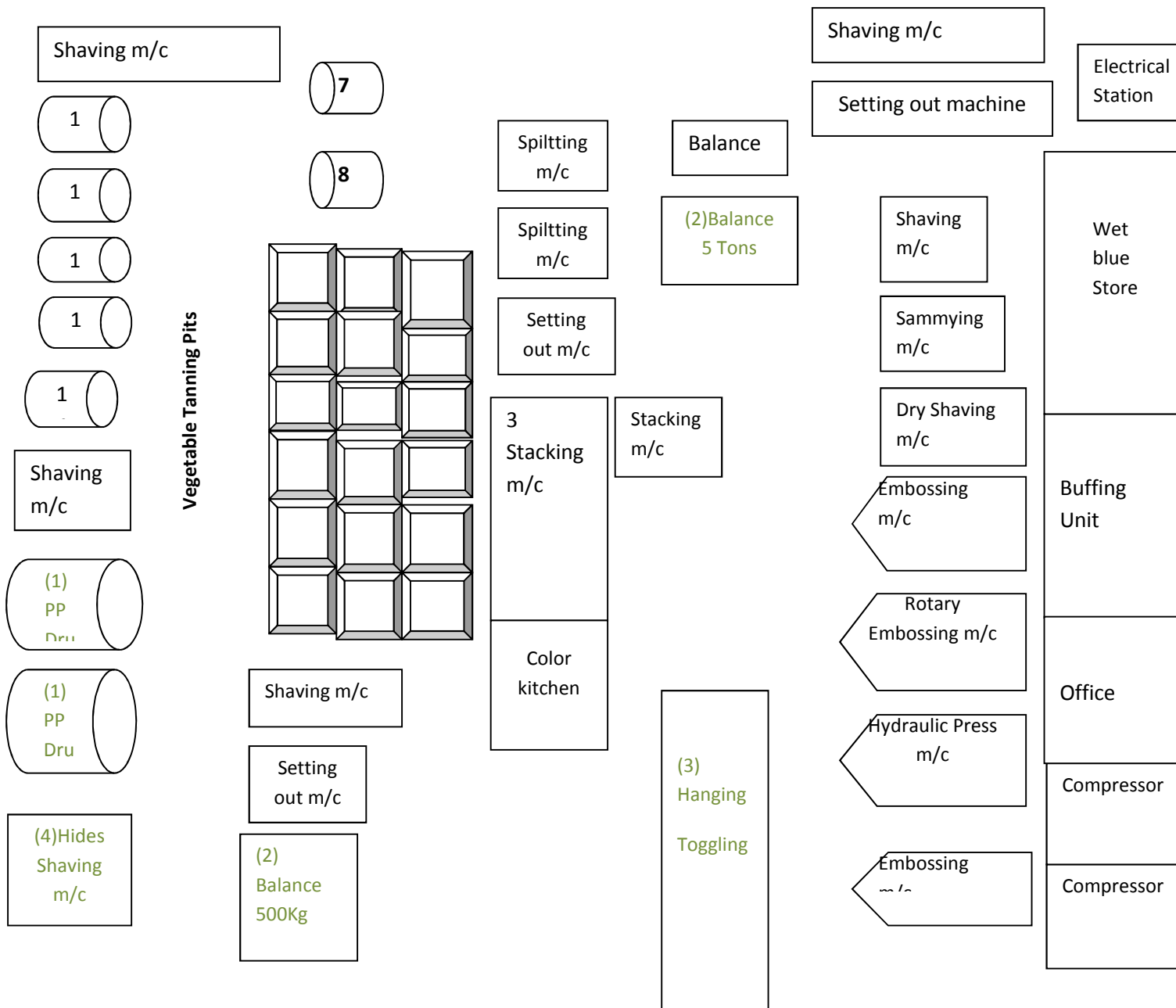
Dr.Shadia DafaAllah

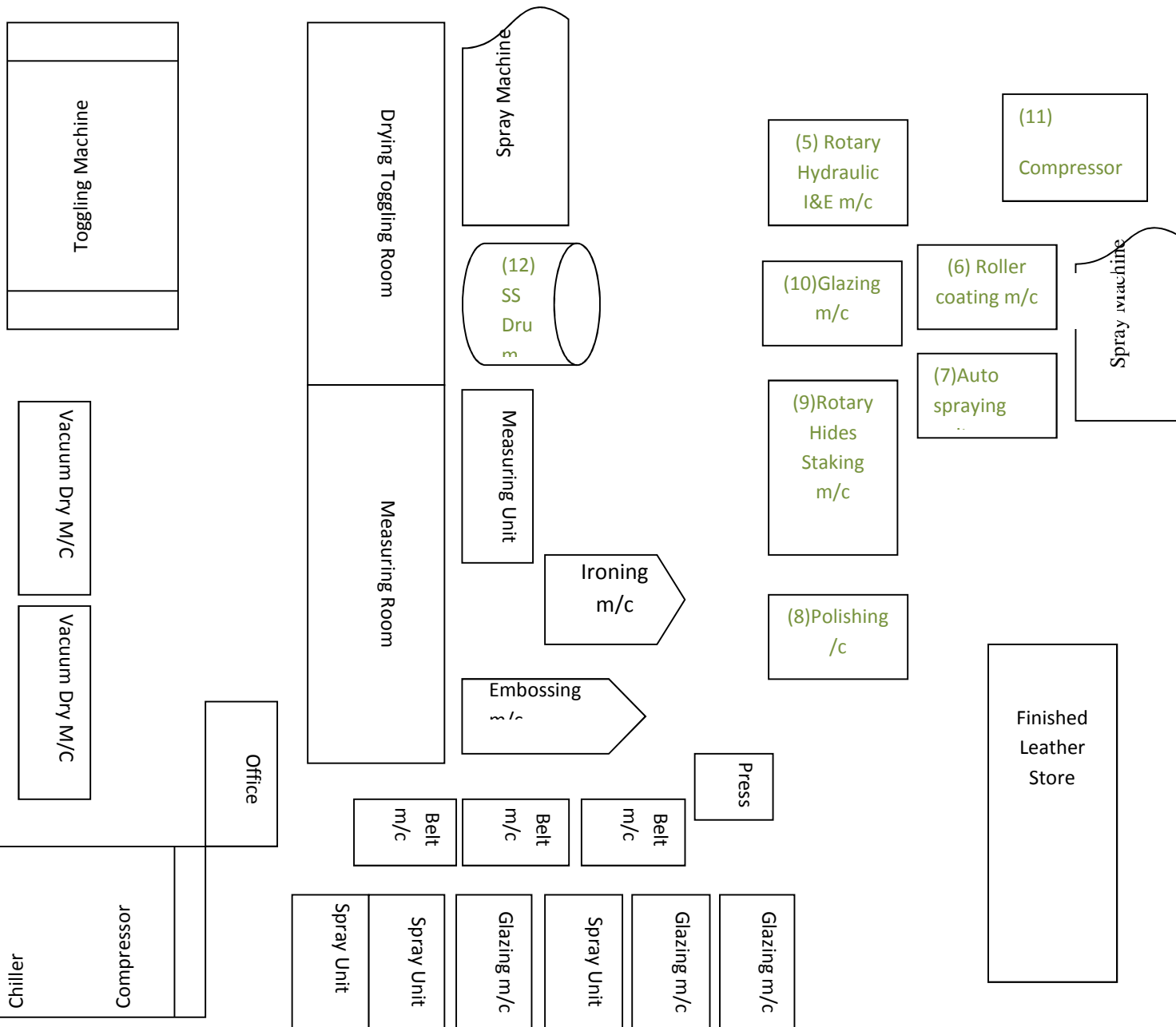
Abobakr Tagelasir Osman

Rabab Mustafa Talha.

**b) AlAmatong Leather Factory Layout Of Leather Processing Operations & Technological Changes Proposal**







c) Slides of some machineries & operations at AlAmatong Leather Factory:





























