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Sustainable Textiles for Sustainable Development

Environment, Occupational Health & Safety in the Craft Sector in India

Baseline study of selected craft clusters

TRAIDCRAFT
Fighting poverty through trade

aiaca
All India Artisans and Craftworkers Welfare Association

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Executive Summary

The handicrafts sector in India plays an important role in the country's economy, providing employment to a significant population in rural and semi-rural areas. It generates sizeable foreign exchange for the country and is a repository of the cultural heritage of the nation. The sector, however remains largely unorganised and heavily dependent on market fluctuations. Furthermore, the crafts workers face restraints of weak institutional frameworks, low income, and little exposure to new technologies.

At the request of AIACA. The Hazard Centre undertook a baseline study of the environmental and occupational health impacts in six different cottage industries located in India. The study aimed at developing an understanding of environmental and occupational health impacts, reviewing the existing ETPs (Effluent Treatment Plants) and preparing a draft manual indicating the potential hazards, impacts and methods of mitigation at source. The study areas were: Hand Block Printing in Jaipur; Blue Pottery in Jaipur; Leather in Ajmer and Jaipur; Bell Metal in Orissa; Dhokra in Orissa and Ikkat in Pochampally.

Beginning with the collection of secondary information on the selected clusters, the study followed up with primary research. The field survey involved preparation of a checklist, semi-structured interviews, conducting of health check-up, and sampling and analysis of effluents and ground water to assess the performance of the existing ETPs. At each location, the process was documented and the potential pollutants and hazards identified. About 100 workers in each cluster were measured for their general physique, muscle tone, lung condition, and eyesight, using simple techniques. In addition, a questionnaire was used to understand the health problems faced by the workers, and its relation to their occupation. The study team also observed the environmental effects and attempts to control them if any.

Some important findings of the study are:

- ❖ General body health improves for the workers in all crafts as they work for more years, indicating that regular work is beneficial for workers in the long run. A partial exception to the above was observed with leather work.
- ❖ All the workers in all the crafts are exposed to significantly high levels of air pollution as only one-tenth seem to have normal lung functions, over half suffer from shortness of breath, and the incidence of chronic distress increases with the number of years worked. An exception was observed in those engaged in the production of blue pottery.
- ❖ In the textile printing, leather, and blue pottery units in Rajasthan, and among the weavers in Andhra, it was observed that the muscle tone of those workers engaged in repetitive laborious work declines with increasing number of working years.

- ❖ The eyesight of most workers are deteriorating over time in all locations, and a comparison among the workers shows that it is declining more rapidly for those engaged in certain tasks requiring immense and constant attention to detail.
- ❖ Interviews with workers yield a range of complaints regarding body aches, sores cuts, burns and calluses, lung and eye problems, deafness, fatigue and sleeplessness, and stomach problems
- ❖ However, some of the problems are made worse by workers' habits of smoking, chewing tobacco, drinking alcohol, and taking intoxicating materials.
- ❖ Environmental impacts are visible only in textile printing in Bagru, leather tanning in Beawar, and tie-and-dye in Pochampally.

A safety manual that addresses the occupational hazards observed and spells out the general safety provisions in each case has been prepared. To begin with, the research team makes the following recommendations for safety:

- Regular work with regular wages
- Use of non-toxic materials and processes
- Improved ventilation and lighting
- Regular medical check-ups, rest periods, and job rotation
- Better designs of equipment and tools
- Intensive surveys covering a larger sample

Work in these home-based industries, involving entire families directly or indirectly, poses health risks to artisans as well as adversely affects the environment. A pollution-free environment largely depends upon reducing the hazards at source. This baseline study, which has tried to examine the implicit linkages between safe work, healthy environment, and artisans' health, has to be backed by a more detailed observation of a larger sample with experimentation at specific pilot locations, in order to provide a detailed menu of safety precautions to be taken.

1. Background

The handicrafts sector in India occupies an important position in the country's economy, provides employment to a large population and generates foreign exchange for the country. It also is a repository of the cultural heritage of the nation. The workers mainly inherit the skills from their parents and become experts in it. The sector, however, remains largely unorganised and dependent on market fluctuations and the workers are faced with several challenges in the practice of their craft.

In all, six crafts processes were identified in six craft clusters to conduct the baseline study:

1) Block printing in Rajasthan

2) Ikkat in Andhra Pradesh

3) Leather in Rajasthan

4) Bell Metal in Orissa

5) Dhokra in Orissa

6) Blue Pottery in Rajasthan

2. Objectives of the Study

The main objectives of the study were as follows:

- Documenting the production processes, materials used, and labour engagement in selected units in 6 craft clusters.
- Determining the different types of substances used in dyeing in selected units.
- Identification of the occupational hazards due to dyes and the work process in the units.
- Identification of environmental impact because of release of effluents and waste in different craft processes.
- Review of the existing effluent treatment plant with respect to its efficacy.
- Preparation of a draft manual on hazards in these clusters, their potential impact, and methods for mitigation at source.

3. Methodology

During the field survey, semi-structured interviews of unit owners and crafts workers in various villages and craft clusters were conducted with the help of a checklist. The various steps involved in the process of each craft, raw materials used, the environmental scenario due to usage of raw materials, review of existing ETP units (in case of Bagru and Pochampally), present health status of workers and their working conditions were documented. The study covered a range of units from the small scale or cottage industries (home based) to big parks. On an average, samples of 100 craft workers from each cluster participated and were assessed on various parameters.

The monitoring equipment and parameters for measuring occupational health status are detailed below:

Weight and Height: Body mass index (BMI) a tool used to estimate the ratio of body weight to height. Due to its ease of measurement and calculation, it is the most widely used diagnostic tool to identify weight problems within a population-to determine whether individuals are underweight, overweight, or obese. The BMI is dependent on patterns of food consumption, associated living and working conditions, the nature and duration of physical work. It is computed by measuring the weight and height of each worker and using the following formula:

$$\text{Metric BMI} = \frac{\text{Weight in kilograms}}{\text{Height in meters}^2} \text{ kg/m}^2$$

Interpretation of BMI	
BMI	**Weight Status**
Below 18.5	Underweight
18.5 - 24.9	Normal
25 - 29.9	Overweight
30 & Above	Obese

Hand Grip Meter: The test measures the maximum isometric strength of the hand and forearm muscles. This test is often used as a general test of strength. Strength also depends upon various activities like daily food intake, working hours, and pattern of work.

Rating	Males (Kgs)	Females (Kgs)
Above average	>52	>30
Average	48-52	26-30
Below Average	<48	<26

Peak Flow Meter: A peak flow meter is a portable, inexpensive, hand-held device used to measure how air flows from the lungs in one "fast blast." In other words, the meter measures the ability to push air out of the lungs. Peak flow meters may be provided in two ranges: a low range peak flow meter is for small children, and a standard range meter is for older children, teenagers, and adults. Generally, a peak flow measurement of 350 l/min is considered to be normal for adults, while 200 l/min indicates a condition of chronic bronchitis and, therefore, significant lung damage.

Peak Flow Meter	Status
>350 l/min	Normal
200-350	Asthmatic tendency
<200	Chronic bronchitis

Eye testing: The snellen chart is a chart used by eye care professionals and others to measure visual acuity. There are several lines of block letters printed on the chart. The first line consists of very large letters or symbols, and subsequent rows have increasing letters or symbols decreasing in size. If the smallest row can be read accurately, it indicates that the person has good eyesight.

4. Textile Printing in Bagru, Rajasthan

Bagru is a village situated around 30 km east of Jaipur city, Rajasthan and is known for its hand block printing. The traditional process of hand block printing on textiles, with rich natural colours, has been known for many centuries, beginning perhaps 450 years back. A community of Chhipas, originally hailing from Sawai Madhopur, Alwar, Jhunjhunu, and Sikar districts of Rajasthan, settled in Bagru and printed the fabrics by hand. There were about 3000 households who engaged in the craft using only vegetable dyes. However, the practice has undergone changes, diversifying towards screen printing and digital printing catering to market demands. The processes too have undergone changes with mechanisation requiring less manpower, faster production requirements, and the use of chemical dyes. Thus, the hand block printing practice has declined in Bagru (only about 600-800 households remain now), while screen printing has spread to more urban neighbourhoods in Sanganer (300 units) and Jaipur.

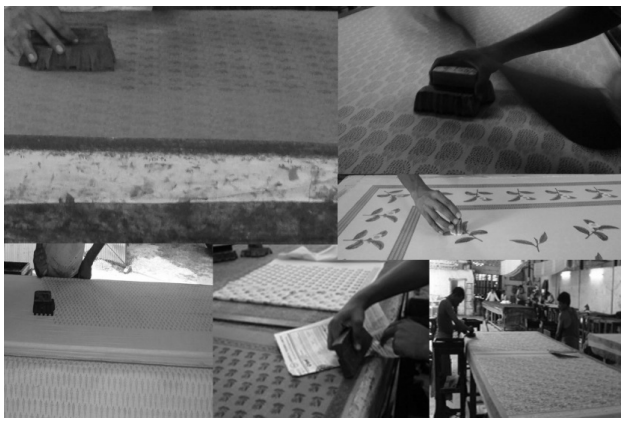
Hand Block printing has declined in Bagru (only about 600-800 households remain now), while screen printing has spread to more urban neighbourhoods in Sanganer (300 units) and Jaipur.

Although, there are hundreds of printing units located in Bagru, Sanganer, and Jaipur, visits could be made only to those units where AIACA has a presence. The study covered small scale or cottage industry units, typically handling 2000-4000 m/d cloth in a dyeing unit, 200-400 m/d cloth in a hand printing unit, and 1000-1500 m/d in a screen printing unit. Attempts were made to interview at least 10% of the workers from each of the units with different work patterns; overall, 80 workers were part of the exercise.

4.1 Findings

4.1.1 Hand Block Printing

The printing process is unique in Bagru, where primarily vegetables dyes are used. The colours for the Bagru print are prepared from natural dyes. The prints are essentially two colours-Red and Black. Traditionally natural dyes like ochre, indigo, pomegranate rind, turmeric etc., were being used as colouring agents with madder lake (alizarine) as the fixing agent. But for the past few years, synthetic alizarine has also been used. The process for dye preparation and printing is described below [Fig. 1].



Block Printing

Process Description

Block Printing

Block preparation

Sheesham wood is selected for making the blocks as the wood has good absorption capacity. The designs on the blocks are carved according to the requirements of the clients, and each design usually requires a set of several different blocks, for outline prints (*rekh*), filler prints (*gad*), and resist prints (*dabu)*. Various tools like compass, saw, routers, rulers, chisels, and wooden mallets are used for making the design on the blocks. Before usage, the blocks are soaked overnight in mustard oil or refined oil and then washed.

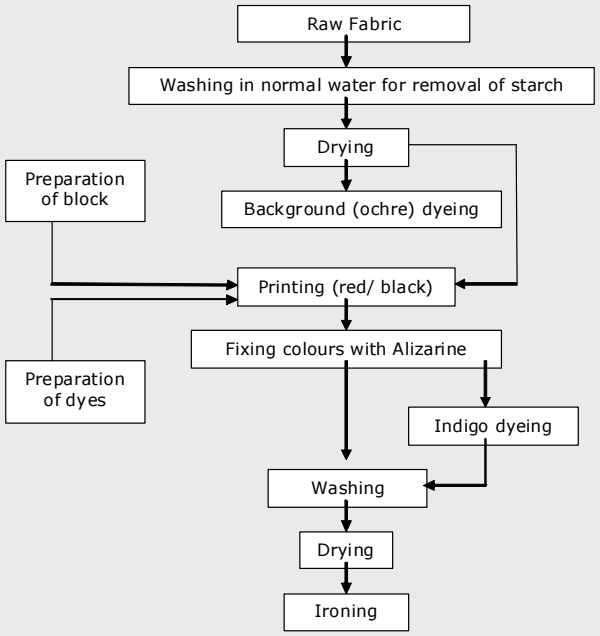
Washing of fabric

The printing process begins with the fabric, which is either hand-woven or mill-made and purchased from Jaipur. The cloth is washed several times in water to remove starch and to make it more absorbent and softer for dyeing and printing. The cloth is then dried in the sun and is ready for dyeing and printing.

The dyes

There is a long and complex process for preparing natural printing dyes, which are usually in two base colours-red and black. The base for the red dye is prepared by

Fig. 1: Flow chart of Block Printing



Note: See Annexure 2 for more details.

mixing ochre earth (*geru*) with the gum of the *babul* tree and alum (*fitkari*).It is stored in earthen vessels until the proper consistency has been acquired. The base for the black dye is prepared by immersing old iron horseshoes in a water and jaggery (*gur*)solution for about a month in plastic or earthen drums, followed by heating the supernatant in an Aluminium vessel with the flour of the tamarind seed (*chinya*). Apart from these two natural dyes, turmeric (*haldi*) may be used for a yellow base and the skin of the pomegranate fruit (*anaar or nashpaan*) for a green one. If other colours are demanded by the customer, then synthetic pigments may be used which are cheaper and easier to procure. These pigments (*Remazol dyes*) are generally mixed with *guaar* gum and hot water. Background colours may be given to the cloth with solutions of chebula seeds (*harra*) or indigo placed in vats for dyeing. The printing dyes with the appropriate colour and binder are poured into trays of different sizes (usually 9"x13"), with an intermediate wire mesh covered by a layer of woollen cloth.

Printing

There are generally two type's of printing practiced in Bagru. They are known as Direct Printing and Resist Printing. The printing is done on long wooden tables, varying in height from 2.75' to 3.25', and about 5' wide. The tables are covered with several layers of jute matting (about 18 layers) and a sheet of cloth over which the fabric to be printed is placed or pinned.

- ***Direct printing:*** In this process the master printer develops the main pattern with an outline block with a single colour. He is then followed by a series of assistant printers who use filler blocks with different colours to produce the final pattern.

- ***Resist printing:*** *Dabu* or resist printing involves the application of a mixed mud paste onto the fabric with the filler or outline blocks. Since this paste does not dry immediately, it may be sprinkled over with sawdust which acts as an absorbent. After drying, when the fabric is immersed in a dyeing vat, the colour is not taken up by the fabric where the paste has been applied. Although women have traditionally done the dabu printing, men are also now involved in the craft.

Fixing

After the printing process, the fabric is dried in the sun. The colours are then matured and fixed by dipping the fabric for about 4-5 hours in a heated copper vessel (*tamra*) containing alizarine (traditionally made from the Madder Lake root, but now synthetics are available) mixed with sakura flowers.

Indigo dyeing

Sometimes, particularly for resist printing, the fabric may be imparted a blue background colour. For this purpose, 2m deep sunken vats (*math*) are used and filled with indigo, lime, molasses, and water. The cloth may be dipped several times for a deeper shade

of blue, or for *dabu* (resist) printing it will be first dyed a light blue and then, after the *dabu* print is in place, it may be re-dyed to acquire a deeper hue.

Finishing

Once the printing and dyeing are complete, the cloth is again hand-washed and sun-dried, and finally ironed to heat-treat the colours.

4.1.2 Screen Printing

Screen printing (Fig. 2) is primarily done in Sanganer and Jaipur, and is aimed at the export market owing to significantly higher productivity than hand block printing and lower costs. It has been reported that while hand block printed cloth using natural dyes costs as much as Rs. 90/m, the use of synthetic pigments brings down the cost to Rs 18-50/m, while screen printing costs only Rs 8/m.

Screen Printing Process

Process Description

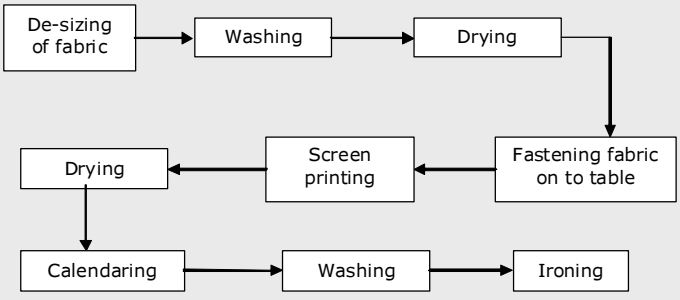
Washing

First, the mill fabric is de-sized with a mild solution of caustic soda for the removal of starch. It may even be bleached with hydrogen peroxide, after which it is thoroughly washed in water and dried in the sun.

Printing

The fabric is then printed on with the help of screens on which the pattern has been developed through a photographic process. The pigments are poured on the upper portion

Fig. 2: Flow Chart of Screen Printing



of the screens and spread out with the help of a rubber slider. The colour seeps through the pattern and gets imprinted on to the fabric which is fitted on to long cement tables covered with bees wax. The size of the screens vary according to the pattern and fabric, and may be 1.5mx1m or larger. Several screens are used depending on the number of colours to be imparted to the design on the fabric. Placers are fixed along the edges of the tables to enable the workers to accurately position the screen on the fabric.

Drying

After printing, the cloth is hung for drying in sheds, but the colour remains un-fixed (*kachha*), and has to be fixed with the help of sodium silicate on a heated calendaring machine.

Washing

After fixing of the colours, the cloth is washed several times to remove excess colour.

Tailoring and Cutting

In a few selected units, the printed fabric is also converted into clothing and household items. Hence, there are a number of workers employed to cut the patterns, sew and stitch them into final products, cut off extra threads, and clean the fabric with chemicals wherever the colours have run or there are marks.

Ironing

Finally the cloth is dried and ironed.

4.1.3 Digital Printing

Owing to the globalisation of markets, a new trend has arisen wherein a high production rate of fabric is demanded with minimum time and costs. The use of digital printing is part of this trend. Designs are prepared on the computer and then printed on to the fabric using computer-aided machines with multiple colours all at once. As many as 8-10 pigments can be used simultaneously, and the computer produces the shade required by the customer. The fabric is de-sized and pre-treated to hold the ink better. After printing it is dry-cleaned and ironed on vacuum tables.

Digital Printing

Due to globalisation of markets, a new trend has arisen wherein a high production rate of fabric is demanded with minimum time and costs. The use of digital printing is part of this trend.

4.2 Status of the Craftworkers

In the 14 units visited, the team was able to interview and measure the selected health parameters of 80 workers. Of these, a majority (38) were engaged in block printing, while 8 were involved in screen printing. There were 6 workers who mixed colours and pigments for printing. Another 28 were engaged in subsidiary occupations such as

The body mass index (BMI) of the workers (see Table 1) indicates that those remaining in the same unit for longer durations have better health.

thread cutting (11), tailoring, stitching, and sewing (9), washing (4), ironing (3) and block making (1). To aid comparison of the occupational health status, these workers were divided into two categories depending on the number of years of engagement in the current unit: 43 of them had been with the units for up to 5 years, while 31 had worked for more than 5 years-6 workers could not specify the number of years worked. Furthermore, it was considered advisable to compare the status of the block and screen printers and colour mixers with the rest, on the assumption that the former were most exposed to the hazards of printing.

S. No	Category of Workers	Number
1	Block maker	1
2	Paint and colour mixer	6
3	Block printer	38
4	Screen printer	8
5	Washing	4
6	Thread cutter	11
7	Tailoring, stitching, sewing	9
8	Ironing	3
	Total	**80**

Body Mass Index (BMI)

The BMI of the workers (see Table 1) indicates that those remaining in the same unit for longer durations had better health. Among workers engaged in work other than printing, 9/18 (50%) of those who had been working for 5 years or less in the same unit had normal BMI; there is a dramatic increase in the number of workers with normal BMI i.e., 9/10 (90%) among those who had worked beyond 5 years. There is a similar improvement among the workers in printing processes, but the rate is lower as the respective percentage jumps from 72% to 81%. In other words, regular work benefits the workers, while also reflecting the sound health of the industry.

Table 1: Body Mass Index of Workers

Category of workers	Years worked in present unit	No. of workers	Body Mass Index		
			Under weight	Normal	Over weight
Block makers, washers, cutters, tailors, and ironing	0-5	18	7	9	2
	>5	10	1	9	
	Unknown				
Block printers, screen printers, and colour mixers	0-5	25	7	18	
	>5	21	4	17	
	Unknown	6	2	4	

Pulmonary Function Test (PFT)

The measurement of the PFT, gives rise to much concern (see Table 2). Only 5 of the workers tested have a lung function that would be considered to be normal for an adult.

50% (9/18) of the other workers (other than printers) have shortness of breath in the short-term growing to 70% (7/10) in the long-term, although chronic bronchitis decreased from 39% (7/18) to 20% (2/10) over time (but the incidence of this tendency at such an early period is disturbing). For workers in the printing process, 64% (16/25) showed breathing problems when working for 5 years or less, while chronic symptoms were displayed by 32% (8/25). As they worked for longer periods (over 5 years), printers with asthmatic tendencies decreased to 57% (12/21), whereas those with chronic bronchitis increased to 38% (8/21). In other words, all the workers are being exposed to vapours, gases, fibres, and particles in a work atmosphere that is not conducive for pulmonary health, and the printers, as they work longer, display a marked tendency towards chronic bronchitis.

Workers are exposed to vapours, gases, fibres, and particles in a work atmosphere that is not conducive to pulmonary health, Printers, who work for a long period of time, display a marked tendency towards chronic bronchitis.

Table 2: Pulmonary Function Test of Workers

Category of workers	Years worked in present unit	No. of workers	Pulmonary Function Test		
			Normal	Asthmatic tendency	Chronic bronchitis
Block makers, washers, cutters, tailors, and ironing	0-5	18	2	9	7
	>5	10	1	7	2
	unknown				
Block printers, screen printers, and colour mixers	0-5	25	1	16	8
	>5	21	1	12	8
	unknown	6		4	2

Hand Grip Meter (HGM)

This trend towards poorer health for the printers and non-printers also shows up in the HGM test (see Table 3). For the non-printing sections, in the early years, 61% workers display below-normal grip strength in the right hand and 56% in the left hand, and this improves to 30% and 40% respectively in later years as the percentage of above-normal hand grips in the right hand increases significantly. But for printers, the below-normal figures are 44% for the right hand and 64% for the left hand for the first 5 years, going up to 52% and 62% respectively after that, with no particular improvement in the

Table 3: Hand Grip Meter Test of Workers

Category of workers	Years worked in present unit	No. of workers	Hand Grip Meter					
			Above normal		Normal		Below normal	
			Rt	Lt	Rt	Lt	Rt	Lt
Non-printing processes	0-5	18	4	3	0	2	11	10
	>5	10	7	4	0	2	3	4
	unknown	0						
Printing processes	0-5	25	7	6	8	4	11	16
	>5	21	7	4	2	3	11	13
	unknown	6	1	1	3	3	2	2

Note: Rt = right; Lt = left.

above-normal figures. This may have much to do with the repetitive and strenuous work that the printers have to do, to accurately position the block or screen and place sufficient pressure on it to transfer the design on to the fabric.

Eye Strain

Apart from the effects of work on the body, the lungs, and muscle tone, the repetitive work and the continuous visual attention to detail also seems to have had an impact on the eyes of the workers (see Table 4). Normal eyesight, hypermetropia (long-sightedness), and myopia (short-sightedness) could be estimated through eye testing using the Snellen chart. The 50% demonstrating normal eyesight among the non-printing workers improved to 80% in later years, but among the printing workers it dropped from 72% to 57% after 5 years of work. The numbers displaying hypermetropia and myopia in the printing workers was also much higher at 37% than the 21% for non-printing workers. In addition, a few of the workers also reported symptoms of watering, cataract, strains and swelling in the eyes in both categories.

