Waste to Useful: A Business Strategic View of Crumb Rubber and Beach Sandal Manufacturing

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Abstract— This paper presents qualitative research that investigates the feasibility and prospects of crumb rubber and beach sandal manufacturing. Further it deals on with detailed financial analysis for the setup of the crumb rubber and beach sandal manufacturing by thoroughly addressing the demand of the same. Rubber in its commercial form is obtained from latex by a set of processes. Havea latex in the latex vessel of the tapped trees contains 30-40% rubber in the form of particles. Latex is a hydrosol in which the dispersed particles are protected by a complex film. The grading of synthetic rubber is done by technical specification. Technically specified rubbers are largely block types made by adopting new methods of processing which include size reduction, de-watering, dirt removal, drying, baling and grading. The detailed financial analysis shows that the plan will make a profit of around Rs.148 lacs in a year and the break-even will be achieved in one year.

Key words: Rubber Technology, Crumb rubber, Value-addition, Manufacturing, Recycling, Standardization

I. INTRODUCTION

Rubber in its commercial form is obtained from latex by a set of processes. Latex is obtained from the bark of the rubber tree by tapping. Tapping is a process of controlled wounding during which thin shavings of bark are removed. The aim of tapping is to cut open the latex vessels. Budded plants are regarded as tappable when they attain a girth of 50cm at a height of 125cm from the bud union [1]. In seedlings, the first opening for tapping is recommended at a height of 50cm. In India, the best period to open new areas for tapping is March-April. The trees left behind during this season due to want of sufficient girth may be opened in September [2]. Latex is a white or slightly yellowish opaque liquid with a specific gravity which varies between 0.974 and 0.986. It is a weak lyophilic colloidal system of spherical or pear-shaped rubber globules suspended in an aqueous serum. The rubber globule is surrounded by a protective layer of proteins and phospholipids which impart the lyophilic colloidal nature to latex and stability of latex is due to the negative charge present on the protective layer. Fresh latex, as it comes out from the tree is slightly alkaline or neutral [3]. It becomes acidic rapidly due to bacterial action. The formation of organic acids neutralizes the negative charge on rubber particles and the latex gradually thickens and gets coagulated on keeping. An anti-coagulant is a chemical added to the latex to prevent pre-coagulation before it is processed. Anti-coagulants generally used are ammonia, sodium sulphite and formalin [4]. Latex is coagulated in suitable containers into thin slabs of coagulam and sheeted through a set of smooth rollers followed by a goove set, and dried to obtain sheet rubber. A major quantity of rubber in India (about 71%) is marketed in the sheet form at present, as it is the oldest and the simplest method of processing latex into a marketable form [1].

Ribbed smoked sheets and crepe rubbers are graded and classified by visual comparison methods [14]. This provides ample room for malpractice. Besides, this unscientific system is not helpful to the consumer in assessing the quality of raw rubber. Synthetic rubbers are sold to manufacturers in solid block form in attractive packing. Besides, the grading of synthetic rubber is done by technical specification. Technically specified rubbers are largely block types made by adopting new methods of processing [1]. All the new methods thus evolved can handle coagulum produced from latex and all forms of scrap rubber and involve practically the same unit operations which are given below:

1) Size reduction
2) de-watering
3) dirt removal
4) drying
5) baling and
6) grading

This method of processing is a revolutionary departure from the conventional method particularly in the rapidity in preparation and presentation in high density polythene packed bales of rubber having uniform quality and in facilitating the production of rubber having special properties such as constant viscosity (CV) rubber, low viscosity (LV) rubber etc [9].Further, this rubber can be utilized for beach sandal manufacturing yielding better commercial value for rubber.