Table 4: Eye Problems Reported by Workers

Category of workers	Years worked in present unit	No. of workers	Eye problems							
			Hyper-metropia	Myopia	Watering	Swelling	Cataract	Eyesight increase	Strain	No problem
Non-printing processes	0-5	18	3	0	2	1	0	1	2	9
	>5	10	2	1						8
	unknown	0								
Printing processes	0-5	25	5	2	2					18
	>5	21	6	2			1	1		12
	unknown	6		1	1					4

Muscular Pains

Craftworkers complained of chest pains and pain in right arm and shoulder. These complaints are clearly related to the nature of the work.

Additionally, many of the workers also reported muscular pains in the back, the joints and the lower abdomen (see Table 5); the proportions rose distinctly higher from 12% to 57% for those engaged in printing processes over the years, as compared to those in non-printing work who remained about the same at 44% and 50% respectively even after 5 years of work. There were also some complaints of pain in the chest and the right arm and shoulder. These complaints are clearly related to the nature of work. Particularly so for block printers as they have to reach out across the wide table to place the block at the extreme end, and then again reach back to place the block in the pigment/ dye tray, in an unbroken rhythm that maintains the pace of the work.

Table 5: Pains Reported by Workers

Category of workers	Years worked in present unit	No. of workers	Pains									
			back	joint	knee	elbow	lower abdomen	chest	right shoulder	right arm	leg	headache
Non-printing processes	0-5	18	7				1	1	1		4	2
	>5	10	4	1					1			2
	unknown	0										
Printing processes	0-5	25	1	1			3	2	2			
	>5	21	4	4	3	1	3	1	1	1		1
	unknown	6					1					

The number of block printers exposed to occupational hazards that impact the body is significantly higher than for other workers.

Other Symptoms

Other reported symptoms (see Table 6) are calluses on the edge of the palm or on the palm itself, itching hands, stains and colours on the hands-all only for the printers and clearly related to the printing process and the dyes used. Both categories of workers also reported some breathing problems. For the printers, the increase in working years did not appear to significantly affect the numbers reporting no problems. Hence, it is evident that the number of block printers exposed to occupational hazards that impact the body is significantly higher than for other workers.

Table 6: Other Symptoms Reported by Workers

Category of workers	Years worked in present unit	No. of workers	Other symptoms								
			callus on palm edge	callus on palm	itching of hands	coloured nails	stain in palms	cracked heels	hearing problem	breathing problem	no problem
Non-printing processes	0-5	18						1		1	
	>5	10									
	unknown	0									
Printing processes	0-5	25	3	1	2	1	1		1	2	8
	>5	21		2						2	6
	unknown	6		1							3

It should be mentioned here that only 19% of the surveyed printers use vegetable dyes, while the remaining 81% have switched over to synthetic chemicals in response to market demands. Additionally, many of the units that were visited are functioning from residential areas or in sheds where lighting and ventilation is often inadequate. Furthermore, as mentioned earlier, the heights of the tables do not take into consideration the height of the workers, and frequently the printers have to take a step up on the foot-rail by the side of the tables to reach the opposite edge for printing. The working posture of other workers too, such as those engaged in cutting and tailoring, and the

The working posture of those engaged in cutting and tailoring, and tedious repetitive tasks is not conducive to healthy body posture.

tedious repetitive nature of the work is not conducive to healthy body postures. The ironing workers in the more modern units are exposed to sound above the permissible decibel levels when the vacuum pumps are operated.

Majority of workers are not permanently employed, and only 13% have access to facilities such as Employees State Insurance and Provident Fund.

About 13-23% of different categories of workers claimed to be smoking, and this probably contributes to further weakening of the state of their lungs; however, it identified as the cause of the prevalent bronchial disorders of almost all the workers. Muscle tone may also be affected by the reported consumption of alcohol (15% for block printers and as high as 50% for the others) but, again, it is the nature of the work that is the cause of increased fatigue and strain on the body. This is further compounded by the fact that the majority of the workers are not permanently employed, and only 13% have access to facilities such as Employees State Insurance and Provident Fund. Few facilities were observed to be provided to the workers at the work-site, including toilets, rooms for resting and eating, washing places, natural or artificial exhaust systems for fresh air circulation, adequate lighting, and first-aid facilities. A few good practices were observed, such as provision of cold drinking water, placer strings for positioning the blocks, cut-out patterns, registration dowels on the blocks, safety guards on moving parts, and separate storage and mixing rooms with containers clearly marked. But these were few and far between with safety evidently not being a serious consideration for the industry.

4.3. Safety Recommendations

General Health

Regular work provides security to craftwokers. Sustained income for families is one of the most crucial element.

For the improvement of the body mass index, our findings suggest that regular work with security over time and incomes that enable the workers to sustain themselves and their families may be the most crucial element. This appears to be more critical for those workers in non-printing occupations, where our assessment (based on interviews with the owners) is that the printers are skilled workers who get more pay and whose services are valued more by the industry.

Pulmonary Health

The fact that only 5 workers had what is considered to be a normal lung function points to the most prevalent and severe hazard present in the industry. The fact that both printers and non-printers are widely affected (although the rate of normality for printers is almost one-third that for non-printers) indicate that the chemical vapours and micro-particles that cause pulmonary problems are present all through the units. In fact, our observation is that the washers, thread cutters, and tailors work in closed environments where the odours of various chemicals are clearly discernible, and the printers are always exposed to the pigments being used. The precautions to be taken in such situations are to (a) use pigments and cleaning agents that do not emit vapours known to be injurious; (b) install exhaust systems which ensure proper ventilation in the sheds and a regular supply of fresh air; (c) periodic medical check-ups of all workers to identify the early signs of pulmonary distress; and (d) rotation of jobs so that exposed workers are able to reduce the duration and intensity of their exposure.

These would avoid health and material costs, as well as cut down on absenteeism that adversely affects the production process.

Muscle Tone

The results of the hand grip meter test show that it is the printers who are suffering from a decline in muscle tone. These seem to be related to the nature of work that the printers do. The safety measures comprise (a) regular rest periods to avoid muscle fatigue; (b) better designs of grips for the blocks and screens; (c) design of suitable placers and registration guides; and (d) table heights that enable pressure to be applied directly on to the blocks. These measures would also improve productivity.

Eyesight

Almost half of the workers reported some form of eye trouble and one-fourth had measurable short or long sight. Our observations at the work place suggest that there is a lack of uniform and adequate lighting in most of the sheds. It is most necessary, therefore, to redesign or retrofit the sheds to ensure better natural lighting in regular working hours and make provisions for sufficient artificial lighting of the work site in case of work in shifts or unusual periods/time. Regular breaks from work that enable the eye muscles to avoid fatigue and redesign of the working tables to enable work to be done within the normal eye range would offer further relief to the workers as well as improve the quality of the work.

Body Pains

Back and joint pains are the most common, especially amongst the printers. These are clearly linked to the movements of the body required during work. Once again, regular rest periods to avoid fatigue are the recommended safety measure, but these should be accompanied by a study of the work process to develop ergonomic designs, and regular check-ups that dictate rotation of jobs and tasks to prevent repetitive motions causing stress to a particular set of muscles.

Other Impacts

Calluses on the hand, itching, stains, hearing and breathing problems have been reported by the workers. These would require safety precautions such as avoiding direct contact with load bearing and hard surfaces or chemicals. Personal protection is, of course, a possible solution but we do not recommend this as it does not permit the worker to function easily; therefore, all hard surfaces need to be appropriately cushioned while chemicals need to be handled with proper equipment. The use of noise dampeners where necessary (the vacuum ironing boards, for example), and proper ventilation would also be useful in reducing the hazards that cause health problems.

4.4 Environmental Status

Background

This section concerns the generation of wastewater from the industry, its treatment and disposal. The operations involved in dyeing and printing units have been schematically shown in Figures 3 and 4. Wastewater generation is expected from all washing and dyeing operations. The possible constituents of wastewater may be categorized as belonging to the following groups:

- **Acids,** mineral and organic (acetic, citric, formic, tartaric)
- **Alkalis** (caustic soda, carbonate)
- **Oxidants**, from bleaching (hypochlorite, hydrogen peroxide, borates, dichromate used as developers for certain dyes)
- **Reducing agents** (sodium hydrogen sulphite, sulphite)
- **Auxiliary chemicals** (alginates, carboxymethyl cellulose, starch, enzymes, gums, detergents, sodium chloride, and sodium sulphate for dye baths)
- **Dyes** in solution: acid, basic, reactive, mordant and other dyes
- **Dyes** in suspension: vat, oxidation, disperse, pigment, azo and other dyes

As different dyes produce the best results in different chemical environments, such as, pH, salt concentration, auxiliary chemicals, etc., the wastewater characteristics from dyeing and printing units will vary from the type of operations and, for the same unit, the dyeing and printing scheme. Therefore the characteristics of the wastewater can be stated only in terms of a wide range of aggregate parameters as given in Table 7:

Table 7: Wastewater Parameters

pH	3-12 (Usually Basic)
COD	200-1500 mg/l
BOD	60-500 mg/l
Colour	500-2000 Pt-Co units
SS	30-400 mg/l
Cr-VI	1-4 mg/l
Sulphides	0-50 mg/l

Mordant dyes associated with heavy metals Ni, Co, Cr, can be hazardous to health.

A special mention needs to be made of the toxicity of dyes. Mordant dyes associated with heavy metals Ni, Co, Cr, can be hazardous to health. Their use and wastewaters from units using such dyes should be handled with extreme care. Further, azo dyes derived from benzidene are carcinogens; exposure to them has been associated with bladder cancer. The Central Pollution Control Board has prescribed limits for treated effluent characteristics from cotton textile industries (see Table 8).

Azo dyes derived from benzidene are carcinogens. Exposure to them has been associated with bladder cancer.

Table 8: Limits for Treated Effluents

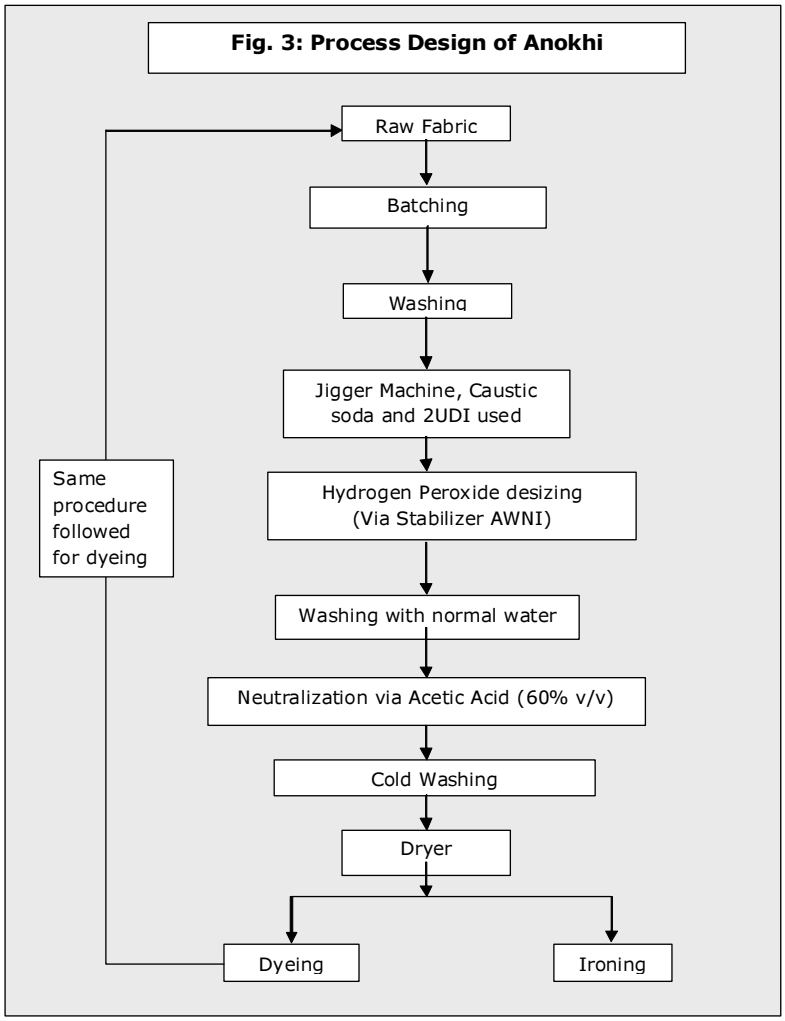
pH	5.5 to 9
Suspended Solids	100 mg/l
Biochemical Oxygen Demand*	150 mg/l
Oil and Grease	10 mg/l
Bio-assay	90% survival of fish after 96 hours
Chromium as Cr	2 mg/l
Sulphide as S	2 mg/l
Phenolic compounds as phenol	5 mg/l

Note: * Where the recipient environment so warrants, the BOD limit may be lowered down to 30.

Dyeing Process

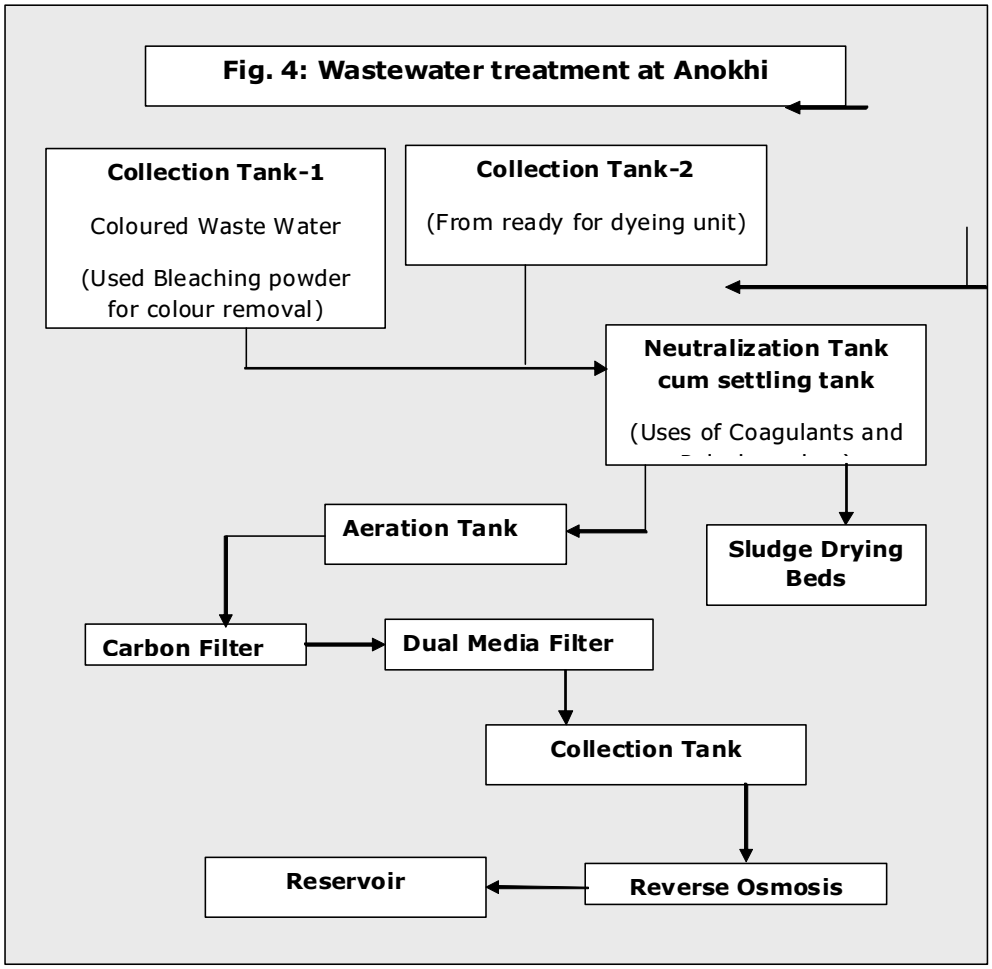
Fig. 3 shows various operations in the Anokhi dyeing unit. The wastewater generated from the dyeing and washing operations is subjected to physico-chemical treatment.

Fig. 3: Process Design of Anokhi



Wastewater Treatment

Fig. 4 shows a schematic diagram of the wastewater treatment and water reclamation plant at Anokhi.



The coloured waste from dye baths, and initial washes and clear wash water is collected separately in 2 tanks. It is neutralised as required by adding coagulants and a polyelectrolyte, flocculated by bubbling air and allowed to settle, chemical sludge is withdrawn from the bottom and the supernatant is taken to a holding tank, where it is kept aerobic by bubbling air. It is then filtered through a dual media filter and a carbon adsorption bed. Finally, the wastewater is passed through a reverse osmosis (RO) unit.

The sludge from the settling unit is sun dried. It is estimated that about 250 to 300 kgs of dried sludge is produced every 3 months. It is sent to Udaipur, presumably to a secure land fill.

Exact flow data was not available, except for the RO unit. The RO system produces 3600-3800 l/h reclaimed water and 2000-2200 l/h rejected water. Assuming middle values, the influent would be 5800 l/h. This gives a recovery rate of 3700/5800 x 100 = 64%.

For 6 hour/day operation (at times it is less) and 10% water loss in other units of the treatment system, the total wastewater flow works out to be 1.1 x 5800 x 6 = 38280 l/d, say 40 m3/d.

The analysis record available with the factory shows that the reclaimed and the rejected water have about 50 mg/l TDS concentration and 3000 mg/l TDS concentration, respectively. The recovered water is reused in the dyeing process. The reject stream is used for gardening within the premises of the factory.

The BOD and COD values, as per the record of the factory, of both the reject and the recovered streams are around 50 mg/l and 200 mg/l, respectively. Phenol concentration in the recovered water is around 0.3 mg/l.

In sum, the choice of wastewater treatment and recovery system is appropriate for the waste, and the treatment plant is functioning satisfactorily. However, there is scope for improvement in the monitoring of its performance. Some suggestions are as follows:

- Every 15 days, an intensive sampling and analysis for inputs and outputs of each unit should be done and a material balance made.
- Given that the plant has been in operation for 6 months, the adsorption capacity of the carbon bed and its efficacy for removal of specific metals and organic compounds needs to be tested.
- The water recovery rate of 64% for the RO appears to be on the lower side, unless it is the design value.

Common Effluent Treatment Plant

At present, many small dyeing and printing units do not have any wastewater treatment facility. They simply discharge their untreated waste at various locations in the city. A proposal to relocate several dyeing and printing units in a designated industrial estate, provided with a common wastewater treatment plant, has been made. The plant could be of the type already functioning in Anokhi. However, it is quite possible that a common treatment plant would receive a combined waste containing a significant concentration of organic matter that cannot be removed completely by chemical treatment alone. Therefore, it will be advisable to consider inserting a biological treatment system after chemical treatment in the treatment train.

The biological treatment could be an aerobic activated sludge system designed to operate as sequential batch reactor-more economical for intermittent wastewater flows. The effluent after biological treatment will then be polished by granular filter and carbon adsorption units. After polishing, the water can be used for irrigation, as construction water, or for fire fighting, etc. The RO unit, which is costly to install and maintain, would be necessary if the water after polishing has a high TDS value unacceptable for industrial use in the estate.

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5. Leather in Beawar and Jaipur, Rajasthan

5.1 Background

Leather is the name given to the skins of animals when tanned and prepared for different uses in industry. Skins consists of two layers: the epidermis (upper layer) and hypodermis, which is much thicker (tightly interwoven structure of fibres), and, in the tanning process, the epidermis layer is removed and it is the hypodermis layer that is transformed into leather. In general, tanning is a process which converts the decaying skins into robust and versatile materials for the use of mankind. The resistance, flexibility, and elasticity of leather are dependent on the quality of the fibre structures, and age of animals.

It is mainly the rural population that are engaged in the ancestral art of leather tanning, designing, and manufacturing. The craft of leather tanning, which was inaugurated in the distant past, got developed in India in the period around 3000 B.C.

Leather has played an important role in the development of civilisation. The concept of leather art came to the human mind as they killed animals for their food. Gradually they found uses for leather for clothing, shelter, and flooring, and even for decorative items. From leather, humans made footwear, belts, clothing, containers, boats, and even armour. Pieces of leather dating back to 1300 B.C. have been found in Egypt and, later, societies in Europe, Asia, and North America developed the technique of turning skins into leather independently of each another. The Greeks were using leather garments by the age of the Homeric heroes (about 1200 B.C.); the use of leather later spread throughout the Roman Empire. During the middle ages, the Chinese learnt the art of making leather. In India, the leather industry was led by the "*Chamars*" who, while processing dead animals, would take the skin of the animals for tanning. It is primarily the rural population that is engaged in the art of traditional leather tanning, designing, and manufacturing. The craft of leather tanning, which was developed in the distant past, got developed in India in the period around 3000 B.C. Though leather is used to make caps, armour, bags etc., foot wear is the main product of leather art as well as the leather industry.

Bhinmal in Southern Rajasthan is a place where embroidered footwear is manufactured in abundance. A large variety of the traditional leather chappals are made of original and fine coloured leather, often decorated with brocade or embroidery. *Jutti* or *Mojdi* is one of the most admired, fancied and eye-catching footwear of Rajasthan. *Chappal* or sandal is another kind of footwear which is preferred in warmer climates and seasons. Jodhpur and Jaipur are two cities where the traditional footwear, of excellent texture and designs are manufactured. The two cities are, in fact, well known for the *jootis* or *mojdis*, which are shoes decorated with great embroidery work.

5.2 Findings

5.2.1 Beawar

Beawar is a town situated amidst the Aravali hills of Ajmer. Apart from its importance in raw cotton, wool and food processing trades, Beawar also has a small cluster of

about 200-300 families, which has traditional expertise in (and income from) the fine trade of leather crafts. Hides for the fabrication of leather are gathered according to accessibility; in fact, Beawar artisans collect raw buffalo hides from Kanpur. Depending on their quality, the hides are categorised into two types- first and second grade. The first grade is of superior quality as it is fresh and unscratched and is based on the age of the buffalo, costing around Rs 300-350 per hide; the second grade, on the other hand, is somewhat poor in quality and costs around Rs 150-200 per hide. Each of the artisans collect around 50-60 hides at a time, and the entire processing from the preservation to the final product takes around 2-3 months depending on the weather conditions.

Leather Crafts in Beawar

Process: (Beawar)

Liming

As the artisans receive skins that are already cleaned and soaked, they are introduced directly into the liming process. As the skins still have hair on them, and this needs to be removed along with the hair roots and the epidermis layer, in order to expose the grain layer. The soaked hides are dipped in a tank of 500 litres (for 50 hides) with the addition of sodium sulphide and 5 kilograms of lime. Sodium sulphide penetrates deeply into the hair and grain of the skin, and causes the breakdown of Keratin, the main protein constituents of the hair and epidermis. Lime (an alkali), on the other hand, is added for enhancing the breakdown and dissolving of the hair and epidermis. With the hides churned manually daily, the process takes 9 days to complete.

Pre-Unhairing

After liming, hair is removed manually from the hide using traditional instruments; this process takes the whole day.

Fleshing

Fleshing is done for the removal of fats and tissues which act as a barrier to the penetration of chemicals. The fleshing process not only removes flesh, but leads to the

The fleshing process is carried out manually and it takes 5-7 workers about 5 hours to complete.

relaxing of the skins and aiding the removal of any hair roots remaining in the skin. This process is carried out manually and takes 5-7 workers about 5 hours to complete.

De-liming

Before going ahead with the tanning process, the alkalinity, which has set in during the liming process, has to be removed. This process is carried out with the help of ammonium chloride. As the lime in the skin gets neutralized by the ammonium chloride (4 kilograms in 500 litres for 50-60 hides), the skin starts to de-swell. As a result, the inter-fibrillary and keratin proteins, which were destroyed during liming, are washed out of the skin. This process takes 24 hours, and the material is churned every 2-3 hours.

Post Unhairing

Unhairing for the second time is done after de-liming.

Bleaching

After unhairing, the leather is bleached in a tank of 500 litres of water containing seven litres of sulphuric acid; this is sufficient for 50-60 hides. The bleaching is done for the removal of iron from the skin; the very process, however, has a detrimental effect on the future stability of the tanned leather.

Babul Tanning

After bleaching, the hides are dipped in a mixture of Babul bark/ pods, salt, and water (the ratio is 7 kgs Babul seeds, 15 kgs salts, and 500 litres of water for 50-60 hides) for 4 days. Leather made from Babul bark is firm and durable, though harsh and dark coloured, and of excellent quality especially for sole and heavy leathers. Babul pods, on the other hand, yield fairly light coloured leather. In this process, the hides are lengthened from 1 meter up to 1.25 meter. This process is also known as vegetable tanning.

Oiling

The leather prepared from above process is then oiled with soyabean or sesame oil. This operation is done to bring a shine to the leather.

Drying

In the production of vegetable-tanned leather, after the skins have been tanned, they have to be dried for several days for the fixation of the tanning to proceed. The method and degree of drying is dependent on the type of leather being produced, with any future transportation of the skins also an important concern.

Scratching

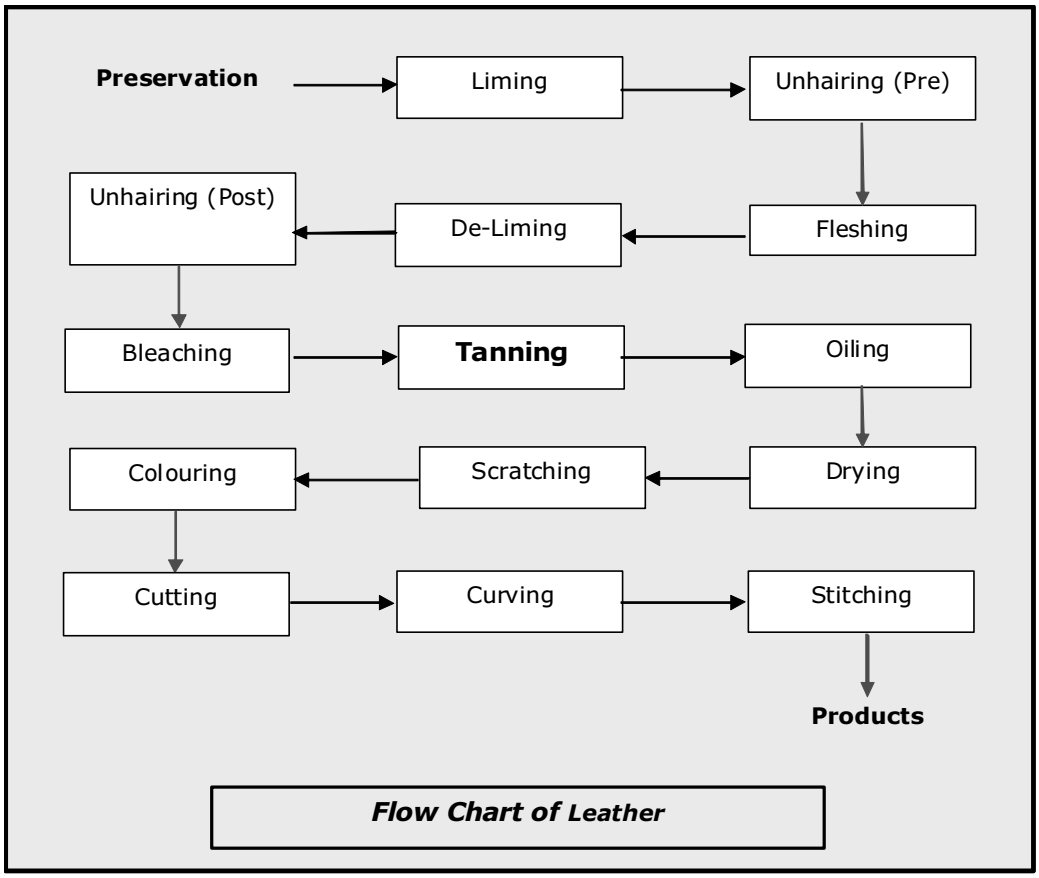
This is done with the help of rounded bottles for the removal of excessive fibres from the skins and to make then durable.

Colouring

The leather is then coloured according to the requirement.

Cutting, Curving and Stitching

Finally, cutting, curving, and stitching into different forms is carried out with traditional instruments for producing a range of products.



Flow Chart of Leather

5.2.2 Udaipuria - Mojdi Shoes

AA famous name in Mojari production, Udaipuria is situated on the NH-11, Jaipur-Sikar road, about 45 km from Jaipur city. It has a population of approximately 13,000, with a majority of them being Scheduled Caste leather craft artisans (Raigars and Meghwals). The village houses around 700 leather craft artisan households, 100 of which are currently involved in Mojdi making. The women members of the community make equal contributions in this craft. And the village is also the first of its kind to

The women members of Raigar and Meghwal community make equal contributions in leather. The village is also the first of its kind to register a fully women-owned producer company.

register a fully women-owned producer company. The craft here has been in practice for generations, and the younger generations are quick to experiment with colours and designs bringing the products in tune with national and international market trends.

Udaipuria Cluster

5.2.3 Manpura-Machedi

Manpura Machedi is a small village cluster located a few kilometres off Jaipur, on the Jaipur-Ajmer highway. Most of the families in this village have traditionally been engaged in processing leather and crafting *mojdis* in the units that function from home. In most of these units, both the male and female members of the household are involved in the work. The *mojdis* crafted here are sold either in the village or at a weekly *haat* in Jaipur. At the time of the team's visit to the village, a training programme was being run by SMART (Society for Marketing of Artisan and Rural Things) there to train the local workers in the mechanised form of production of *Mojdis.*

Leather Units in Manpura-Machedi

5.2.4 Sawarda

Sawarda is situated in Jaipur. Most of the families of the village are dependent on the leather trade for their livelihood. The process of leather tanning here is quite similar to the process followed in Beawar, with an exception of the raw materials used in tanning. The two important materials that differ from the units in Beawar are sulphuric acid and *bajra*.

Only very low concentration of sulphuric acid is used (5 litres in 200 litres of water with the addition of 15 kgs of *bajra*). Sulphuric acid, being a strong acid, actually increases the likelihood of acid damage to the leather. The reason behind the introduction of sulphuric acid to the processing was the development of man-made dyes and mechanical shaving. The remaining processes are the same.

5.2.5 Mojdi

Produced primarily in Jaipur and Jodhpur, mojdi refers to a man's closed shoe with an extended curled toe, whereas *juttis* have flat fronts. In *juttis*, the rear is normally covered but *mojdis* have an open look from behind. The *mojdi* is a traditional Indian shoe especially of Punjabi origin. Elsewhere, similar Indian shoes are called khussa or *jutti*. They are usually made of fine leather and are delicately embroidered with threads or beads. Assistance under the NLDP (National Leather Development Programme) to the artisans producing *mojdi* of Rajasthan, *kolhapuri* of Athni, and *juttis* in Punjab is scheduled for completion. The Society for Marketing of Artisan and Rural Things (SMART) has taken over the management and operation of the marketing structure, in order to ensure continued support to the artisans.

In its *mojdi* unit in Jaipur the leather is procured from different sources as they are not directly involved in leather production.

5.3 Process Description

Cutting

First, the two pieces of the upper portion of the *mojdi* are cut into accurate and desirable sizes with the help of a machine.

Process in Mojdi

Skiving

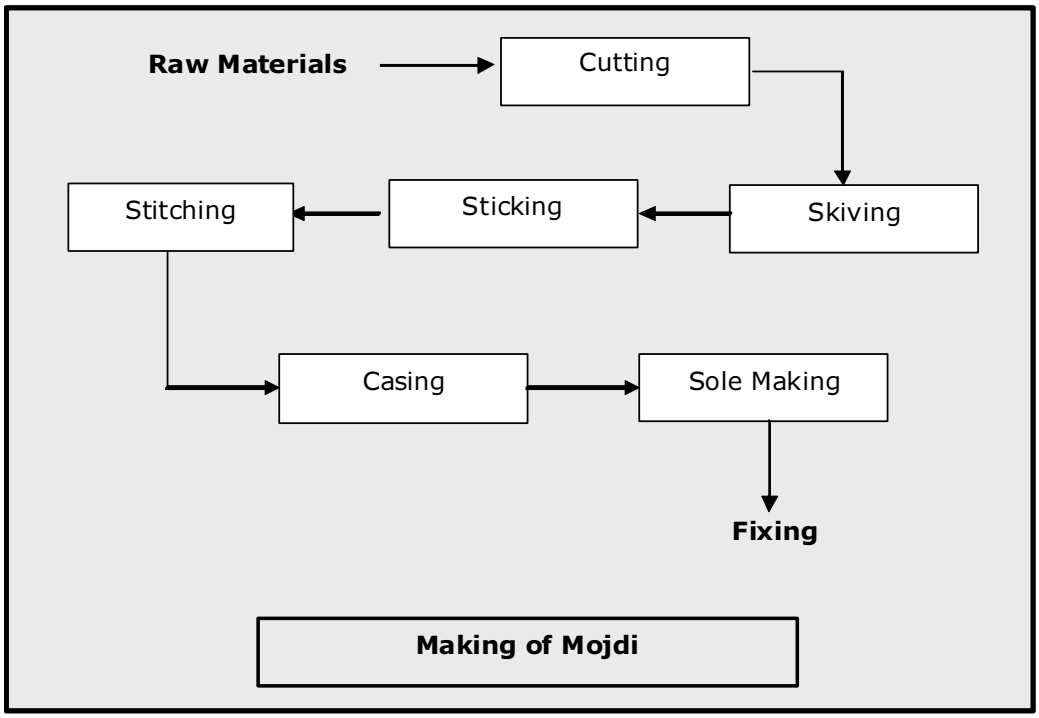
After cutting, each piece is smoothened with the help of a skiving machine. An artisan can skive around 500 pieces of leather in a typical 8 hour work day. An exhaust is attached to the lower portion of the machine, and the dust that passes through it is collected in a box.

Sticking

After smoothening, the two pieces of the upper portion are pasted together with an adhesive called dendrite; the adhesive is applied to the edges of the pieces and they are then dried for few hours to enhance the pasting. After that, the two adjacent portions are joined and pasted together by beating with hammers or other traditional instruments.

Stitching

Stitching of the pasted portion is done manually.



Casing

Casing is done to curve the leather to form the upper portion of the shoe. After stitching, the upper portion is placed in the desired blocks made of plastic.

Sole making

The lower portions (sole) of the *mojdis* are made up of rubber. The pieces are placed in a rotating glider of electronic equipment for labelling onto a size that would be fitted with the upper portions of the Mojdi.

Fixing

Finally the sole and the upper portion are fixed with the help of equipment run by a compressor.

5.4 Status of the Craftworkers

In the 4 locations, 96 artisans were interviewed and their health status examined through some simple instruments. Out of the 4 locations, only one (*mojdi*) is not directly involved in leather fabrication. And for the leather fabrication units/ villages, one single artisan is involved in the whole process. Hence, the trend of health status is somewhat similar among all artisans.

As leather art is practiced by families and passed on through generations, almost workers are engaged with this work from childhood; hence, the age group of workers

ranges from 25 to 85 years and the workers have been associated with the craft for 10 to 65 years respectively. For interpretation of health status, the artisans were divided into three categories with respect to their working years: 0-10 years; 10-30 years; and above 30 years

As artisans work for longer duration, their health deteriorates and the percentage of workers with normal BMI decreases from 61% for those working up to 10 years, to 56% in the medium term, and 57% in the long term.

Body Mass Index

The BMI of the artisans (see Table 9) indicates that as the artisans work for longer duration, their health deteriorates and the percentage of workers with normal BMI decreases from 61% for those working up to 10 years, to 56% in the medium term, and 57% in the long term.

Table 9: Body Mass Index

Years worked in present unit	No. of workers	Normal	Under weight	Over weight	Obese
0-10	38	23	10	5	0
10-30	32	18	6	5	3
>30	26	15	8	3	0

Pulmonary Function Test

From the pulmonary function test (see Table 10), it is observed that only 8% of the 96 artisans examined have normal lung functions-and they have been working for less than 30 years. Most of the artisans reported being plagued by constant cough in the mornings and evenings, a tendency which is also indicated by the pulmonary test. In the working-years groups, 76% of the workers in the 0-10 years group, and 65% in the 10-30 years group display an asthmatic problem. However, as the years of work increase, the cases of chronic bronchitis rise sharply from 13% for the short term to 22% for the medium term and 50% for the long term exposure.

As the number of working years increase, the cases of chronic bronchitis rise sharply from 13% for the short term to 22% for the medium term and 50% for the long term exposure.

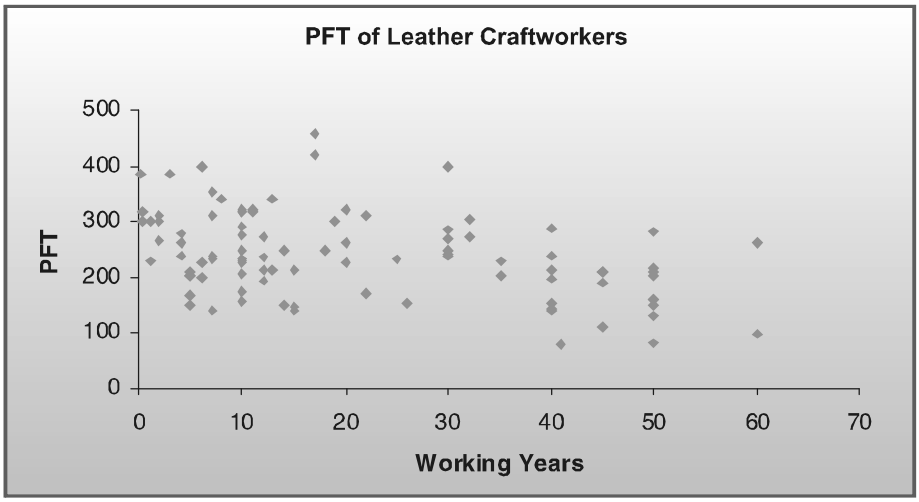
Table 10: Pulmonary Function Test

Years worked in present unit	No. of workers	Normal	Asthmatic tendency	Chronic bronchitis
0-10	38	4	29	5
10-30	32	4	21	7
>30	26	0	13	13

The scatter graph (see Chart 1) illustrates the decline in lung function and the increasing incidence of distress over time. There is a clear trend of lower PFT values as the working years increase.

The percentage of craftworkers with below normal hand grip strength is generally more than those with above normal.

Chart 1: Lung Function Test with respect to Working Years for Leather Craftworkers



Hand Grip Meter

This trend towards poorer health shows up in the hand grip meter test (see Table 11). In the early years, only 5% of the workers display normal grip strength in the right hand which increases to 28% and then decreases to 12% in the later years; similarly, 18% of normal hand grip displayed in the left hand improves to 29% and then declines to 15% as the working years increase. The percentage of those with below normal hand grip strength is generally more than those with above normal.

Table 11: Hand Grip Meter

Years worked in present unit	No. of workers	Above normal		Normal		Below normal		Injured
		Rt	Lt	Rt	Lt	Rt	Lt	Lt
<10 years	38	13	18	2	7	23	12	1
10 to 30 years	32	7	5	9	7	16	20	
>30 years	26	1		3	4	22	22	

Eye Strain

The percentage of workers with normal eyesight is 49% for those in the span of 0-10 working years, it decreases to 29% for the range of 10-30 working years, and to 22% for more than 30 years of continuous work.

The eyesight of the artisans (see Table 12) displays a similar pattern, with deterioration being observed with the passage of time. The percentage of workers with normal eyesight is 49% for those in the shorter span of 0-10 working years, decreasing to only 29% for the range of 10-30 working years, and to 22% for more than 30 years of continuous work. In addition to this, several workers report symptoms of watery eyes, eye strain, blurred vision, and weak eyes. Myopia and hypermetropia are found in 7 workers, and the numbers increase for those who have worked for more than 30 years.

Table 12: Eyesight

Years worked in present unit	No of workers	Normal	Watery eyes	Strain/ blurred vision	Myopia	Hypermetropia	Weakness
0-10	38	29	6	3			
10-30	32	17	5	5		2	3
>30	26	13	2	2	3	2	4

Muscular/ Body Pain

A large number of artisans reported having pains in different parts of the body (see Table 13), especially in the back; this may be caused by the uncomfortable posture that they have to adopt for long durations at work.

Table 13 : Pains Reported by Artisans

Years worked in present unit	Back	Knee	Body	Shoulder	Neck	Arm	Joints	Chest	Head	Stomach
0-10	7	2	3	2	1			1		1
10-30	7	2	1	2	1	4	1	2	1	
>30	2	1	3	1	1	2	4	2		1

Other Symptoms

Apart from the symptoms reported above, about 11% and 34% of the workers also complained of cough and breathlessness, particularly among those engaged in the leather profession for more than 30 years (see Table 14). This is supported by the findings of the PFT test. Other symptoms of liver and gastric problems, calluses, cuts and blisters, itching of the skin, sleeplessness, and tiredness and fatigue were also mentioned occasionally by the workers. Only 9 workers said they had no problems at all.

Table 14 : Others

Working years	Muscle strain	Cough	Breathlessness	Liver problem	Gastric	Skin itching	Callus on palm	Callus on feet	Cold	Cuts/blisters on palm	Tiredness/fatigue	Kidney stone	Insomnia	No problem
0-10			1						1	1				3
10-30	1	1	2		1	1					1	1	1	5
>30		3	9	1		1	2	1	1					1

It is very important to provide regular periods of relaxation within the working hours. Improvement of general well-being would also require sufficient and nutritive diets.

Personal Habits

About 43% of the artisans reported their addiction to tobacco, *bidi / hukka* and alcohol; out of this, 20% were, in fact, habituated to tobacco smoking.

5.5 Safety Recommendations

General Health

As the leather works, especially the tanning and pre-tanning processes, are very laborious and demand severe exertion from the workers, the BMI correspondingly decreases with increased working years. Our observation is that though most of the older people are engaged in making goods from leather rather than in tanning, they have to engross themselves in such work for a long stretch of 9-11 hours on a daily basis. Tobacco consumption during this period may also be responsible for loss in appetite for the artisans. Hence, it is of great importance to provide regular periods of relaxation within the working hours. Improvement of general well-being would also require sufficient and nutritive diets.

The odour from the hides, adoption of new methods for rapid production of leather products, and personal habits of the workers due to heavy workloads cumulatively causes worsening of the lungs.

Pulmonary Health

The odour from the hides, the adoption of new methods for rapid production of leather products, and the personal habits of the workers due to heavy workloads cumulatively cause the worsening of the lungs. It is advisable to remove and dispose the decaying matter as soon as possible. In addition, the use of machinery for skiving leather creates a large amount of minute respirable particles. It is necessary that this machinery is shielded adequately and proper exhaust mechanisms are put in place. Medical check-ups at periodic intervals are essential to detect the early onset of pulmonary distress; precautionary measures such as change in work tasks and mitigation of dust and odours should also be undertaken.

Medical check-ups at periodic intervals are essential to detect the early onset of pulmonary distress;

Eyesight

Almost all artisans are reported to suffer from eyesight problem. The main source of eyes strain is the constant exertion involved in stitching, colouring, curving etc. Thus, regular breaks from work to prevent eye muscles fatigue and some simple forms of eye relaxation exercises are advisable.

Body Pains

Back and joint pains are the most common occurrences, and these are clearly linked to the body movements required during work. Once again, a regular rest period to avoid fatigue is the recommended safety measure, but it should be accompanied by a study of the work process to develop ergonomic designs, and by regular check-ups that dictate rotation of jobs and tasks to prevent repetitive motions causing stress to a particular set of muscles.

The work processes have to be studied in detail to develop efficient ergonomic designs.

Other Symptoms

Cough, breathlessness, cuts, blisters, calluses, itching etc., have been reported by the artisans; these would require early detection through regular medical check-ups, the use of gloves while working in tanning processes, and the design of tools to avoid contact with chemicals and wash waters.

5.6 Environmental Status

In most of the places visited, artisans have continued with their traditional ways of tanning, i.e., through the use of vegetable dyes (seeds and barks of babul) and common salts (15 kgs). The waste water generation in these processes is about 400-450 litres for tanning 50-60 hides in two months. The main concern is of the salt that is released from these processes can increase the salinity of the land over a span of time.

In most of the places visited, artisans have continued with their traditional ways of tanning,

Dust particles from skiving process

Secondly, in the rapid production of leather products like mojdis and juttis minute particles are produced from the skiving of rubber and leather; this is released in the air without adequate collection mechanisms. Mitigation measures will have to be put in place for these forms of water, soil, and air pollution.

6. Blue Pottery in Jaipur, Rajasthan

6.1 Background

Blue Pottery is a unique craft as it is primarily a ceramic body made of quartz, unlike other pottery, that is made of clay. Its uniqueness also lies in the hand-painted motifs, which not only reflect the rich traditions of its present abode but also its origin in Persia. Blue Pottery is a kind of glazed stoneware pottery primarily of silica mixed with glass powder, gum, fuller's earth and bicarbonate soda. Due to its low plasticity, it cannot be moulded on the potter's wheel, but has to be moulded by hand. This facilitates shaping and easy joining; shrinkage is low during drying as well as after firing.

The origin of Blue Art Pottery lies in Iran. It is from there that it spread to Delhi and Agra through Afghanistan. The name comes from the eye-catching Persian blue dye used to colour the clay. At present the best form of Blue Art Pottery is practiced in Jaipur. From Delhi, the technique of Blue Art Pottery travelled to Jaipur in the 17th century, through the patronage of the erstwhile rulers of the Jaipur State. For about 100 years, the art of Blue Pottery continued to flourish here, but thereafter, for reasons unknown, this art gradually vanished in its entirety. The revival of this art began in the late 19th century, and Jaipur became the centre of a thriving industry producing blue ware.

Consisting of an entirely manual process, Blue Art Pottery is labour intensive. It provides employment, directly and indirectly, to hundreds of people in the surrounding areas.

Consisting of an entirely manual process, Blue Art Pottery is labour intensive. It provides employment, directly and indirectly, to hundreds of people in the surrounding areas. It is based on ground quartz, and the colour palette is restricted to blue derived from cobalt oxide, green from copper oxide, and white, although other non-conventional colours, such as yellow and brown, are occasionally included. The Jaipur Blue Pottery, made out of Egyptian paste, is glazed and low-fired. The dough is pressed into moulds and the unfired pieces are hand painted with oxide colours, dipped in clear glaze, and fired once in wooden kilns. The Jaipur mix usually contains no clay at all but is made up of ground quartz, green glass, fuller's earth, borax, and gum. Being fired at very low temperature also makes them fragile. Some of this pottery is semi-transparent and mostly decorated with animal and bird motifs.

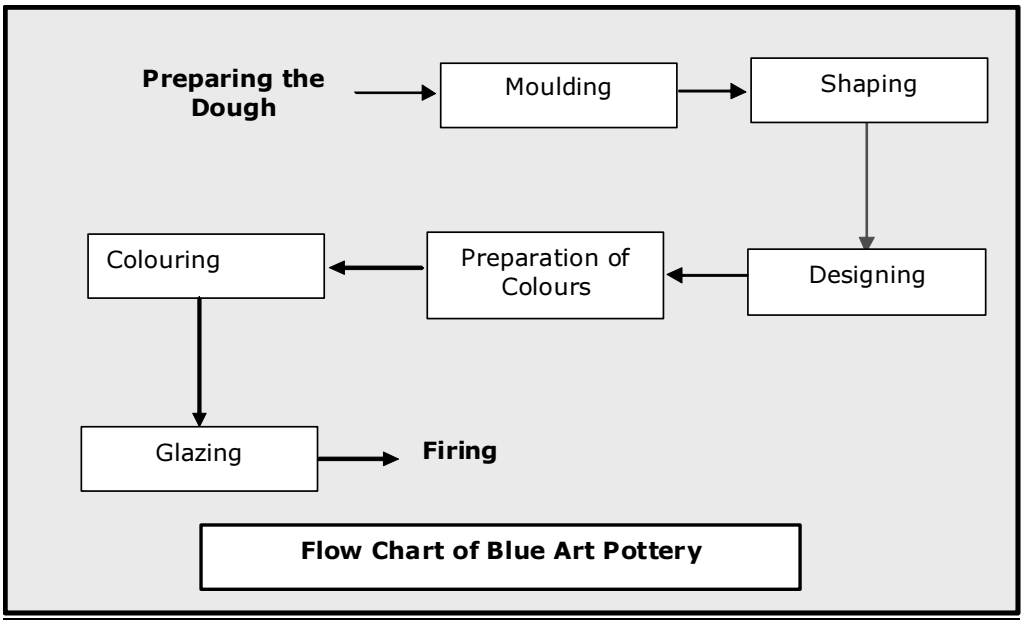
The process involved is very tedious and time consuming. Once made, the Blue Pottery items cannot be reworked. It is a craft where one is never sure if the finished product will have the exact shade that one may have wanted. The smallest mistake could lead to the piece either cracking up or turning black. This tedious process was one of the main reasons why few people were willing to experiment with new products in Blue Pottery. Not only did it require time and patience but also money. Blue Pottery has survived as a decorative item-ideal for gifts and souvenirs. But its practical use is quite limited.

Present Status of Blue Art Pottery

The Muslim, Rajput, Natt, Kumhar, and Regar communities are involved in manufacturing Blue Art Pottery and, at present, about 1000 people in the study cluster are employed in its manufacturing and export. Out of the 1000 artisans, 370 are involved directly in manufacturing, and are dependent on it for their livelihood. Usually, the artisan or their family members are responsible for all stages of the production process right from the preparation of raw material to the production of finished products. They use traditional methods for grinding raw material, preparation of colour, and design and fabrication of the articles. However, as the marketing system of this cluster is fully controlled by the exporters and traders the condition of the artisans is very dismal?

A basic limitation with blue pottery products is that they are fragile and porous, making them prone to blackening. A larger concern, especially with increasing pollution, is the use of lead in the production. Lead is a known pollutant and a cause of several health problems. Furthermore, the standards of scrutiny to which Blue Pottery products were put, and the lead found in most of them, also led to mass scale cancellations of orders, and as a result the export demand for Blue Pottery articles has reduced over the past few years.

Process Description



Flow Chart of Blue Art Pottery

Preparing the Dough

Blue Pottery involves the use of quartz powder, indigenous glass powder, *katira* (banyan tree gum), *saji* (rock salt), and *multani* (fuller's earth). All these are mixed in a certain proportion: about 40 kgs of quartz with 6 kgs of glass powder, 1 kg of *katira*, ½ kg of *saji,* and ½ kg of *multani.* The dough takes about 2 hours to prepare and is then kept in a plastic bag to retain moisture.

The glass for making glass powder is first crushed into smaller pieces by using stones; it is then ground to a fine powder in a *chakki*. This work is usually done by women. The quartz powder is procured from Beawar near Ajmer, and is of two qualities, one coarse and the other finer: the former is used for making the dough that goes into making the body, while the latter is used for making the paste that shapes the pottery. The price of about 50 kgs of quartz powder is Rs. 200 for the fine quality and Rs. 150 for the coarse one. The green glass variety earlier used for making the dough was hazardous because of lead content. Today, owing to the technological intervention of RUDA this glass is no longer used.

Dough Making

Moulding

The dough is flattened into a chapatti with a *thepai* (a traditional wooden tool). This is then set into a mould, and the edges are trimmed with a knife. The mould is filled with ash to prevent deformation. After the mould sets, the ash is removed and mould lifted. The edges are smoothened and the finishing touch is given with sand paper.

Moulding

Shaping

The pottery is then coated with a white paste which consists of the same ingredients used for the preparation the dough. This is done to fill gaps or crevices that might have been left on the surface of the pottery in the moulding process. Consisting of silica, glass powder, and fine wheat flour it seals the cracks, and gives a clear white base for painting.

Shaping

Designing

Design outlines are drawn on the pottery with Cobalt Oxide with a squirrel-tail brush (the painters make their own brushes from the tails of dead ground squirrels, which are frequently found run over) The patterns, which are a range of lines and flower motifs, are drawn by hand. There is almost no use of stencils in the process of drawing.

Preparation of the Colours

Designing and Colouring

The colours come in the form of various metal oxides. These oxides lend specific colour to the pottery: for instance, cobalt oxide gives the trademark blue colour to the pottery; green is derived from chromium oxide; sky blue comes from copper oxide; cadmium oxide yields bright yellow; and iron oxide is the base for red-brown. The colours, which are obtained in a lumpy powdery form, are ground with a *Sila Batt*. The powder is then mixed with water and gum of *babul* trees.

Colouring

The designs and the patterns earlier drawn on the pottery are then coloured. The colour scheme of Blue Pottery is predominantly a blue green palette, thus rendering it its name.

Glazing

The ingredients used to prepare the glaze are borax (*suhaga*), zinc oxide, potassium nitrate, boric acid, and glass powder, which is made adhesive by the addition of boiled flour. These ingredients are kept inside a kiln and fired, and the final product drains out of the kiln's bottom into cold water where the molten glaze solidifies in the form of lumps. These lumps are then ground thoroughly and reduced to a fine powdery form, which is mixed with water and applied to the pottery, or the product is simply dipped into the glaze. The pottery is left to dry in the sun for 3-4 days.

Firing

The kiln is prepared and the potters make offerings to the family deity for a successful firing. The glazed pottery is then neatly arranged inside a kiln. The closed kiln is fuelled with charcoal and fired with a temperature of 750^{o}C to 800^{o}C for six hours.

Firing causes all the glass to melt, but 80 per cent of the quartz is left, and this maintains the form of the vessel. The kiln is then left to cool for three days, avoiding any rapid temperature changes which could easily crack the pottery.

6.2 Status of the Craftworkers

S No	Category of Worker	Number
1	Making body of pottery	17
2	All steps in the process	47
3	Designing and colouring	8
4	Colouring	12
5	Crushing/grinding of Glass	4
6	Preparation of colours	3

The team visited four locations in and around Jaipur, amongst which two were village clusters: Kot Jewar and Neota. The team visited several of these home-based units in the above-mentioned clusters as well as two units in Jaipur, and was able to interview and examine the selected health parameters of 91 workers. The majority (47) of the workers were found to be engaged in performing all the steps/ procedures in the process of making Blue Art Pottery. While 17 workers were involved in just making the body, 8 were engaged in designing and colouring; another 12 were engaged in just colouring. Seven of them were working in other subsidiary occupations such as crushing and grinding of glass (4) and preparation of colours (3). For assessing the occupational health status, the workers were divided into 3 categories: 38 of them had been in the units for up to 10 years; 48 had worked for 10 to 30 years; and 4 workers had worked for more than 30 years (this category was only notional because the numbers were so few and, therefore, not very significant). But it was considered advisable to compare the status of the workers involved in performing all the steps in process with those involved in just the work of designing and colouring.

Body Mass Index

Table 15: BMI (Body Mass Index)

Category of Workers	Years worked	No. of workers	Under weight	Normal	Over weight	No response
Body Makers and others	0-10	30	20	10	-	-
	10 to 30	42	16	22	3	1
	>30	3	1	2	-	-
Designing and Colouring	0-10	8	4	3	1	-
	10 to 30	6	3	2	1	-
	>30	1	1	-	-	-

Doing multiple tasks with frequent changes in occupation and exposure patterns is beneficial for workers compared to doing specific tasks with continuous exposure.

The BMI of the workers indicates (see Table 15) that the health of the workers for the two processes observed differs. Among workers engaged in making the body of the

pottery, 33.3% of those who have been working for 10 years or less in the same occupation had normal BMI. This increases to 52.38% for those who have been working for between 10 to 30 years, and further increases to 66.6% for those who have been working for more than 30 years.

In contrast, for the workers engaged only in the designing and colouring of the pottery, the BMI remains almost constant varying from 37.5% to 33.3%. This indicates that undertaking multiple tasks with frequent changes in occupation and exposure patterns is beneficial for workers compared to engaging in specific tasks with continuous exposure. The workers engaged in designing and colouring have colouring has to sit and work for long hours at a stretch. Many of these workers also complained of digestion problems and gastric troubles.

Pulmonary Function Test

Table 16: PFT (Pulmonary Function Test)

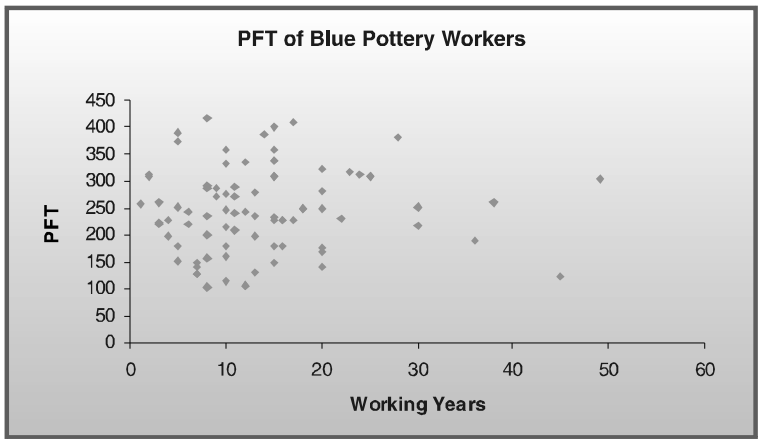
Category of Workers	Years worked	No. of workers	Normal	Asthmatic tendency	Chronic bronchitis	No response
Body Makers and others	0-10	30	3	15	11	1
	10 to 30	42	4	27	9	2
	>30	3	-	1	2	
Designing and Colouring	0-10	8	1	5	1	1
	10 to 30	6	2	2	2	
	>30	1		1		

Only 10 of all the workers examined had a lung function that would be considered normal for an adult (see Table 16). Of the workers engaged in all tasks, 50% have shortness of breath in the short term (work up to 10 years), growing to 64.28% for work in the medium term. Chronic bronchitis, though, decreases slightly over the short term to the medium term from 36.6% to 21.42%. Most of these workers exhibit hampered lung function while working over a long duration. Workers engaged only designing and colouring work exhibited a higher degree 62.5% of shortness of breath when working for 10 years or less, while only 12.5% displayed chronic symptoms. But for these workers, when working for more than 10 years, although the asthmatic tendency decreased to 33.3%, chronic bronchitis jumped to 33.3% (2/6).

Thus, it can be deduced that all the workers are being exposed to fine particles of quartz, powdered glass (silica particles), and metallic oxides in the work environment. This is not conducive for the pulmonary health of the workers. None of the workers use appropriate dust masks while working; even the use of cloth for covering the nose and mouth is almost non-existent. The workers involved in work related to the making of the body of blue pottery such as preparation of the dough, grinding of glass, glazing, and firing have a higher exposure level to potentially hazardous fine particles. They exhibit a higher rate of both asthmatic tendency and chronic bronchitis than workers involved in designing and colouring, as the exposure levels of the latter are less. The amount of exposure clearly leads to deterioration in lung function.

None of the workers use appropriate dust masks while working; even the use of cloth for covering the nose and mouth is almost non-existent.

Chart 2: Lung Function Test with respect to Working Years for Blue Pottery Workers



Hand Grip Meter

Table 17: HGM (Hand Grip Meter)

Workers	Years worked	No. of workers	above normal		normal		below normal	
			L	R	L	R	L	R
Body Makers and others	0-10	30	16	9	3	8	5	7
	10 to 30	42	9	11	10	7	17	18
	>30	3	0	1	0	0	5	4
Designing and Colouring	0-10	8	2	5	5	1	1	2
	10 to 30	6	1	1	1	2	4	3
	>30	1	0	0	0	0	1	1

For the artisans involved in designing and colouring, the below-normal figures are 12.5% for the left hand and 25% for the right hand. This is related to repetitive and strenuous work that they are involved in with minimal number of breaks.

This trend towards poorer health for both categories of workers also shows up in the HGM test. Amongst the workers engaged in occupations related to body making, in the early years, 17% workers display below-normal grip strength in the left hand and 23% in the right hand, and this deteriorates to 40.5% in the left hand and improves to 43% respectively in later years. The percentage of the above-normal hand grips in the right hand decreases marginally (30% to 26%) over the years, while that of left hand deceases significantly (53% to 21%). For the artisans involved in designing and colouring, the below-normal figures are 12.5% for the left hand and 25% for the right hand for the first 10 years of work, going up to 67% and 50% respectively for work above 10 years. This might be related to the repetitive and strenuous work that they are involved in with minimal number of breaks. Their work also requires greater accuracy, scarce movement, and the continuous use of hands in one position.

Eye Strain

Apart from the effects of work on the body, the lungs, and muscle tone, it was possible to assess the impact of working conditions on the eyes of the workers. Among body makers, 87% demonstrated normal eyesight amongst the body makers and others dropping to 71% after working for more than 10 years, and further drops to 67% after working for 30 years and above. But, unexpectedly, among the workers engaging in

designing and colouring work only, normal eyesight drops marginally from 87% to 83% after 10 years of work, while there was only 1 worker displaying signs of hypermetropia. On the other hand, 22 workers amongst the body makers reported various symptoms of watering, eye strain, blurred vision, and irritation.

Table 18: Eye Problems Reported by Workers

Category of Workers	Years worked	No. of workers	Hypermetropia	Myopia	Watering	Strain	Weakness	Blurred Vision	Irritation	No Problems
Body Makers and others	0-10	30	-	-	3	3	-	-	1	26
	10 to 30	42	-	1	4	8	-	2	1	30
	>30	3	1	-	-	-	-	-	-	2
Designing and Colouring	0-10	8	-	-	-	-	-	-	-	7
	10 to 30	6	-	-	-	-	-	-	1	5
	>30	1	1	-	-	-	-	-	-	-

Muscular Pains

Table 19: Muscular Pains

Category of Workers	Years worked	No. of workers	Back	Joint	Knee	Lower Abdomen	Chest	Shoulder Blades	Right Arm	Nape of Neck	Headache
Body Makers and others	0-10	30	5	1	-	1	2	2	-	1	1
	10 to 30	42	14	-	1	1	-	1	-	3	1
	>30	3	-	1	1	-	-	1	1	-	-
Designing and Colouring	0-10	8	2	-	-	2	-	-	-	-	-
	10 to 30	6	-	-	-	-	-	-	-	-	-
	>30	1	1	-	-	-	-	-	-	-	-

Additionally, many of the workers also reported muscular pains in the back, chest, shoulder blades, and nape of neck. The proportion distinctly rose from 33% to 43% for those engaged in all processes over the medium term. It can thus be generalised that as the years of work increase, the strain related to the work also increases, and working repeatedly in the same position results in pain in various parts of the body. The back and chest pain may be attributed to working for long hours in awkward postures; this goes for the pain in the neck as well. Chest pain might also be caused by gastric problems. Among the workers involved in designing and colouring, only 3 of the workers reported having back pain.

As the years of work increase, the strain related to the work also increases, and working repeatedly in the same position results in pain in various parts of the body.

Other Symptoms

Table 20: Other Symptoms

Category of Workers	Years worked	No. of workers	Breathing Problem	Tuberculosis	Corn in Feet/ Hands	Cough and Cold	Cough and Cold-Allergy	Insomnia	Gastric Problem	Cuts on Palms	Abdominal Pain
Body Makers and others	0-10	30	1	1	-	2	-	1	1	5	0
	10 to 30	42	5	1	2	2	-	-	2	-	-
	>30	3	1	-	-	-	-	-	-	1	2
Designing and Colouring	0-10	8	-	-	-	-	1	-	1	-	-
	10 to 30	6	-	-	-	-	-	-	1	-	1
	>30	1	-	-	1	-	-	-	-	1	1

Other reported symptoms are breathing problems, cuts in the palm, gastric and digestion problems, constant cough and cold, corn in hands and feet, insomnia and abdominal pain. The breathing problems reportedly increased with the years of work. Some of the workers also reported to have been diagnosed with tuberculosis and have taken medication for it. But even after that their problems have more or less continued. A few of the workers complained of constant cold and cough. Allergy to the suspended particles could be the cause of some of these problems. About 17% of the female workers are suffering from cuts in the palms and hands as they are involved in crushing the glass.

Apart from this, about 13% of the workers consume alcohol, and most of them share that they do so to ward off the tiredness related to the long hours of work. Although, 18% of the workers admitted to smoking, and this probably contributes to further weakening of the lungs, it cannot be identified as the cause for the prevalent bronchial condition of almost all the workers. Most of the units were home-based and located in open spaces. The exposure level to the finer particles is also similar for the workers engaged in designing and colouring work, as they also share the same workplace. Another health problem for the workers working above 30 years, in both categories, is that of abdominal pain which is present in 67% of the workers involved in all tasks.

6.3 Safety Recommendations

The artisans report a lot of health problems that are related to their environment, but they do not appear to be fully informed and aware about the hazards that impact them and their families.

Artisans engaged in the Blue Art Pottery clusters are in a disadvantaged position socially. Most of are either uneducated or possess low educational level and have a limited access to basic services. The artisans and their families use the same place for production and for living. The artisans report a lot of health problems that are related to their environment, but they do not appear to be fully informed and aware about the hazards that impact them and their families.

General Health

For the improvement of the body mass index, our findings suggest that regular work

with security over time and incomes enable the workers to sustain themselves and their families, and may thus be the most crucial element for better health.

Pulmonary Health

The fact that only 10 workers had what is considered to be a normal lung function points to the most prevalent and severe hazard related to the craft. That both categories of workers are widely affected indicate that the fine particles of quartz and powdered glass in the air are present in all the units. The prevalence of such symptoms amongst the workers engaged in designing and colouring, and not only among those working on the body, also means that all workers are exposed to the fine particles. In both the village clusters visited and in other urban units as well, the working units function from home. Therefore, not just during the working hours, but even in their other day-to-day activities, the workers are continuously exposed to the particles in the air. Therefore, the duration and extent of exposure is greater.

The fact that only 10 workers had what is considered to be a normal lung function points to the most prevalent and severe hazard related to the craft.

The precautions to be taken in such situations are:

(a) Periodic medical check-ups of all workers to identify the early signs of pulmonary distress;

(b) Separation of the workplaces from the workers' residential space; and

(c) Installation of proper exhaust and ventilation systems to reduce the amount of fine particles in the air around the workers.

Muscle Tone

The results of the hand grip meter test show that both categories of workers are suffering from a decline in muscle tone. These seem to be related to the nature of work they do, i.e., holding, moulding, colouring, and grinding with their hands for a long time. The safety measures can be:

(a) Regular rest periods to avoid muscle fatigue; and

(b) Provision of platforms of suitable height to the workers so that they can keep the articles on them while working with/ on them.

Eyesight

Most of the workers complained of strain in the eye muscles and watery eyes. Our observations indicate that the workers engaged in the designing work have to concentrate on the patterns continuously, leading to eye strains. Also, while making the body, a lot of fine particles get into their eyes resulting in watering. This is also a hazard for the workers firing the kilns. Although the female workers involved in the work of crushing the glass pieces wear spectacles at work, this is not an appropriate protective eye-gear despite preventing direct physical injury to the eyes. Proper protective gear, sufficient provision of artificial lighting that illuminates the work site, and regular breaks are recommended.

Although the female workers doing the work of crushing the glass pieces wear spectacles at work, this is not an appropriate protective eye-gear despite preventing direct physical injury to the eyes.

Body Pains

Pain in the back, shoulders, and nape of the neck is quite commonly reported by workers. These are clearly linked to the position in which the workers work. Once

Heavy metals such as copper, cobalt, and cadmium, present in the colours have known adverse impacts on health attacking the neurological systems in the body.

again, regular rest periods to avoid fatigue and appropriate elevations (ergonomic interventions) to perform tasks without bending in uncomfortable postures are recommended. Also, muscular pains may be avoided by regular and adequate rest and relaxation of muscles in between work.

Other Symptoms

Other reported symptoms are corn in hands and feet, constant cough and cold, gastric and digestion problems, cuts in the palms, insomnia and abdominal pain. For abdominal pain it can be suggested that the workers increase their water intake to flush out the impurities getting into their bodies, which, otherwise, could lead to stone formation. The same recommendation also goes for the workers suffering from acidity and bile related problems.

6.4 Environmental Status

Wooden fired kilns emit a lot of smoke and fumes that are potentially carcinogenic. In addition, heavy metals such as copper, cobalt, and cadmium, present in the colours have known adverse impacts on health, attacking the neurological systems in the body. In particular, the use of leaded glass has both environmental as well as health impacts. The gathering of firewood for the kilns poses a further environmental hazard, especially in an arid zone such as Rajasthan.

1. Quartz Particles

Prolonged or repeated exposure to fine airborne crystalline silica dust may cause severe scarring of the lungs, a disease called silicosis.

Powdered quartz is used for making the dough which is needed for making the body of Blue Pottery articles and also in preparing the paste for shaping. While mixing the ingredients for both the stages, a lot of powdered quartz gets dispersed in the air, which is then inhaled directly by the workers. No protective masks or even rudimentary masks made out of cloth are used by workers. Repeated exposure over the years leads to deterioration in lung function. Prolonged or repeated exposure to fine airborne crystalline silica dust may cause severe scarring of the lungs, a disease called silicosis. The severity of silicosis depends on the airborne concentration of respirable-size silica dust to which a worker is exposed and duration of exposure. Silicosis usually develops gradually over 20 years or more of exposure. Particles with diameters less than 1 micrometre and freshly cleaved particles are considered most hazardous. Silicosis has usually been found in workers with exposure to even less than 1 mg/m3 respirable quartz.

Glaucomatous pneumonitis, a respiratory problem caused by inhalation of dust particulates of glass etc., may occur in workers exposed to their constant and prolonged inhalation.

The early symptoms of silicosis (cough, mucous production and shortness of breath upon exertion) are non-specific; so, the development of silicosis may not be detected until advanced stages of the disease. Silicosis may continue to develop even after exposure to crystalline silica has stopped. Inhalation of quartz has also been associated with a number of other, less well-characterized, harmful effects including effects on the kidney (glomerulonephritis), the liver, the spleen and immune system disorders (progressive systemic sclerosis, scleroderma or rheumatoid arthritis).

2. Powdered Glass

The lead oxides present in various colours can be released during firing into the air. Lead is hazardous to breathing and digestion.

Powdered glass is inhaled by the workers in the process of grinding it over the years. Glaucomatous pneumonitis, a respiratory problem caused by inhalation of dust particulates of glass etc., may occur in workers exposed to their constant and prolonged inhalation. Women do most of the glass breaking and grinding work. In many units, the glass still used for making pottery is green glass which contains lead oxide that gives it its distinct colour. Most of the manufacturers admitted to still using green glass in the process, as it increases the durability of the Blue Pottery articles. Only in Kot Jewar, due to the technical intervention of RUDA, has the use of green glass in Blue Pottery been completely phased out.

The prime hazard of lead is toxicity. Apart from adverse neurophysiological effects, it can also have potential adverse effects on the offspring of pregnant workers. The main route of entry of inorganic lead compounds is the respiratory tract; it is then absorbed by the pulmonary blood stream and transported to the various organs and tissues. Poor work hygiene, smoking during work (pollution of tobacco; polluted fingers while smoking), and poor personal hygiene may considerably increase total exposure through the oral route. Thus, the workers who are addicted to smoking and eating tobacco are potentially more at risk.

3. Fuller's Earth

Exposure to dust is harmful only when it is inhaled in excessive amounts and may lead to signs of pneumoconiosis. The disease is relatively mild and associated with little clinical disability in the early stages.

4. Colours

The colours used for colouring the Blue Pottery are usually oxides of metals. The lead oxides present in various colours can be released during firing into the air. Lead is hazardous to breathe, to ingest (eat), and can be released at high temperatures. Finally, any container glazed with these materials may be toxic to eat or drink from because lead can leach into food or drink stored in the vessel. Lead is not a colourant by itself, but is used to help the glaze melt at low temperatures of a wood-fired kiln.

Disposal of this waste is also a problem as the metallic oxides are toxic in nature. The damaged pottery when disposed brings these colours directly in contact with the environment.

5. Waste Generation

Once made, the Blue Pottery items cannot be reworked. It is a craft where one is never sure if the finished product will have the exact shade that one may have desired. The smallest mistake could lead to the piece either cracking or turning black. If the pottery cracks due to improper maintenance of temperature, or the colours do not emerge appropriately after firing, the product has to be discarded. This creates a lot of waste, which is completely non-recyclable in nature. Disposal of this waste is also a problem as the metallic oxides are toxic in nature. The damaged pottery when disposed brings these colours directly in contact with the environment. When these get leached away by water or rain, they enter the soil, and can be potentially hazardous.

7. Bell Metal in Balakati, Orissa

7.1 Background

Bell metal is one of the most popular types of metal used in the crafts. It is a hard alloy that has a composition of 80% copper and 20% zinc, and resembles bronze.

Metal craft is an integral part of Indian culture with the artisans having mastered the art of metallurgy long ago. Bell metal is one of the most popular types of metal used in the crafts. It is a hard alloy that has a composition of 80% copper and 20% zinc, and resembles bronze. Bell metal is used in manufacturing a variety of items both for utilitarian and aesthetic purposes. Kerala, place the place of origin of the art of Bell metal. The people of Bihar, Orissa, West Bengal, Assam and Madhya Pradesh have also over time developed the expertise for Bell metal products. Popular lore suggests that two artists named Dhiman and Vithpal spread the art of Bell metal to people of different countries.

Orissa is famous for handicrafts that exhibit the skill and creativity of its artisans. Its brass work, silver work, terracotta art objects, and appliqué work are unique examples of artistic excellence. The fine engraving of Bell metal utensils is an important aspect of Orissa art which reveals the high workmanship of the artisans. The manufacture of Bell metal utensils typically takes place in the village of Balakati at a distance of 20 km from the capital, Bhubaneswar. It is a village of 750-800 households and their primary occupation is production of Bell metal utensils, usually as a home-based industry. The scrap raw material used in the manufacture is sold at Rs. 300/kg by suppliers located in the village. The fabrication of the utensils takes place in the backyards of the houses, and the finished utensil is sold in the nearby Uttara market or in Delhi's Paharganj market. Homes in Balakati are greater in length with a lean corridor along the rooms leading to the workspace at the back. In the summers the villagers start their work as early as 3 o'clock in the morning, continuing up to 1 o'clock in the afternoon to avoid the heat during the rest of the day.

The Process

Smelting

The scrap metal is first placed in a ceramic jar known as kui having a capacity of 10-40 kgs. This jar is then placed in a pit furnace fired with charcoal to smelt the scrap metal. The heat in the furnace is maintained by aeration with a manually operated blower. This blower is usually operated by

Scrap Metal

young artisans (or women) who are in the process of learning the skill.

Smelting of Metal

Artisan Operating the Blower

Moulding

The molten metal in the furnace is then ladled out with a small ceramic pot on to a clay pallet called acchu to give an ingot.

Clay pallet (acchu)

Ingot

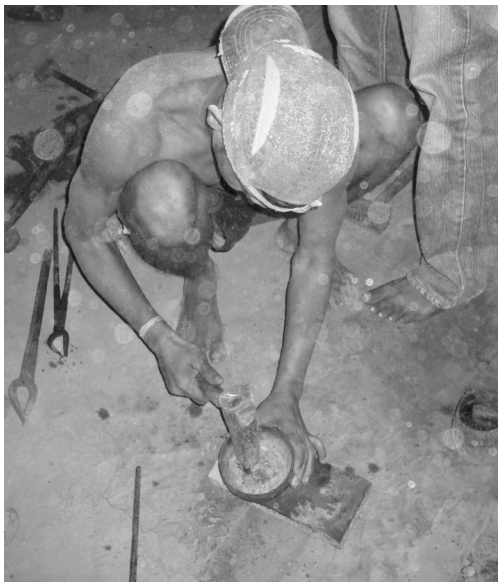
Beating

The ingot is then repeatedly heated in the furnace and beaten with a hammer or mallet till it acquires the shape of a vessel. This beating takes place in several stages. The first and second beating, with regular heating, is done by several persons together till it acquires the definite shape of a vessel (e.g. a bowl). The third and fourth beating is done individually by artisans to give final shape to the metal.

Ingot in furnace

Hot ingot

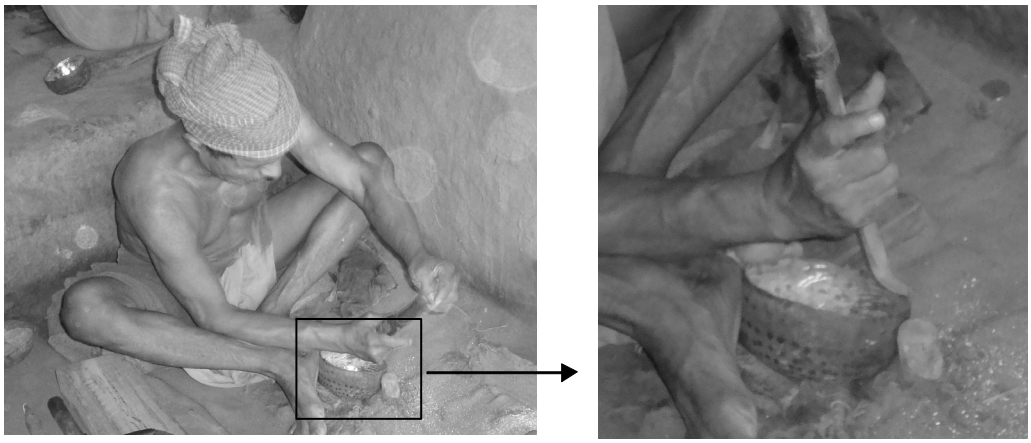
Collective beating



Collective beating

Scraping

The raw vessel is scraped with steel scrapers (forged from old files) to achieve an even surface to the vessel.



Scraping

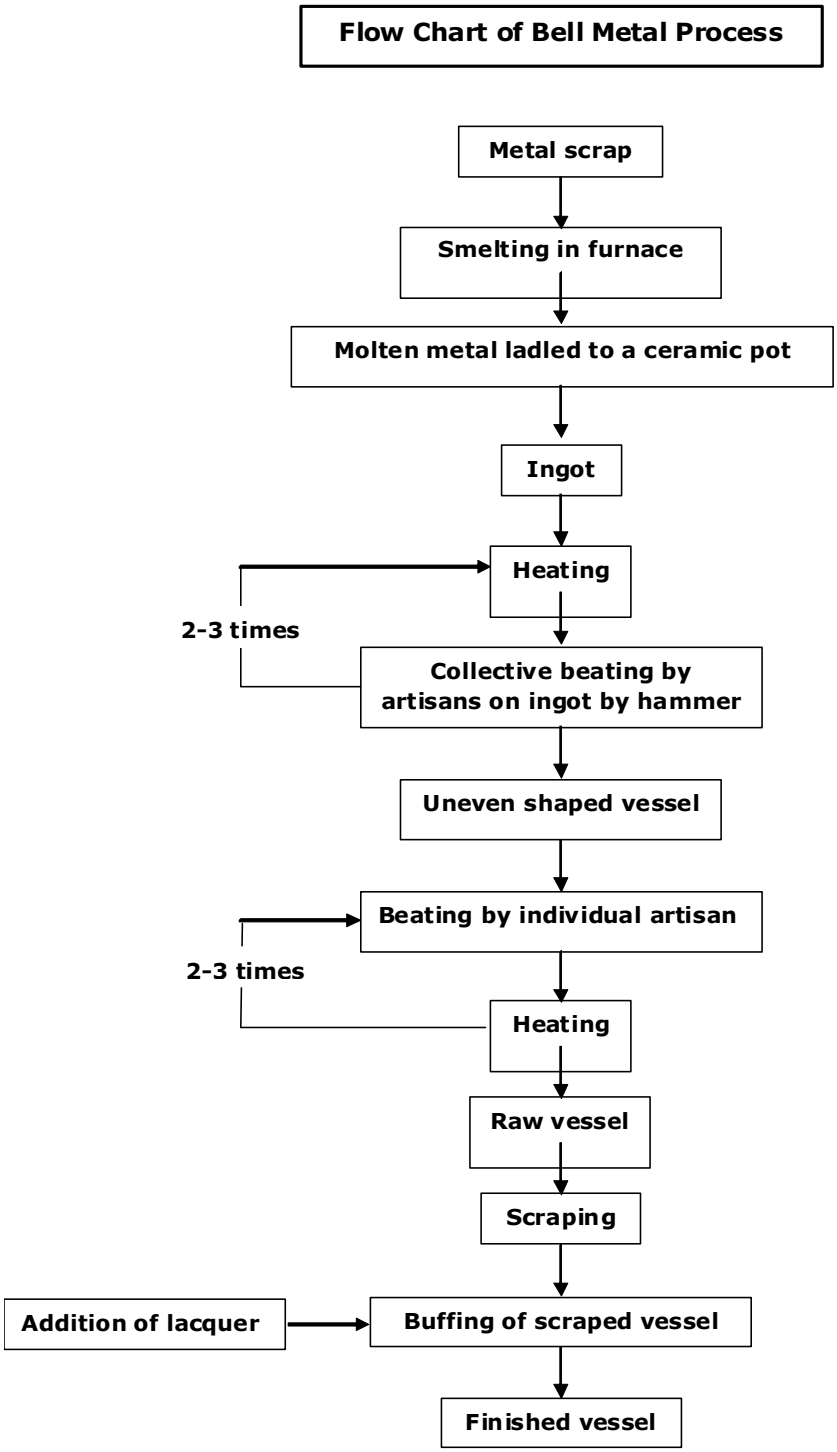
Buffing

A black adhesive lacquer is heated and applied to the bottom of the vessel which is then fixed on a rotating chuck for buffing with another tool to acquire a polished finish. The rotating chuck is either manually or mechanically operated. If it is manually operated then women or young artisans perform the task.

Adding lacquer

Scraping

Finished vessel



7.2 Observation of Hazards

- **Smelting:** Considerable smoke and soot is emitted by the furnace, and the artisan working in it is often covered with particles blown out by the forced draft. He is also exposed to metal vapours and heat. This leads to burns, skin irritation, and acne.

- **Beating:** Continuous hammering results in calluses on palm and fingers with black pigmentation. There is also a high noise level and poor ventilation in the room. Moreover, cuts occur as the vessel is turned and the sharp wedges have an impact on the wrists and feet.

- **Scraping:** Once again, calluses and cuts are part of the hazards of the process.

Workplace

- **Buffing:** The buffing process yields fine metal particles that may remain attached to the hands even after washing and become ingested with food. Mechanical grinding may produce even finer particles that are inhaled. Metal accumulation in the body generally attacks the nervous system. Apart from the above, there are the general impacts of hard manual work in stooped body postures, and poor lighting and ventilation that may contribute to body aches and eye strain.

7.3 Findings

The team interviewed and examined the health status of 94 artisans and 6 businessmen who have been taken as a partial control for the study. The artisans are mostly male as the women are involved in other home-based work like making bags and sewing clothes. Some women help the men in operating the blower. Since the work is home-based, 52% (see Table 21) of the workers are self-employed and the rest are employed, with a few doing both. Earlier the employed workers earned a daily wage of Rs. 30-60 a day. This has now increased to Rs 160 a day. Although there are different types of work involved in manufacturing, like smelting, beating etc., there is little or no division of labour among the artisans. The younger generation starts work by helping with the blower, observing the others at work and steadily learn the skills.

Since the work is home-based, 52% (see Table 21) of the workers are self-employed

Although there are different types of work involved in manufacturing, like smelting, beating etc., there is little or no division of labour among the artisans.

Table 21: Employment of Workers

Category of workers	Years worked	No. of workers	Employment		
			Self	Employed	Both
Bell metal	0-10	28	16	11	1
	10-30	38	24	14	
	>30	28	9	9	1
Control	0-10	3	3		
	10-30	2	2		
	>30	1	1		

While 14% show chronic bronchitis in the earlier years, this increases to 32% for the group between 10-30 years of work, and further increases to 79% in the long term.

Body Mass Index

The BMI of Bell metal workers (see Table 22) shows a gradual increase from normal BMI from 68% in those working for less than 10 years, to 71% for the 10-30 years of work category, which decreases to 54% for workers working for more than 30 years; the 'control' population, on the other hand, generally has normal body weight without any person being underweight.

Table 22: Body Mass Index of Workers

Category of workers	Years worked	No. of workers	Body Mass Index		
			Under weight	Normal	Over weight
Bell metal	0-10	28	3	19	6
	10-30	38	8	27	3
	>30	28	8	15	5
Control Group	0-10	3		1	2
	10-30	2		1	
	>30	1		2	

Pulmonary Function Test

As workers in Bell metal manufacturing are constantly exposed to metallic fumes, vapours, gases, and particles, the pulmonary function test (see Table 23) gives us a clear picture of the respiratory problems suffered by the artisans. Only 10 workers of those tested for lung function can be said to possess a normal adult lung function. 54% of the workers having shortness of breathe in the short term rises to 65% in the medium term, and then gradually declines to 21% in the long term. While 14% show chronic bronchitis in the earlier years, this increases to 32% for the group between 10-30 years of work, and further increases to 79% in the long term. The test amongst the control group shows that 2 workers have normal lung functions, 3 display shortness of breath, and 1 has chronic bronchitis. There may not be much difference in the respiratory problems of this control group as they live in and around the workplace.

Table 23: Pulmonary Function Test of Workers

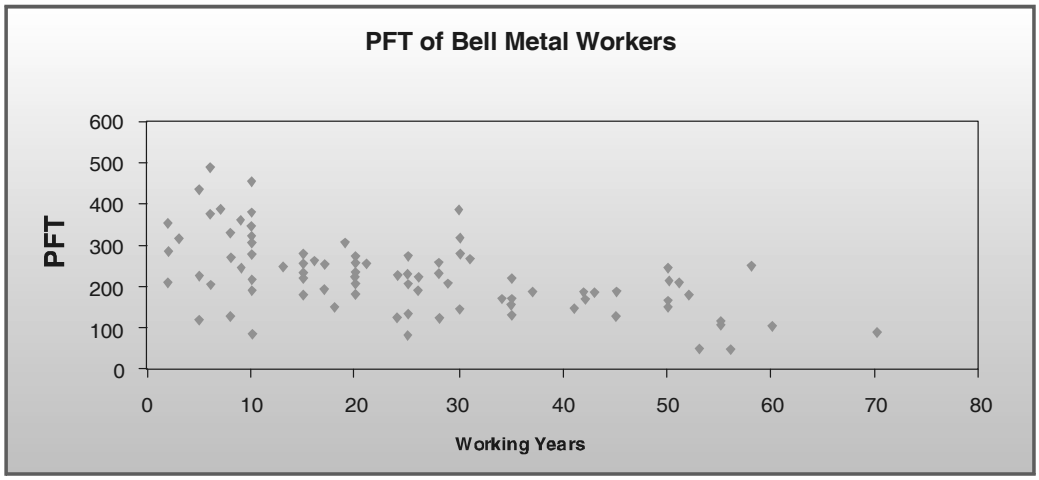
Category of workers	Years worked	No. of workers	Pulmonary Function Test		
			Normal	Asthmatic tendency	Chronic bronchitis
Bell metal	0-10	28	9	15	4
	10-30	38	1	25	12
	>30	28	0	6	22
Control Group	0-10	3	1	2	
	10-30	2	1		
	>30	1		1	1

All the workers associated with bell metal manufacturing show asthmatic tendency during the earlyyears, which is aggravated to chronic bronchitis in the later years

Therefore, all the workers associated with bell metal manufacturing show asthmatic

tendency during the earlier years, aggravating to chronic bronchitis in the later years (see Chart below).

Chart 3: Lung Function Test with respect to Working Years for Bell Metal Workers



Almost all the workers, young or old, have calluses on palms and fingers. This is due to the repeated hammering of the utensil to give its shape.

7.4 Visible Health Problems

Apart from the test results, there are many visible health problems (see Table 24) observed among the artisans, and rarely seen among the control group. Almost all of the workers, young or old, have calluses on palms and fingers. This is due to the repeated hammering of the utensil to give its shape. It is extremely strenuous work and requires much strength. Callus is the result of continuous friction of the hammer with the palm and the fingers. Especially big calluses can also be seen on the palms of the workers; some of the workers, in fact, cut these open with blades. In workers who have retired from work due to old age, these calluses are still evident.

Callus

Cinder from fire

Cuts in the hands are also prominent in workers who have worked for more than 10 years. These cuts are largely on account of handling the vessel's sharp edges during beating, scraping, and buffing.

With workers being mostly bare-bodied in the heat and without shoes or gloves or coveralls, burns occur commonly during repeated heating of the ingot where cinders scatter from the fire. The arms and feet are most prone to burns as they are more exposed; however, a few cases of burns are

Old and aged workers suffer from severe tremors of hands, even a few younger ones are seen with mild tremors in the fingers which may be due to metal toxicity as well as muscular fatigue because of the strenuous work pattern.

also observed on the palms, fingers, knees, and face. Small spots are seen on the palms and fingers of some workers.

Old and aged workers suffer from severe tremors of the hands, even as a few younger ones are also seen with mild tremors in the fingers which may be due to metal toxicity as well as muscular fatigue owing to the strenuous work pattern.

Table 24: Visible Health Problems of Workers

Category of workers	Years worked	No. of workers	Callus		Cuts				Burns						Spots	Tremors		No problem
			Palm	Fingers	Palm	Fingers	Hands	Feet	Palm	Fingers	Arm	Feet	Knee	Face	Palm/Fingers	Fingers	Hands	
Bell Metal	0-10	28	24	19	2		4		1		14	2			4	7		1
	10-30	38	33	29	6	5	8	1	1	2	14	6	1	1	9	25	1	
	>30	28	27	19	2	4	8	1	1	4	10	5			1	9	16	
Control Group	0-10	3					1											
	10-30	2																
	>30	1																

Major accidents are common among workers who have worked for at least 10 years.

Accidents

Major accidents are common among the workers who have worked for at least 10 years. These accidents take place during the stage where a group of 6-7 workers engage in collective and repeated beating of the vessel to give it shape. Apart from than the hands and lips, the forehead is also another body part which gets hurt either with one's own or a co-worker's hammer. Sometimes the wound is so severe that the skin gets ruptured and has to be stitched leaving behind permanent scars.

Table 25: Accidents Reported by Workers

Category of workers	Years worked	No. of workers	Major accidents during hammer use		
			Forehead	Hands	Upper lips
Bell metal	0-10	28			1
	10-30	38	8	5	
	>30	28	17	4	
Control Group	0-10	3			
	10-30	2			
	>30	1			

Eyes

The eyes are most affected by the direct impact of chemical agents such as metallic fumes and physical agents such as dirt, dust and particles. Poorly lit workplaces often put strain on the eyes which leads to watery eyes and poor eyesight. Normal eyesight, hypermetropia (long-sightedness), and myopia (short-sightedness) could be estimated through eye testing using the Snellen chart. Bell metal workers below ten years of

work, 39% (see Table 26) demonstrate normal eyesight, which decreases to 16% among 10-30 years of work, and touches a low 3% in the later years. With the increase in working years, hypermetropia and myopia rise from 7% to 30% to 57% and 11% to 24% to 50% respectively among the three groups. Watery eyes are a common symptom among the workers, which surges up from 57% to 71% and 93% with the increase in working years. Moreover, a few aged workers are also suffering from cataract, with some having undergone surgery to cure it.

Among Bell metal workers below ten years of work, 39% (see Table 26) demonstrate normal eyesight, which decreases to 16% among 10-30 years of work, and touches a low 3% in the later years.

Table 26: Eye Problems Reported by Workers

Category of workers	Years worked	No. of workers	Eye problems					No problem
			Hyper-metropia	Myopia	Watering	Strain	Cataract	
Bell Metal	0-10	28	2	3	16	5		11
	10-30	38	11	9	27	6		6
	>30	28	16	14	26	13	3	1
Control Group	0-10	3	1					2
	10-30	2	1	1				
	>30	1						1

Musculoskeletal Pains

Musculoskeletal pains are prevalent among Bell metal workers due to the uncomfortable posture adopted during work. Among workers of the first category, 21% of them (see Table 27) do not show any musculoskeletal problems, but this figure decreases to 8% and 7% in the medium and long term. Most of the workers are suffering from pain in the knee (46% to 86%), back (54% to 89%), neck (8% to 7%), legs (18% to 21%), and joints (4% to 14%), and these increase with increase in working years. The vigorous up and down motion of the hand while beating the vessel with the hammer leads to wrist (7% to 14%), elbow (21% to 29%), and shoulder (39%) aches, which also increases with the increase in years of work. A few workers also reported stomach pains, probably due to irregular and inadequate food.

Table 27: Pains Reported by Workers

Category of workers	Years worked	No. of workers	Pains										No problem
			Knee	Back	Arm	Neck	Wrist	Elbow	Stomach	Shoulder	Legs	Joints	
Bell Metal	0-10	28	13	15	11		2	6	2	11	5	1	6
	10-30	38	26	30	7	3	1	11	1	7	5	1	3
	>30	28	24	25	4	2	4	8	3	11	6	4	2
Control Group	0-10	3		2									
	10-30	2		1									
	>30	1		1						1			

Other Symptoms

Metallic dust on the back

In addition, other symptoms (see Table 28) reported by workers are cold, cough, breathlessness, and chest pain due to continuous exposure to dust and fumes at the workplace, which is inadequately ventilated. Itching and acne appears on the skin of the upper back due to metallic dust deposit (see picture) on the bare skin. Deafness is reported among the old workers and this may be due to the noisy environment. Other symptoms are hernia and high/ low blood pressure, low appetite and sleep, weakness, stomach upset, gastric and vomiting, and these may be related to the strenuous work environment with irregular food intake.

Table 28: Other Symptoms Reported by Workers

Category of workers	Years worked	No. of workers	Other Symptoms													
			Deafness	Cold	Cough	Breathlessness	Chest pain	Itching on skin	Acne	Less appetite	Less sleep	Weakness	Gastric	Stomach upset	Vomiting	Hernia	High/low BP
Bell Metal	0-10	28	2	2	7	4	1	14	3	1	1	2	5				
	10-30	38	1	2	18	7	2	14	3	3	4	1	15	1	1	1	
	>30	28	9	1	14	9	5	16	5	7	8	5	13			1	4
Control Group	0-10	3											1				
	10-30	2											1				
	>30	1											1				

Habits

Among those working for less than 10 years, 39% do not have any kind of addiction; the figures are 32% and 14% for those between 10-30 working years and above 30 working years respectively. The rest of the workers are habituated to chewing *paan*, *ghutka* and *tobacco*; smoking cigarette, *bidi* and *ganja*; and drinking alcohol and *bhang*. Chewing *paan* is quite common in the lower age groups. Workers said that consuming alcohol gives them a good sleep. Bhang, alcohol, and smoking aggravate their health problems. Yellow and brown pigmentation on the teeth are also seen among the older workers which may be related to excessive tobacco consumption.

The safety equipment is reportedly uncomfortable to work with, and a few who wear masks have to buy them at Rs. 50 per piece from the nearest market.

Table 29: Habits Reported by Workers

Category of workers	Years worked	No. of workers	Habits							
			Paan	Smoking	Tobacco	Alcohol	Ghutka	Ganja	Bhang	None
Bell	0-10	28	8	2		4	5	2	1	11
metal	10-30	38	18	6	2	5	2	3	3	12
	>30	28	13	8	7	1		1	1	4
Control	0-10	3				2				
Group	10-30	2			1					
	>30	1		1			1			

Safety Equipment

The workers wear only a trouser or a towel around the waist, and most of them prefer working bare-chested and barefooted because of the extreme heat from the furnace and the hot metal. Some prefer to use a thin cotton towel to cover their heads and wrists; very few use masks, goggles, or gloves. The safety equipment is reportedly uncomfortable to work with, and a few who wore masks had to buy them at Rs. 50 per piece from the nearby market.

Table 30: Safety Equipment Reported by Workers

Category of workers	Years worked	No. of workers	Safety equipment					
			Caps	Mask	Towel on head	Towel on wrist	Goggles	Gloves
Bell metal	0-10	28	1	2	9	2	2	2
	10-30	38		2	12	1		1
	>30	28		4	13	1		

7.5 Safety Recommendations

General Health

Work pattern of bell metal workers is extremely strenuous, starting at three o'clock in the morning in summers and lasting till one o'clock in the afternoon. For the improvement of body mass index, the workers need to take rest at periodic intervals during their working hours and have access to nutritional food and clean water.

Pulmonary Health

The most prevalent hazard in this type of industry is metallic dust which causes pulmonary health disorders. Our observations show that only 10 out of 94 workers

Proper protective clothing and footwear are required to prevent cuts and burns.

have normal lung function. In fact, the workers work in closed environments where all the processes take place together; the whole working population is thus exposed to the metallic fumes, vapours, and dusts rendering them vulnerable to respiratory problems. The precautions to be taken in such situations are: (a) install exhaust systems which ensure proper ventilation in the sheds and a regular supply of fresh air; (b) segregate processes like smelting which emits fumes from the other processes, so that all the workers are not exposed at a time; (c) conduct periodic medical check-ups of all workers, to identify the early signs of pulmonary distress; (d) introduce regular rest periods during working hours to let workers regain strength and continue work safely; and (e) craft workers could wear personal protection gears such as masks to protect them from metallic fumes and dust. However, we do not recommend the last point as wearing masks impedes workers' efficiency, and also the masks are expensive.

Visible Symptoms

Almost all the workers have visible symptoms of callus formation on the hands due to continuous beating of the vessel with a hammer. A periodic medical check-up is necessary as the workers often cut the calluses with razor blades unintentionally inviting infections in the process. Proper protective clothing and footwear is required to prevent cuts and burns.

Eyesight

More than half of the workers have measurable short or long sight and reported watery eyes. Our observations at the work place suggest that there is a lack of adequate lighting in most of the sheds and less exposure to air. It is most necessary, therefore, to redesign or retrofit the sheds to ensure better natural lighting and air in regular working hours, and sufficient artificial lighting during the other periods. Regular breaks from work that enable the eye muscles to avoid fatigue, and the redesign of the working space to enable work to be done within the normal vision range would offer further relief to the workers as also improve the quality of the work.

Body Pains

Musculoskeletal pains are prevalent among the workers, and our observations show that only 11 workers are free from body pains. These are clearly linked to the constant movements of the body required during work. Once again, regular rest periods to avoid fatigue is the recommended safety measure, but this should be accompanied by a study of the work process to develop ergonomic designs, and regular check-ups that dictate rotation of jobs and tasks to prevent repetitive motions causing stress to a particular set of muscles.

It is most necessary, to redesign or retrofit the sheds to ensure better natural lighting and air in normal seasons, and sufficient artificial lighting during abnormal periods.

Other Symptoms

Other symptoms reported by the workers such as cold, cough, breathlessness, chest pain, itching and acne may be due to continuous exposure to metallic dust and fumes;

deafness is seen among the old workers due to prevailing noisy environment; other symptoms like loss of appetite and sleep, weakness, stomach upset, gastric problems and vomiting is reported due to strenuous work environment with irregular food intake. Personal protection is, of course, a possible solution but we do not recommend this as it does not permit the worker to function with ease; hence, all hard surfaces need to be appropriately cushioned while chemicals should be handled with proper equipment. The use of noise dampeners and proper ventilation would also be useful in reducing the hazards.

Habits

Chewing *paan*, smoking and drinking alcohol are common habits of the workers. The reasons stated for the addictions are: relief from the hard work, good sleep in the case of alcohol consumption etc. So, it is imperative to inform the workers about the long-term health consequences of their dependence on these addictions that, in any case, provide only short-term relief.

7.6 Environmental Status

Manufacturing of Bell metal involves smelting of scrap which releases copper and zinc fumes in the air, minute metal particles are also released during the scraping of vessel. Copper fumes and dusts remain floating in the atmosphere for a long time until they settle on soil after rain. Once it reaches the soil, copper gets attached to organic matter and minerals. As it does not break down in the environment, it gets accumulated in plants and animals. A soil rich in copper cannot support many plants; copper interrupts the activity in soils, making the survival of micro-organisms and earthworms quite difficult. The result is a slowdown of organic matter decomposition. That is why there is not much plant diversity near copper-utilising industries; in fact, Balakati does not have any farmland in its vicinity. This may be one reason why the villagers here have not taken to agriculture as a subsidiary occupation.

8. Dhokra metal craft in Ransinghpur, Badparpur, Orissa

8.1 Background

India is credited with the creation of brass over 2 centuries ago by fusing copper and zinc in a particular proportion.

India has a rich metal craft tradition dating back to about 3rd century BC Among some other alloys, India is credited with the creation of brass over 2 centuries ago by fusing copper and zinc in a particular proportion. Every state has its own tradition of casting metal into various forms depending on the availability of raw materials, weather conditions, and local skills in metal craft. Metal was considered to be a superior base resource due to its permanence, and as it had to be 'purified' in fire before being turned into articles of daily use, jewellery, or figures of deities. While metal work can be seen in true splendour in the various temples and the ubiquitous gold and silver jewellery, some metal crafts that are used to create artefacts for home use have found their patrons in the urban homes today.

Metal craft in Orissa is one of the oldest crafts with some truly indigenous designs emerging from its craftsmen's skills. The metal craft in Orissa can be divided into 2 broad categories: Bell metal and brass work; and the more famous antique looking Dhokra work. Bell metal and brass work are carried out throughout the state to make numerous religious and household utensils. The traditional Dhokra work is typically a tribal craft in brass with its mesh-like features giving it a distinctive beauty. Dhokra is practiced largely by the tribal families in Sadeiberini, a village near Dhenkanal town. Other tribes practicing this beautiful craft are the Situlias and the Khoduras.

Dhokra art is one of the earliest known methods of non-ferrous metal casting known to human civilisation.

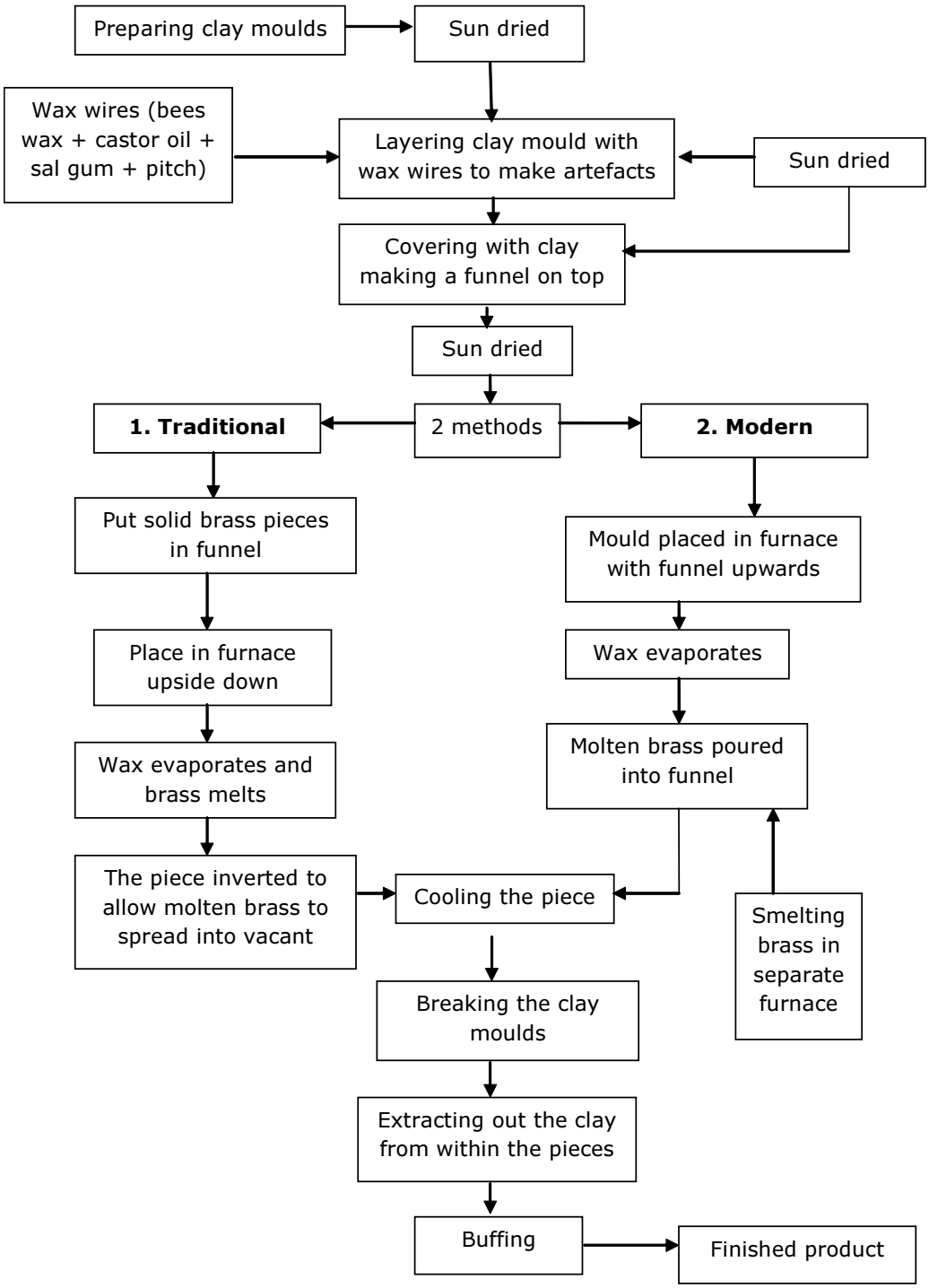
Dhokra art is one of the earliest known methods of non-ferrous metal casting known to human civilisation. This form of metal casting is popular because of its primitive simplicity. Dhokra Damar tribes are the traditional metal smiths of West Bengal and they live in regions extending from Bihar to West Bengal, Orissa, and Madhya Pradesh. It is an important handicraft because of its more or less exclusive folk character. These tribes in Bihar, Orissa, and West Bengal are distant cousins of the clan in Madhya Pradesh. All of them, perhaps, belong to a tribal group of that area. The Dhokra metal casting uses the lost-wax technique that was probably used by the Mohenjodaro craftsman to cast the bronze figurine of a dancing girl some 4500 years ago. It is this continuity of tradition coupled with the intrinsic starkness and vitality of the art form that makes Dhokra a coveted collector's item in India and abroad for connoisseurs, scholars, and laypersons alike. The skill of Dhokra craft making is passed on from one generation to another and the craftsmen become experts in it, but it remains largely unorganised and rural based. It is a home-based industry involving all the members of the household. The crafts workers face restraints of weak institutional frameworks, low income, and little exposure to new technologies.

The Dhokra metal casting uses the lost-wax technique that was probably used by the Mohenjodaro craftsman to cast the bronze figurine of a dancing girl some 4500 years ago.

8.2 Process

Dhokra craftsmen are artists first and metal workers later. It is bees-wax and not metal that permits them to give material shape to the creative images they form in their minds.

Flowchart for Dhokra Metal Craft Process



Steps in the Process of Dhokra Craft

The craft of Dhokra is prepared by using scrap metal-a truly eco-friendly way to create works of art that are functional too. The process of casting is called Lost Wax Process, also known as cire-perdue. There will always be minor differences in every piece as they

The craft of Dhokra is prepared by using scrap metal-a truly eco-friendly way to create works of art that are functional too.

are hand crafted and processed. This process derives its name from the procedure where the wax is lost and replaced by molten brass. Care, precision, time and above all artistic ability are vital ingredients to create works of art through the lost-wax process. The process shows that though the images might be of the same form, no two pieces can be the same because the mould has to be broken to retrieve the final product. So, despite similarities, each piece is unique in itself.

Core Making: A basic structure of the desired design is made with clay and left to be dry in sun till the clay hardens.

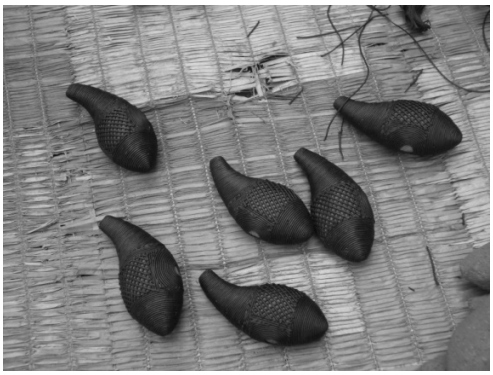
Wet clay

Clay moulds

Modelling with wax wires: Dough of wax is made by heating and filtering a mixture of Bees wax (1 Kg), Castor oil (100 grams), Sal gum (200 grams) and pitch (400 grams) using cloth. This mixture is then re-heated and converted into wax wires (strips) by using a device called an extruder. In the summer these wax wires are dipped in water so that they do not melt due to heat. These thin molten wax wires are used to make detailed designs/ artefacts on the clay moulds which are then left to dry in the sun.

Working of the extruder to make wax wires

Wax wires dipped in water



Artefacts made with wax wires

Moulding: : A second layer of clay is used to cover the wax image so that the clay acquires a detailed form from the wax model. At this stage, a funnel is made on the structure to allow the molten metal to seep in and an opening is also left to allow break-off of the hardened clay later.

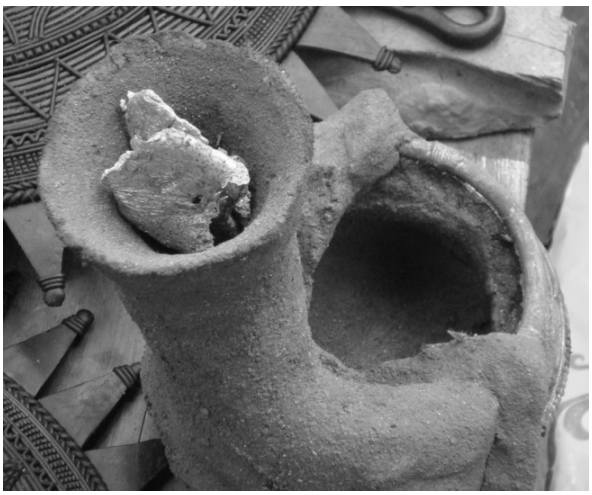
Wax image with second layer of clay

Funnel made on top of the structure

Opening left in the structure

Casting: After the piece dries, there are two methods of casting it.

- **Traditional method:** In this, the solid brass pieces are placed in the funnel of the mould and capped with clay. The piece is then placed upside down in the furnace for about 2-3 hours. When blue flame appears from the furnace, it implies that the brass has melted and the wax has evaporated. Then the piece is inverted using iron tongs or bamboo tongs so that the molten brass runs into the vacant spaces. It is then taken out from the furnace and left to cool.



Solid brass pieces being put in the funnel

This piece (left picture) is placed in the furnace (right picture) upside down

Piece being inverted using bamboo tongs

- **Modern method:** In this, two furnaces are used simultaneously. In one, the mould is placed with the funnel upwards and in the other, smelting of brass is done by placing solid brass pieces in a ceramic *kui*/crucible which is placed in the furnace. When wax evaporates from the clay mould in the first furnace, it is taken out and molten brass from the ceramic *kui* is poured into the funnel using a ladle and the piece is left to cool. Leakages, if any, are plugged with wet red clay.

Mould is placed with the funnel upwards

Smelting in a separate furnace

Molten brass being poured in funnel using ladle

Cooling: After cooling, the clay moulds are broken using a small hammer to reveal the raw piece.

Clay mould being broken with small hammer

Finishing: The clay from within the piece is extracted out through the opening left in the piece.

Raw piece after extra clay has been extracted

Buffing: The piece is then given a polished finish.

Final product with antique finish after buffing

8.3 Observation of Hazards

- There is considerable smoke and soot from the furnace, and the workmen are often covered with particles as they do not wear clothes on the upper body while working. They also inhale metallic fumes which are released during casting. Metal accumulation in the body generally attacks the nerves causing tremors and anxiety.

Metal accumulation in the body generally attacks the nerves causing tremors and anxiety.

- All processes, except casting, are done in the open. Since it is a home-based industry, all toxins get spread around the house creating an unhealthy environment for the younger generation.

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- Working continuously with clay and wax result in drying and blackening of skin. The tiny particles may remain attached to the hands, even after washing, and get ingested along with food.

- No footwear is worn during casting, thus exposing the workmen to frequent burns and boils on their feet.

- General aspects of strenuous manual work like stooped sitting posture and long working hours contribute to increasing incidence of eye strain and body ache. Absence of safety equipment also adds to the occupational health hazards.

8.4 Status of the Craftworkers

In the two villages visited, the team was able to interview and measure the selected health parameters of 90 artisans. All of them are involved in all stages of the process of Dhokra craft. For comparing the occupational health status, the workers have been divided into three categories depending on the number of years they have been in

the craft. This has been shown in the table below.

Years worked	No. of workers
0-10 years	20
10-30 years	47
More than 30 years	23
Total	90

Body Mass Index

The BMI of the workers (see Table 31) indicates that 59% of the total workers are underweight and only 40% are normal. Amongst the underweight workers, the maximum proportion (78%) is of those who have been working for more than 30 years, indicating that the more the working years, the higher is the deterioration in health. This may be attributed to inadequate nutrition and increasing pressure of work. Of the workers who have been in the craft from 10-30 years, 49% have normal BMI.

Table 31: Body Mass Index of Workers

Years worked	No. of workers	Interpretation of BMI		
		Underweight	Normal	Over weight
0-10years	20	12	8	0
10-30years	47	23	23	1
> 30 years	23	18	5	0
Total	90	53	35	1

Pulmonary Function Test

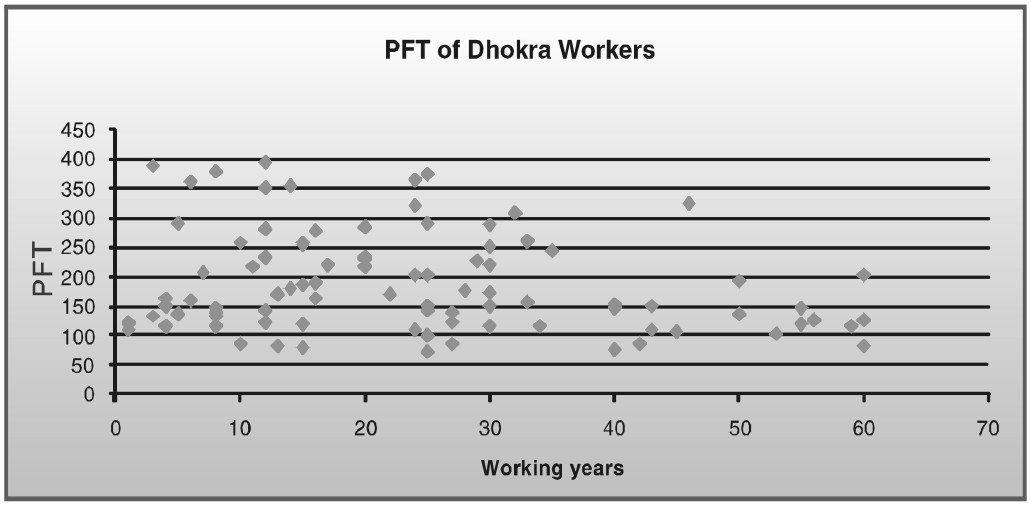
The result of the measurement of PFT (see Table 32) is a cause for much concern. Only 9% of the total workers tested have a lung function that would be considered normal for an adult. While 31% have asthmatic tendencies, 60% show signs of chronic distress. Among those in the 0-10 years working period, 15% of the workers have shortness of breath; this grows to 40% as the working years increase from 10-30 years, although it decreases to 26% in the long term. The incidence of chronic bronchitis increased from 70% (in the 0-10 years working group) to 74% in the long term, and the incidence of chronic bronchitis at such an early age is indeed disturbing. In a nutshell, all the workers are being exposed to metallic fumes and high temperatures, making the work environment hazardous and unfavourable for their health.

Table 32: Pulmonary Function Test of Workers

Years worked	No. of workers	Pulmonary Function Test		
		Normal	Asthmatic Tendency	Chronic Bronchitis
0-10years	20	3	3	14
10-30years	47	5	19	23
More than 30 years	23	0	6	17
Total	90	8	28	54

The incidence of chronic bronchitis increased from 70% (in the 0-10 years working group) to 74% in the long term

Chart 4: Lung Function Test with respect to Working Years for Dhokra Workers



Eye Strain

Apart from the effects on the body and lungs, the repetitive work and the continuous visual attention to detail also seems to have an impact on the eyes of the workers (see Table 33). Normal eyesight, hypermetropia (long-sightedness), and myopia (short-sightedness) could be estimated through eye testing using the Snellen chart. The 60% demonstrating normal eyesight in the short term (0-10 years) decreases to 38% as the working years increase over 10 years, and it further decreases to 4% as the working years increase to more than 30 years. The proportion of people suffering with hypermetropia increases from 10% to 38%, and finally to 91%, indicating that as the working years increase there is increasing pressure on the artisans' eyesight. Similar trends are visible in the case of myopia for which the proportion of people suffering with it increased (5% to 10%, and to 61%) with the increase in working years. In addition, a few of the artisans also reported problems of watering, strain and night blindness largely due to the smokes and fumes in the workplace.

Table 33: Eye Problems Reported by Workers

Years of working	No. of workers	Eye Problems						
		Hyper metropia	Myopia	Watery	Strain	Cataract	Night Blindness	No Problem
0-10years	20	2	1	7	2	0	0	12
10-30years	47	18	5	13	9	0	2	18
More than 30 years	23	21	14	14	9	0	2	1
Total	90	41	20	34	20	0	4	31

Muscular Pains

Many of the workers also reported muscular pains (see Table 34). Only 15% (14/90) of the workers seemed to have no muscular pains and, within that also, the maximum proportion is of the workers who have worked from 0-10 years. The proportion of workers with pains in knee, back, shoulder, and neck increased with the increase in working years. This can be attributed to the strenuous nature of work and long working hours. Their stooped sitting posture is another reason for back pain. Other pains reported by the workers are pain in the arm, elbow, legs, joints, and toes; these may be because of working continuously with clay and wax, using the extruder to make wax strips (which requires a lot of muscular pressure), and long hours of standing without footwear. The increase in back ache may also be due to the daily routine involving going uphill to get wood for household use and for selling in the market.

Table 34: Pains Reported by Workers

Years worked	No. of workers	Pains										
		Knee	Back	Arm	Elbow	Stomach	Shoulder	Legs	Joints	Neck	Toe	No Problem
0-10years	20	6	11	3	3	4	3	3	3	6	3	8
10-30years	47	23	37	3	3	10	11	8	3	22	5	5
More than 30 years	23	22	22	13	12	13	15	16	12	15	12	1
Total	90											

Habits

Many of the workers are saddled with addictions to certain products such as paan, opium, bhang, tobacco as shown in Table 35. Only 8% of the workers have no addiction, while the remaining 92% are addicted to more than one product. About 15% of the workers take opium and 10% take bhang; these are taken as painkillers during illnesses as they have the effect of blocking the nervous system. Most of them have the habit of chewing tobacco, guthka and ganja at work. Alcohol is consumed during the night for a good sleep. In some cases, the addiction for ganja is so extreme that individual workers consume it about 10-12 times a day. Largely, it is the nature of the work that increases fatigue and strain on the body, thereby pushing people towards addictions.

Table 35: Habits/Addiction

Years worked	No. of workers	Habits								
		Paan	Smoking	Tobacco	Alcohol	Gutkha	Ganja	Opium	Bhang	None
0-10 years	20	5	0	12	4	9	2	0	0	3
10-30 years	47	17	2	30	21	5	7	6	5	3
More than 30 years	23	7	3	14	11	2	4	7	4	1
Total	90									

8.5 Visible Health Problems

Some visible impacts include callus, hardness, spots, cuts, burns, tremors and skin problems (see Table 36 (a) and 36 (b)). Only 9% (8/90) of the workers do not have any of the visible impacts. The incidence of hardness on palm shows an increasing trend from 25% to 64%, and to 73% over the working years, and this is due to the tremendous pressure required for working the extruder (device used to make wax strips), and other equipments such as crucible and tongs for performing the craft. The blackness on palm is primarily on account of working continuously with clay and wax. The incidence of spots also increases with the increase in working years. Cuts are also visible, and they are usually due to logging wood. Burns are prominent as casting is done in the sheds and the workers do not wear footwear while working (as they worship the furnace). A large proportion of workers show tremors, both mild (fingers) and severe (hands). Some of them also complain about itching on skin and eczema as their skin comes in constant contact with the metallic fumes.

Table 36 (a): Visible Health Problems

Years worked	No. of workers	Burns							Tremors		Skin		None
		Palm	Dorsum	Feet	Chest	Fingers	Knuckles	Knee	Fingers	Hands	Itching	Eczema	
0-10 years	20	0	1	1	0	0	1	0	9	0	0	1	6
10-30 years	47	5	4	7	0	2	2	1	35	2	5	1	2
>30 years	23	1	4	6	1	3	2	0	10	12	3	3	0
Total	90												

The incidence of hardness on palm shows an increasing trend from 25% to 64%, and to 73% over the working years, and this is due to the tremendous pressure required for working the extruder (device used to make wax strips), and other equipments such as crucible and tongs for performing the craft.

Table 36 (b): Visible Health Problems

Years worked	No. of workers	Palm			Spots		Cuts					
		Callus	Blackness	Hardness	Palm	Fingers	Palm	Knuckles	Fingers	Hand	Feet	Dorsum
0-10 years	20	6	0	5	8	0	0	0	0	1	0	0
10-30 years	47	13	3	30	28	1	1	1	4	5	1	1
>30 years	23	7	5	17	11	1	3	1	4	1	1	1
Total	90											

Other Symptoms

Other reported symptoms (see Table 37) include cough, breathlessness, and chest pain, thus explaining the reason for the high proportion of people with chronic bronchitis. Low appetite, problems in sleeping, and weakness are largely due to long working hours. Most of the work is done in the open with only casting being done in sheds made for the purpose. The workers continuously inhale metallic fumes and smoke from the furnace. Most of the workers have a case history of fever and typhoid due to consumption of contaminated water and lack of proper sanitation facility. They drink water from a tube well; water for other uses is taken from the natural spring which flows from the mountain. They have stained teeth due to the continuous chewing of tobacco, *paan*, and *guthka*. Regular exposure to heat and smoke is the reason for incidence of skin pigmentation.

Table 37: Other Symptoms Reported by Workers

Years worked	No. of workers	Other Symptoms												
		Hearing problem	Cough	Breathlessness	Chest pain	Less appetite	Less sleep	Weakness	Fever	Gastric problem	Typhoid	Stained teeth	Pigmentation	No problem
0-10 years	20	1	7	2	5	6	4	8	8	3	0	0	0	5
10-30 years	47	6	14	3	14	11	8	10	22	15	2	6	4	4
>30 years	23	10	10	6	10	7	8	6	14	10	2	6	5	0
Total	90													

Dhokra craft is a home-based industry; thus, none of the workers have access to social security facilities like Employees State Insurance and Provident Fund.

8.6 Safety Recommendations

General Health

For the improvement of the body mass index, our findings suggest that regular work with security over time, regular eating habits, and incomes that enable the workers to sustain themselves and their families may be the most crucial element.

Pulmonary Health

The fact that only 8 workers had what is considered to be a normal lung function points to a severe hazard present in the industry. The workers are widely affected by the metallic fumes and high temperatures from the furnace. The problem worsens as the workers neither wear any clothes on their upper bodies nor do they cover their mouths during casting. Suggesting safety equipments is not justified as it obstructs their work. Hoods over the furnaces, and better ventilation and exhaust systems, along with better designed furnaces that improve combustion and seals that keep the molten metal within the moulds, would be preferable.

Eyesight

What is a cause for concern is the decrease in the proportion of workers with normal eyesight with the increase in working years. A similar trend for other eye problems indicates that there is a need to provide them with safety glasses and visors which can prevent particles and vapours from directly coming in contact with the eyes. Regular breaks from work that enables the eye muscles to avoid fatigue and rotation of work (so that the same person is not always near the furnace) would offer further relief to the workers as also improve the quality of the work.

Muscular Pains

Pains in the back, knee, shoulders, and neck are the most common occurrences. These are clearly linked to the postures adopted during work. Once again, regular rest periods to avoid fatigue are the recommended safety measure, but these should be accompanied by regular check-ups that dictate rotation of jobs and tasks to prevent repetitive motions causing undue stress to a particular set of muscles.

Habits

Workers take to consuming alcohol or opium for their numbing effect, without considering the harmful impact on their health. This needs to be rectified through awareness building and proper information provision. In addition to training for work, the workers should be given regular briefing and training on health.

It is important that workers are educated about the health hazards and regular health check-ups are conducted to take care of frequent illnesses.

Visible Health Problems

Callus on hand, hardness of palm, spots, cuts, burns, tremors, and other skin problems are reported by the workers. The most efficient way of avoiding these is to use safety equipments like gloves while working; however, these are not generally recommended as they prevent the worker from functioning with ease. Breaks from work and regular health check-ups can provide some relief. In addition, the design of the equipment and tools and materials used need to be studied in detail to recommend how repeated contact with hard surfaces may be avoided.

Other Symptoms

Symptoms like cough and breathlessness can be partially taken care of through rest from work and rotation of tasks. Gastric problems and acidity can be addressed by encouraging workers to eat at proper timings and maintain balanced diets. Cases of malaria and typhoid can be brought down if the workers are trained how to eliminate mosquito breeding grounds, promote better sanitation, and purify drinking water using chlorine tablets. Therefore, it is important that the workers are educated about the health hazards and regular health check-ups conducted to take care of the frequent illnesses.

8.7 Environmental Status

The scale of the production units is too small and the emission of air and water pollutants too limited for there to be any significant environmental impact. The only cause for environmental concern would be the possible escape of metallic wastes; this can simply be eliminated with better housekeeping and recovery since the metal is also a valuable raw material.

9. Ikkat Textile Craft in Nalgonda, Andhra Pradesh

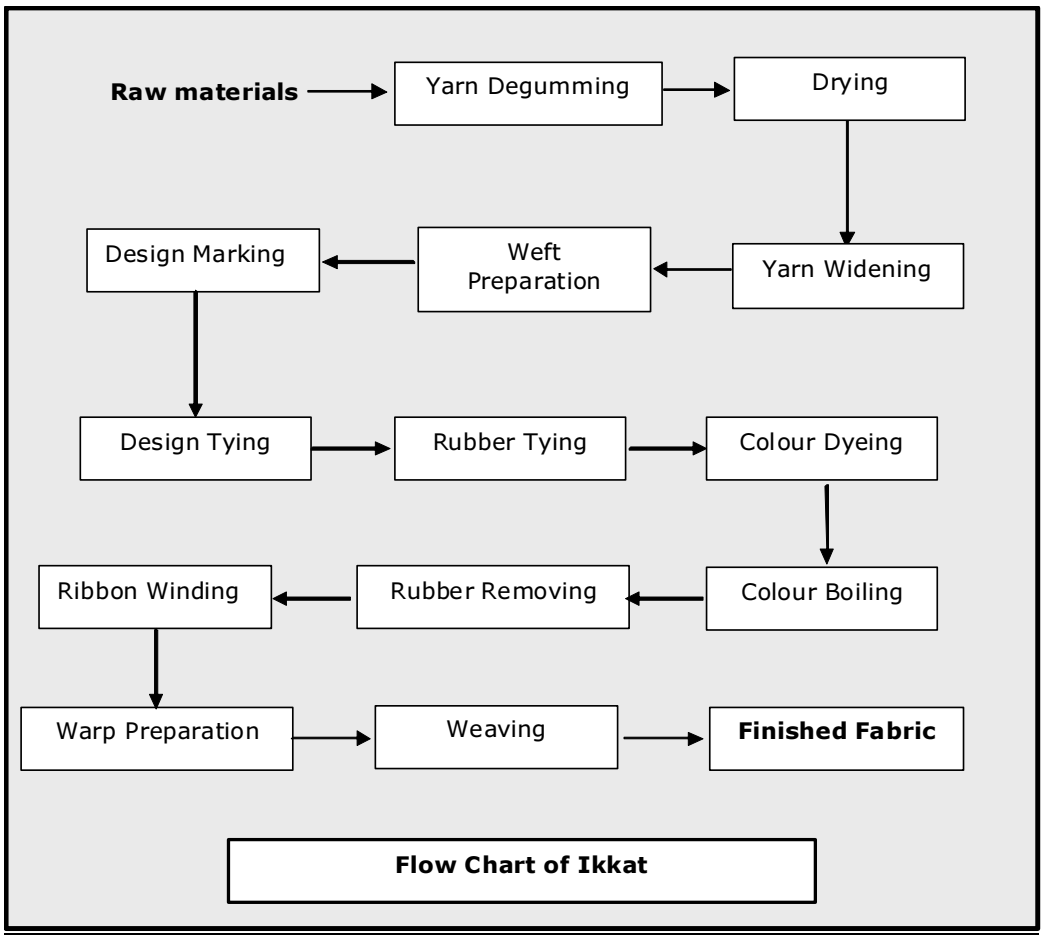
9.1 Background

Pochampally is a small town in Nalgonda district of Andhra Pradesh, a handloom cluster that has been known for its unique Ikkat design for centuries. It is also known as a centre for handloom silk sarees, being developed over the past sixty years. Pochampally textiles attained fame right from 1900, when artisans with their creative skills started manufacturing tie-and-dye Rumals (handkerchiefs) and scarves such as the renowned Asia Rumals, Sobiyani Rumals, and Jananilu. At that time, these scarves were popular not only in and around Hyderabad but were exported to Pakistan, Afghanistan and other Arab countries, where they were mostly used as Keffiyeh/ Shemagh/ Ghutra-a traditional headdress typically worn by Arab men. By the time the Nawab's rule came to an end in 1948, the handloom business of Pochampally was in distress because of the collapse of the Hyderabadi business elites. But in the first Five-Year Plan (1950), handlooms were given priority after agriculture, and weavers started working under a co-operative society in Koyalagudem, which is 20 kms away from Pochampally. The difficulty in bringing raw materials and delivering finished products to and from Koyalagudem persuaded the weavers to open a branch at Pochampally in 1952; in 1960, it became an autonomous society and came to be known as the Pochampally Handloom Weavers' Co-Op. Society Ltd.

After that, artisans made a concerted effort to weave tie-and-dye sarees, which gained popularity, and slowly Pochampally developed as India's centre of handloom silk. Currently, there are about 5000 weavers who are basically Hindus of the Padmasali or Devang communities; having taken up residence in the area for long, they adopted the local dialect and social norms. They produce Ikkat textiles with geometrical designs, but have also recently started experimenting with all-Indian styles. In principle, Ikkat or resist dyeing, involves the sequence of tying (or wrapping) and dyeing exposed sections of bundled yarn to a pre-determined colour scheme prior to weaving. The patterns formed on the yarn are then configured into the woven fabric. The designs in various colours may be formed on the fabric either by warp threads or weft threads (single Ikkat) or by both (double Ikkat). In single Ikkat, the tie-and-dye warp or weft threads are positioned accurately on the woven fabric through a pre-determined sequence of weaving. In case of double Ikkat, not only are the warp and weft threads individually positioned, but the relative position of each is also accurately ensured to give the final design. In these textiles, the forms are deliberately feathered so that their edges appear hazy and fragile, by the use of incredibly fine count yarn, tied and dyed in very small sets. Increasing the number of colours for bringing out the figures increases the number of tying and dyeing operations.

9.2 Process

Manufacturing Process of Ikkat



Raw Materials

Yarn consisting of several strands of material twisted together is the raw material used for preparation of Ikkat. Each strand is made of short fibres that are spun into longer filaments to make the yarn. Long continuous strands may only require additional twisting to make them into yarns. Sometimes they are put through an additional process called texturing. The characteristics of spun yarn depend, in part, on the amount of twist given to the fibres during spinning. A fairly high degree of twist produces strong yarn; a low twist produces softer, more lustrous yarn; and a very tight twist produces crepe yarn. Yarns are also classified by the number of parts. A single yarn is made from a group of filament or staple fibres twisted together. About 15 different types of fibres are used to make yarn. These fibres fall into two categories: natural and synthetic. Natural fibres are those that are obtained from a plant or an animal, and are mainly used in weaving textiles. The most abundant and commonly used plant fibre is cotton, gathered from the cotton boll or seed pod when it is mature.

Yarn Degumming: This operation is done for the removing fats and oils (gums) from the yarn. The various methods for degumming are as follows.

- Water degumming
- Acid-water degumming
- Acid-base degumming
- Enzymatic degumming
- Chelate/ detergent degumming

The artisans of Pochampally follow the water degumming process in which a water bath is heated to a temperature of about 70-90 C by burning firewood; subsequently, the yarns are dipped and washed in the bath with the help of a bamboo.

Water Degumming

In most of Nalgonda District, the ground water is contaminated with high levels of fluoride; hence the water is pre-treated with fluoride removal process as the dissolved minerals could interfere in the degumming process.

Drying: After degumming, the yarn is hung on a bamboo pole for complete drying under a shelter as sun-drying can affect the colour of the yarn. The drying takes several hours for completion, depending upon temperature and humidity conditions.

Drying of Yarn

Yarn Winding: Winding is a process in which an evenly tensioned thread is made from skeined filaments that are drawn onto a hand turned wooden frame or cage-spool. The artisans of Pochampally use a hand-operated winder for winding the yarn. First the

skein of yarn is tightly fixed in a wooden wheel from which the yarn is wound onto a piece of PVC pipe which is attached to a rim. Thus by rotating the rim with a hand pedal, the yarns are wound from the skein of yarn. Generally, women are engaged in the winding process.

Yarn Winding

Weft Preparation: From the winding ball, the yarns are then horizontally coiled into a bunch of yarns called weft preparation. The weft is prepared by wrapping it around two rods, which are inserted into a beam stretched according to the required width. The groups of weft are separated by inserting thick-twisted cotton threads between them. Most of the artisans follow the manual process for weft preparation which is very tedious work; they can produce only 10-12 wefts in a day. However, some of the artisans use an automatic machine called the ASU MACHINE invented by Chinthakindi Bros. The machine can produce hundreds of weft in a single day.

Manual and Machine weft preparation

Design Marking: First, the pattern which is to be designed is plotted on a graph sheet; weft threads are then marked with pen or pencil on the borders of the portions which are to be dyed.

Great precaution has to be taken for measuring the length and breadth of each coloured section from the graph sheet as the accuracy is essential for well-designed and appealing products.

Design Marking

Design Tying: After marking, wefts threads are tied with the help of threads in the marked portions.

Design tying

Rubber Tying: The wasted tubes of bicycles are used for tying as they are easily available and also allow more firmness in tying.

The tubes are cut into elongated forms and wrapped onto the portion of weft threads where dyeing is not required, and the portion to be dyed is kept open. This wrapping process prevents the penetration of dye into the covered yarn.

Rubber tying

Colour Dyeing: There are two processes of dyeing- Naphthol and Vat dyeing- according to the requirement of yarn that is to be dyed. For cotton yarn, Naphthol and base are used for dyeing. The Naphthol is pre-mixed with caustic soda and the base is prepared by mixing alum, hydrochloric acid and sodium nitrate. The base is used for the

Colour Dyeing

Today, synthetic dyes are used in most of the places.

fixation of colour on the yarn. The process of Vat dyeing is used for silk yarns. In Vat dyeing, a mixture of synthetic powder, soda-ash, acetic acid, and water is used.

Once marked out and wrapped with rubbers, the opened portions of weft threads are hand-dipped in the dye bath. Three days and about 30 litres of dyeing water are required for the completion of a single Saree. The number of tying and dyeing operations increases with the number of colours to be used for a particular design. Initially, the dyes are extracted from a variety of natural resources: red dyes from cochineal insect or madder root; green from seed pods and flowers of the pagoda tree; yellow from delphinium flowers; and saffron and pink from brazil-wood etc. But today, synthetic dyes are used in most of the places.

Colour Boiling: After tying and dyeing, the wax is removed by boiling, and this gives a multi-coloured and motif piece of art fabric.

Colour boiling

Rubber Removing: After boiling, the rubbers are removed from the wefts and the threads are straightened; the process is repeated with a different colour of dye.

Rubber removing

Bobbin winding

Bobbin Winding: TThe yarns are then wound on a Bobbin by using the spinning wheel.

Earlier hand-made spinning wheels were used but today, to minimise labour, a motor is attached to rotating wheel.

Warp Preparation: This is an operation where the yarn is transferred from single packages to an even sheet representing hundreds of ends and then wound onto a warp beam. There are two types of warping:

a) Direct Warping: Warp is wound directly onto section beams; this is used predominantly in preparing yarn for warp knitting and weaving.

b) Indirect Warping: Here, either warp is wound in bands onto a patted drum and then used for fancy pattern warps or creel capacity is transferred onto a beam in a separate operation.

Warp preparation

Weaving

Weaving: Finally, weaving is done with the help of a foot-treadle floor loom. In general, the supporting structure of the loom is called the frame. It provides the means of fixing the length-wise threads, called the warp, and keep them under tension. The warp threads are wound on a roller called the warp beam, and attached to the cloth beam which will hold the finished material. Because of the tension the warp threads are under, the cloth beam needs to be strong.

The thread that is woven through the warp is called the weft, and it is woven using a shuttle in which a bobbin is placed. Alternating sets of threads are lifted and lowered by connecting them through string or wire loops called heddles to another bar, called the shaft (or heald bar). Heddles, shafts, and the couper (lever to lift the assembly) are called the harness. It can be mechanically operated using either foot- or hand-operated treadles. After passing a weft thread through the warp, a reed comb is used to beat (to make it compact) the woven weft.

To prepare to weave, the warp must be made. This is done by hand with the help of a warping board. The length of the warp is about a quarter to half a yard more than the amount of cloth needed. Warping the loom means threading each end through an eye in a heddle and then sleying it through the reed. The warp is set (verb) at 10 ends per inch. It then has a set (noun) of X ends per inch. The weft is measured in picks per inch.

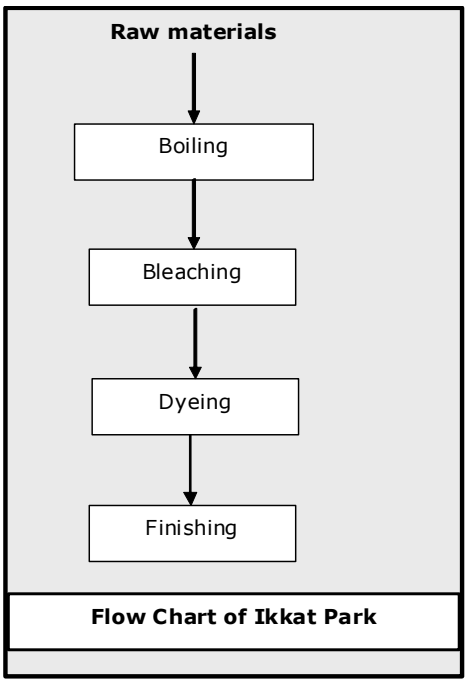
Process of Ikkat in Pochampally Handloom Park

The Handloom Park of Pochampally covers an area of 24 acres, and is the first in India that is conceptualised under Public-Private Partnership. It has provision for 2000 technologically-upgraded looms with a production capacity of 40 lakh metres per

The Handloom Park of Pochampally covers an area of 24 acres, and is the first in India that is conceptualised under Public-Private Partnership.

annum. The employment capacity of the Park is around 5000. Most of the construction of infrastructure such as ETP and STP is yet to be completed but the Park began operations 2 years ago. Currently, around 300 workers from different parts of Nalgonda District work in the Park with an average daily production of around 300 metres. The monthly wages varies from Rs. 1800 to 3500.

The processes are quite similar to the traditional methods, except for some mechanisation.



Flow Chart of Ikkat Park

Step I and II: Boiling and Bleaching: There are 5 chemicals that are used for boiling and bleaching purposes: Wetting agents, Soda-ash, Caustic soda, Hydrogen peroxide, and Acetic acid.

Wetting agents are anionic in nature, and are used to prepare the desired softness in water.

Then washing is done with the help of Soda ash.

The Caustic soda, generally used for cotton fibres, removes the wax by the action of saponification.

Hydrogen peroxide acts as an oxidising agent which reacts in neutral solution (pH 6-7).

But it increases the alkalinity of the water which is later on adjusted using Acetic acid.


Dyeing machine

Step III: Dyeing: Hank dyeing machines are used for dyeing yarns. A few grams of dye powder are used per litre to make required concentrations. The process takes 5-6 hours for completion of dyeing. Additives to promote the dyeing process, such as acids, are also used. By adjusting the input valves, dye liquor can be pumped in at a controlled rate. Thus, dyeing is done mechanically.


Finishing

Step IV: Finishing: Finishing includes washing the dyed yarn several times with water after soaking so that all the extra chemicals and dyes are extracted from the yarn. The operations are done manually in

the Park. Once the yarn is dry, it is ready for weaving in looms with warp and weft preparation as described earlier for traditional processes.

The weavers who work under the Cooperative Society enjoy welfare schemes.

9.3 Status of the Craftworkers

In the 3 villages visited, the team was able to interview and measure the selected health parameters of 106 workers. Of these, 59 artisans are engaged in tie-and-dye operations, while 47 are in weaving.

Overall, there are three types of workers in Pochampally:

1. *Workers under Cooperative Society:* The weavers who work under the Cooperative Society enjoy welfare schemes. Earlier, the materials produced from the Cooperative Society were sent to the US, UK, Japan etc. But in the last 10 years the exports have declined as clients reportedly complain of itching problems from Ikkat products.
2. *Workers under a Master Weaver:* This is like a private body where workers are kept on a daily or monthly basis. The Master Weaver purchases all the raw materials and guides the workers for fabrication and marketing.
3. *Independent Weavers:* These are individual weavers who do all the work, from purchasing raw materials to marketing.

For comparing the occupational health status, we divided these workers into three categories (see Table 38): 23 of them had been in the units for up to 10 years, 65 had been working for 10 to 30 years, and 18 of them had been in this occupation for more than 30 years. Furthermore, it was considered advisable to compare the status of the tie-and-dye workers with the weavers, on the assumption that the former, being engaged in handling dyestuffs, are more exposed to chemical hazards than the latter.

Table 38: Employment of Workers

Category	Years worked	Number of workers	Employment	
			Self-employed	Wage employed
Tie-and-dye	0-10	6		6
	10-30	47	4	43
	>30	6		6
Weaving	0-10	17	2	15
	10-30	18		18
	>30	12		12

Body Mass Index

The BMI of the workers (see Table 39) indicates the variation in the health status in accordance with the pattern of work. Those workers who have worked for less than 10 years in the tie-and-dye operations appear to be healthier (83%) than those engaged up to 30 years (68%), although an improvement (83%) is seen in workers who have more than 30 working years. A larger number of underweight (12%) and overweight (19%) individuals are also seen in the middle category consisting of workers having worked for 10-30 years.

the Park. Once the yarn is dry, it is ready for weaving in looms with warp and weft preparation as described earlier for traditional processes.

The weavers who work under the Cooperative Society enjoy welfare schemes.

9.3 Status of the Craftworkers

In the 3 villages visited, the team was able to interview and measure the selected health parameters of 106 workers. Of these, 59 artisans are engaged in tie-and-dye operations, while 47 are in weaving.

Overall, there are three types of workers in Pochampally:

1. *Workers under Cooperative Society:* The weavers who work under the Cooperative Society enjoy welfare schemes. Earlier, the materials produced from the Cooperative Society were sent to the US, UK, Japan etc. But in the last 10 years the exports have declined as clients reportedly complain of itching problems from Ikkat products.
2. *Workers under a Master Weaver:* This is like a private body where workers are kept on a daily or monthly basis. The Master Weaver purchases all the raw materials and guides the workers for fabrication and marketing.
3. *Independent Weavers:* These are individual weavers who do all the work, from purchasing raw materials to marketing.

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The tie-and-dye workers experience deterioration in their health as they age in their occupation into the middle years, which is much more pronounced than the weavers,

In weaving, on the other hand, the middle category of workers who have been employed for 10-30 years (83%) are healthier than the workers engaged for less than 10 years (41%) and more than 30 years (41%).

Thus, the tie-and-dye workers experience deterioration in their health as they age in their occupation into the middle years, which is much more pronounced than the weavers, and this may have much to do with the nature of their work.

Table 39: Body Mass Index of Workers

Category of workers	Years worked	No. of workers	Body Mass Index			
			Under weight	Normal	Over weight	Obese
Tie-and-dye	0-10	6	1	5		
	10-30	47	6	32	9	
	>30	6	1	5		
Weaving	0-10	17	5	7	2	3
	10-30	18	1	15	2	
	>30	12	4	5	2	1

Pulmonary Function Test

In the tie-and-dye operations, 50% of the workers have shortness of breath in the short term growing to 66% in the long term.

The measurement of the pulmonary function test, though, gives rise to much greater concern (see Table 40). Only 7 of the workers tested have a lung function that would be considered normal for an adult. In the tie-and-dye operations, 50% of the workers have shortness of breath in the short term growing to 66% in the long term. Moreover, chronic bronchitis also shows the same trend as it rises from 16% to 33%. For workers in the weaving process, 41% showed breathing problems when working for 10 years, and it increases over longer durations of work, up to 44%. Besides, the workers with chronic bronchitis also increase dramatically with the duration of work, from 52% for less than 10 years to 100% for more than 30 years. Thus, while all the workers are being exposed to vapours, gases, fibres, and particles in a work atmosphere that is not conducive to pulmonary health, the weavers are more vulnerable over the longer term, probably due to sustained exposure to cotton dust.

Table 40: Pulmonary Function Test of Workers

Category of workers	Years worked	No. of workers	Pulmonary Function Test		
			Normal	Asthmatic tendency	Chronic bronchitis
Tie-and-dye	0-10	6	2	3	1
	10-30	47	4	25	18
	>30	6		4	2
Weaving	0-10	17	1	7	9
	10-30	18		8	10
	>30	12			12

Hand Grip Meter

Longer period of work in tie-and-dye has an impact on the muscle tone of both the arms.

The pattern of poor health for the tie-and-dye workers and weavers also shows up in the HGM test (see Table 41). In tie-and-dye process, 83% workers display below-normal grip strength in the right hand and 40% in the left hand when engaged for less than 10 years. For the right hand, the figures for the workers with 10-30 years service and more than 30 years are similar, i.e., 74% and 83% respectively. But for the left arm the figure increases abruptly to 70% and 83%. This indicates that longer period of work in tie-and-dye has an impact on the muscle tone of both the arms.

Likewise, for the weavers also, the strength of hand grip decreases with the increasing of working years. For the group with less than 10 years, 70% workers display below-normal grip strength in the right hand and 52% in the left hand, which is raised to 77% (right) and 72% (left) for 10-30 years, and finally to 100% for both the arms engaged for more than 30 years. This may have much to do with the repetitive and tedious work that the weavers have to do in a sitting posture.

Table 41: Hand Grip Meter Test of Workers

Category of workers	Years worked in present unit	No. of workers	Hand Grip Meter					
			Above normal		Normal		Below normal	
			Rt	Lt	Rt	Lt	Rt	Lt
Tie and dye	0-10	6	1	2		2	5	2
	10-30	47	6	7	5	7	36	33
	>30	6	1			1	5	5
Weaving	0-10	17	3	4	2	4	12	9
	10-30	18	1	2	3	2	14	13
	>30	12					12	12

Muscular Pains

Almost all of the workers reported muscular pains (see Table 42), from the knee to the whole body. However, the group of workers with 10-30 working years is much more prone to these pains.

The weavers mostly suffer from the muscular pains, with the group in the 10-30 working years being more vulnerable. Pains in the knee, back, and neck were distinctly higher for those engaged for 10-30 years-78% in the case of tie-and-dye and 94% among weavers. The whole body pain also shows a remarkable difference in the working group of more than 30 years. While there are only 33% who complain about whole body pains from tie-and-dye in this age group, the figure is 83% for the weavers. Thus, for weavers, the nature of their work which involves continuous and repetitive movement clearly leads to more muscular exhaustion.

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Table 42: Pains Reported by Workers

Category of workers	Years worked	No. of workers	Pains									No problem
			Knee	Back	Neck	Shoulder	Hands	Elbow	Legs	Head	Whole body	
Tie-and-dye	0-10	6	1						1		1	3
	10-30	47	12	15	10	7	4	2	2	6	13	3
	>30	6	2	1	1				1		2	1
Weaving	0-10	17	8	12	4	6	5	1	1	3	1	
	10-30	18	7	9	1	1	2		1	3	7	
	>30	12			1				1	1	10	2

Other Symptoms

Other reported symptoms (see Table 43) are eye strain, deafness, cough, respiratory distress, low appetite, and sleeping problem. For tie-and-dye workers, eyesight problems are reported for those engaged for more than 10 years, and this increases with longer duration of the same work pattern. For example, 29% of workers complained of watery eyes in the working group of 10-30 years. Short-sightedness also rises from 40% to 83% as the working period increases over 30 years. But, among the weavers, eyesight problems begin in the early stages itself, and steadily increases with the span of time spent with the activity. Among weavers in the early 10 years of work, 29% suffer from watery eyes, and this rises to 58% for those working for more than 30 years. The same pattern may be seen in the case of myopia; the figure is only 17% in the early stages and rises to 66% in the later years.

The respiratory problem also shows a similar pattern. For tie-and-dye workers, the figure is only 8% in the early stages, but increases to 53% and decreases slightly to 50% for the working groups of 10-30 years and more than 30 years respectively. But for the weavers, more cases of cough and breathlessness are reported as the workers age, and this is consistent with the results of the measured lung function test.

Workers also complained of low appetite and lack of sleep. For tie-and-dye workers, these problems arise in the later stages of working: 16% for less than 10 years, 42% for 10-30 working years, and 50% for more than 30 years. For weavers also, the figures increase from 58% (<10 years) to 77% (10-30 years), and to 83% (>30 years).

Table 44: Other Symptoms Reported by Workers

Category of workers	Years worked	No. of workers	Eyes/Eyesight					Ears	Respiratory				Others	
			Watery	Burn	Cataract	Myopia	Hypermetropia	Deafness	Cough	Breathlessness	Nasal irritation	Chest pain	Low appetite	Less sleep
Tie-and-dye	0-10	6							1	1	1	1	0	1
	10-30	47	14	8		19	6	2	11	5	2	7	4	16
	>30	6	2		1	4	2	2	1		1	1	1	2
Weaving	0-10	17	5	2		3	2		3	2		2	5	3
	10-30	18	9	5		9	3	5	6	4		2	6	6
	>30	12	7	2	1	8	5	3	1	1		2	4	4

Habits: Almost all the workers reported that they habitually consumed some intoxicant. There is a custom of drinking toddy-the locally made liquor-in most parts of Nalgonda district, and about 43% of the workers confessed to drinking the same. They also said that toddy is taken to obtain relief from aches and pains (as pain is a common problem for these artisans), as well as to sleep better during the night.

Apart from toddy, 18% reported regular consumption of alcohol, 13% agreed that they were smokers, while 3% chewed tobacco. All these habits are also related to overcoming weariness, finding relief from strain and tension, and inducing a feeling of well-being under adverse conditions of work and shelter. The findings are given in Table 6 and indicate that smoking and tobacco are resorted to much less frequently than toddy and alcohol, particularly for the tie-and-dye workers, who may be less vulnerable to long-term hazards than weavers.

Table 45: Habits

Category of workers	Years worked	No. of workers	Habits			
			Toddy	Alcohol	Smoking	Tobacco
Tie-and-dye	0-10	6	2	2		
	10-30	47	20	8	4	2
	>30	6	4	1	3	
Weaving	0-10	17	5	1	1	1
	10-30	18	7	4	5	1
	>30	12	8	4	1	

In tie-and-dye workers, the impacts are mostly seen among younger artisans.

9.4 Safety Recommendations

General Health

For the improvement of the body mass index, our findings suggest that the workers' working hours be punctuated by regular rest periods and that they be provided balanced diet. In tie-and-dye workers, the impacts are mostly seen among younger artisans. For weavers also, the BMI decreases with increasing working years and hence the emphasis should be on regular rest periods.

Pulmonary Health

The fact that only 7 workers had what is considered to be a normal lung function points to the prevalent and severe hazard in the industry. That both tie-and-dye workers and weavers are widely affected (although the rate of chronic bronchitis for weavers increases abruptly from 52% to 100% over the long term) indicate that the chemical vapours and micro-particles in tie-and-dye and cotton dust in weaving cause widespread pulmonary problems among all the artisans.

The precautions to be taken in such situations are:

(a) Periodic medical check-ups of all workers to identify the early signs of pulmonary distress;

(b) Separate place for dye mixing, colour boiling, degumming etc., with the provision of adequate ventilation; and

(c) Installation of proper exhaust and ventilation systems, especially in weaving for avoiding cotton dusts.

Muscle Tone

Although the results of the hand grip meter test show that both the tie-and-dye workers and weavers suffer from a decline in muscle tone, the rate is much higher among weavers as weaving involves greater and continuous manual work. The safety measures comprise: (a) regular rest periods to avoid muscle fatigue; (b) rotation of work pattern at some interval; (c) designing of suitable weaving tools that need less manual application; and (d) adequate wages to enable proper nutrition. These measures would also improve productivity.

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Body Pains

Similar trends are seen for body pains: the weavers are more prone to pains than the tie-and-dye workers. The knee, back, neck, and whole body pain are quite common. These are clearly linked to the movements of the body required during weaving. Once again, regular rest periods to avoid fatigue are the recommended safety measure, but these should be accompanied by a study of the work process to develop ergonomic

designs, and regular check-ups that dictate rotation of jobs and tasks to prevent repetitive motions causing stress to a particular set of muscles.

Eyesight

Almost all of the workers reported some form of eye trouble and over one-fourth (29%) has watery eyes in both the tie-and-dye workers and weavers, but the rate of increase with duration of work is higher among weavers. This is due to the inadequate natural lighting in most of the sheds during the day, and poor artificial lighting (tube-light or bulb) for weavers having to work at night. Hence, it is most necessary to redesign or retrofit the sheds to ensure better natural lighting in normal seasons and sufficient artificial lighting of the entire work site at night. Regular breaks from work to prevent eye strain are of utmost importance.

Other Symptoms

Respiratory problems, low appetite, and sleeplessness have been reported by the workers. These would require early detection through regular medical check-ups, and the design of tools and equipment to avoid contact with chemicals and cotton dusts.

9.6 Environmental Status

Ikkat involves a dyeing process, in which many dyes and chemicals are used and the waste water generated from these processes is directly released to the environment due to lack of treatment facility in the clusters of Pochampally. Although a single unit of Ikkat manufacturing releases minimal amount of dyeing water, when we take into account the more than 5000 weaving units in Nalgonda district releasing waste water into the environment it becomes a matter of concern.

The dyes and chemicals that are used in Ikkat process are:

- Dyes including Naphthol
- Synthetic coloured powder
- Caustic Soda
- Acetic Acid
- Alum
- Hydrochloric Acid
- Hydrogen peroxide
- Wetting agents

The Pochampally Park, which has a capacity of about 40 lakh metres per annum production, now produces about 8000 metres monthly. But, as the effluent treatment plant is under construction, the waste water is released in the premises of the Park

Although a single unit of Ikkat manufacturing releases minimal amount of dyeing water, when we take into account the more than 5000 weaving units in Nalgonda district releasing waste water into the environment it becomes a matter of concern.

Among the numerous metal contents found in the dyes, Cobalt, Nickel, and Chromium are the main constituents.

without being treated. A kg of production requires about 20-30 litres of water. Within the Park's premises, 4-5 bore wells reaching depths of 150 feet each have been set up.

S.N	Samples	Parameters		
		Chromium as Cr (mg/l)	Cadmium as Cd (mg/l)	Lead as Pb (mg/l)
1	Dyeing water, Pochampally Village	0.022	0.003	0.022
2	Groundwater 150 ft, Pochampally Village	0.008	ND	ND
3	Groundwater, Pochampally Park	0.003	ND	ND
4	Washing Water, Pochampally Park	0.013	ND	ND
	BIS Std - IS:10500	**0.05**	**0.01**	**0.1**

While Cadmium and Lead were found to be absent in ground water and in the wash water of the Park, some low concentrations of these metals were observed in waste water collected from a Pochampally dyeing unit.

The groundwater and waste water samples were collected from 4 different locations: two samples from the Park and 2 from the village of Pochampally.

Among the numerous metal contents found in the dyes, Cobalt, Nickel, and Chromium are the main constituents. Give the time constraints, Cobalt and Nickel tests that need time for testing were not completed. While Cadmium and Lead were found to be absent in ground water and in the wash water of the Park, some low concentrations of these metals were observed in waste water collected from a Pochampally dyeing unit.

The Chromium content was found to be lower (0.003 and 0.008 mg/l) in the ground water samples than in the samples collected from the Pochampally unit (0.022 mg/l) and the Park (0.013 mg/l), although the concentrations remained well below the standard set by BIS.

Annexure

Raw Materials and Dyes used in the Block Printing Process

Vegetable Dyes

Block printing employed vegetable dyes exclusively till the advent of modern chemical dyes. The process of printing cloth with vegetable dyes is exceedingly complex. Vegetable dyes adhere permanently to cotton only in the presence of a bonding agent or mordant; hence, the first step of the dyeing process is mordanting. A mordant is a chemical salt, which when 'cooked' with the fibre, attaches itself to the fibre molecules. The dye molecule, then, attaches itself to the mordant. Different mordants result in different colours when combined with the same dye. For example: the dye, cochineal, when used with alum sulphate gives a fuchsia colour; when used with tin, it results in a colour that is more scarlet; and when used with copper, it results in a purplish hue. Moreover, different concentrations of the same mordant yield varying tints in the same dye bath; hence, their successful application is the cornerstone of the dyers' art. Some of the common vegetable dyes are: Indigo (deep blue), Madder (pink, orange or tan-depending on the mordant used), Pomegranate rind (yellow hue), Kamala (orange yellow or golden yellow), Myrobalan (greenish yellow), Catechu (brown), Himalayan Rhubarb (yellow), Henna (khaki brown), Turmeric (yellow), and Cochineal (fuchsia pink). Common mordants used in block printing are: Tin, Chrome, Iron, Copper, Alum, Cream of Tartar, Oxalic Acid, Soda Ash, Chalk, and Tartaric Acid.

Rapid Dyes

These dyes are used in negative space type designs, where, by printing the negative space the positive space gets defined. Hence they are suitable when a large area of the ground needs to be coloured. Since these dyes penetrate the fabric they are colourfast. Rapid dyes are mixed with water and boiled with caustic soda and a gum paste. Rapid dyes are time consuming to mix since the visual appearance of the colour that is mixed bears no resemblance with the final colour. True colours emerge only after the fabric has been printed and washed in a mild sulphuric acid solution. Hence the process of colour matching is extremely tedious. Added to this is the relatively short potency of these dyes, since many have to be used on the same day. Also, certain rapid hues are extremely sensitive to the weather. For instance, pure blacks can only be printed in winter since Rajasthan's scorching summers make it difficult to print rich blacks. On the other hand, rapid reds are vibrant in summer and mediocre in winter.

Discharge Dyes

These dyes are used when printing has to be done on a dark ground. Discharge dyes when exposed to heat concurrently bleach the colour from the dyed ground of the fabric and print the desired colour in its place. The advantage of this technique is that a whole spectrum of colours from pastels to brights can be printed on medium and dark

grounds. It is often stated that although the fabric may disintegrate with time, the vibrancy of discharge dyes will never fade. Discharge dyes have the same problems with visual mixing as rapids, and only reveal themselves when they are exposed to steam.

Dabu Printing

Unlike the various types of dyes listed above, Dabu is an age-old technique of resist printing, which usually employs the use of vegetable dyes. Hence, unlike traditional block printing where the wood blocks are used to print dyes onto the fabric, the Dabu technique uses blocks to apply the resist, usually a paste of mud, gum and sawdust, to the fabric. The fabric is coloured when the sun-dried mud' printed cloth is immersed in a cauldron of dye. This process (the application of the mud resist followed by dyeing) is repeated for every colour in the design. The term 'double' or 'triple' dabu indicates the number of times the fabric is thus processed. Finally, the mud resist is washed off to reveal the design, which emerges when the non-dyed part of the fabric becomes visible. Some colour penetrates under the resist and results in the characteristic veining, usually associated with resist printed Batiks.

Process of Dabu printing

Ingredients	Process
Cow dung, Soda Ash, Sesame Oil	After preparing solution of given mordants in water, the raw cloth is kept for 2 days in the solution. After washing in sufficient floating water and constant sun bleach in open sunlight, the shape of cloth is attained. This process is called Sun Bleach-cum-Scavering.
Myrobalan	Scavered cloth is dyed in myrobalan solution and dried in open sun by spreading over sandy grounds.
Alum, Red Soil (Geru), Natural Gum	Concentrated thick paste of these mordants is prepared in water and printed with traditional wooden block Singh Badh. Printed cloth has been beaten on stone by dipping in water twice or thrice to ensure that there is no gum in the printed portion of the cloth. This process is called Degumming.
Manzeet (madder), Ali Ki Lakdi, Debudiya Flowers, Shakoor	De-gummed cloth is dyed in the hot solution of these mordants till the required red shade emerges.
Alum	Red-dyed cloth is dipped in Alum solution. Alum has changed the pinkish group shade of the cloth into yellowish.

Manzeet (madder), Debudiya Flowers	Alum-dipped cloth is re-dyed in the hot solution of these mordants till the ground shade of the cloth turns to dark pink.
Beedhan (sour flour of wheat eaten by insects), Natural Gum, Lime, Sand, Black Soil	Pink dyed cloth is printed with Dabu (thick paste prepared with these mordants is called Dabu) , with the wooden block all over the red printed butty. Another name of Dabu is Mud Paste.
Pomegranate	Dabu printed (mud resist) cloth is dyed in pomegranate extract. The ground shade of the cloth changes from pink to pinkish yellow.
Natural Indigo	Pomegranate-dyed cloth is dyed in natural indigo in indigo vat. Now the ground dye of the cloth has changed to dark blue.
Pomegranate	Indigo-dyed cloth is re-dyed in pomegranate extract. Thus, the colour of the cloth changes from blue to olive green.
Alum	Pomegranate - and indigo-dyed cloth is dipped in alum solution and dyed in open sun and kept under shade for 24 hours to have the greenish change shade. Wash the mud-printed, pomegranate- and indigo-dyed cloth to remove the mud and to have the requisite shine.
Beedhan, Natural Gum, Lime, Black Soil	Mud-washed fabric is re-mud printed on the lower portion of the block.
Turmeric Powder, Pomegranate, Sesame Oil	Re-Dabu the printed fabric and re-dye in the thick solution of turmeric and pomegranate with the woollen rug to have yellow colour in the leaves of the block.
Alum	Dyed and mud-printed cloth is dipped in Alum solution. Alum acts as a fixing agent in the vegetable dyes. It gives various shades by processing with different vegetable mordants. On removing the mud, the finished cloth is ready for use. This type of traditional fabric was used by the Pathans and Afghans before partition.

Front Cover: **Dastkar Ranthambore**. Photograph by Anjali Bhatnagar
Back Cover: Courtesy of **Women Weave**

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