II. LITERATURE REVIEW

The high market value of rubber and the constancy in the rate of the same has added to a great extent towards the value addition of rubber processing unlike earlier days. Ancient Mesoamerican peoples harvested latex from Castilla elastica, processed it using liquid extracted from Ipomoea alba (a species of morning glory vine), and fashioned rubber balls, hollow rubber figurines, and other rubber artifacts from the resulting material. Chemical and mechanical analyses of the latex and of the processed rubber indicate that the enhanced elastic behavior of the rubber relative to the unprocessed latex is due to purification of the polymer component and to an increase in the strength and number of interchain interactions that are induced by organic compounds present in I. alba. These ancient peoples' control over the properties of latex and processed rubber gave rise to the Mesoamerican ball game, a central ritual element in all ancient Mesoamerican societies One of the various problems which mankind faces as it enters is the problem of waste disposal management. Since polymeric materials do not decompose easily, disposal of waste polymers is a serious environmental problem. Large

amounts of rubbers are used as tires for aeroplanes, trucks, cars, two-wheelers etc. But after a long run when these tires are not serviceable and discarded, only a few grams or kilograms of rubber (<1%) are abraded out from the tire. Almost the entire amount of rubber from the worn out tires is discarded, which again need very long time for natural degradation due to crosslinked structure of rubbers and presence of stabilizers and other additives. This poses two major problems: the wastage of valuable rubber and the disposal of waste tires leading to environmental pollution. Two major approaches to solve this problem are the recycle and the reuse of used and waste rubber, and the reclaim of rubber raw materials and finally convert it into new product.It is a consumer-oriented product which has ever increasing demand on account of growth in population in the country and also increase in the vehicle population in the Indian roads. The footwear shall be very light in weight as compared to the conventional type of chappals (Bata type).This is based on technology already being used in developed countries but latest in the Indian footwear industry.

Also it can be used as a complex for different filler rubber compounds with the aid of latest technology. Filled rubber compounds are complex polymer systems that exhibit a number of singular flow properties markedly different from those of unfilled, molten polymers. In addition to usual hydrodynamics (or volume fraction) effects, reinforcing fillers such as carbon blacks or high-structure silica, impart modifications in flow properties whose origin is assigned to strong interactions arising between the elastomer and the filler particles. The report discusses the nature of rubber–filler interactions and their effects on rheological properties of uncured materials. The concept of rubber–filler mesophase is first introduced in order to underline the fundamental scaling problem that exists when attempting to relate phenomena occurring in the nanometer range to flow singularities, essentially observed in the macroscopic range. Then flow singularities exhibited by filled rubber compounds are briefly described, before interactions between fillers and elastomers are reviewed with respect to filler characteristics. Bound rubber is consequently considered, as a macroscopic result of rubber–filler interactions, and its importance is stressed as the obvious link towards flow singularities. Eventually dimensional aspects in filled rubber compounds are discussed in detail, since they offer the most likely key to understand the relationships between bound rubber and flow properties.

A. THE CASE- XYZ Ltd.

The project for the manufacture of crumb rubber and supply it to rubber industry as raw material and simultaneously manufacture of rubber foot wears/beach sandals is proposed to be established in Kottayam district (the rubber hub of Kerala state).

1) Land & Building

- Land and site development: Cost Rs.6 lacs approx.
- Building cost will be approx Rs.20 lacs on the particular plot. (Covered area 10000sq.ft)

The construction of factory building will commence as soon approval is obtained from the concerned government authorities. The funds for these land and buildings have so far been raised as unsecured loans and/or as share application money pending allotment from the directors/shareholders. On the disbursements of the required term loans, any amount received in addition to the amount s mentioned in means of finance shall be refunded to them. According to the Architects, estimates the construction of building including Administrative block etc. shall cost around Rs 20 lacs. The land and building is sufficient for our future expansion requirements [5].

B. Raw materials

Waste rubber which is obtained after taking the latex from the rubber tree will act as the main raw material; also the waste tyres and other scrap rubber matter can also be added to the raw material as proper soaking as well as cleaning of these materials is included in the plan [10].This gives an advantage that it can be even setup in any latex free zone, provided there is adequate supply of scrap rubber or tyre wastes. But, then the final product will be focused on tyre manufacturers as tyre wastes have already come as the raw material [8].

C. Products

Blocs of technically specified rubber will be the product. Each bloc has a weight of 25kg and two such blocs will be coming out at a time from the hydraulic press. This product of the company will act as the essential raw material for tyre plants in their banbury mixers [14]. These materials can be put directly into the banbury mixers as this material doesn't need any additional cleaning or processing. Also, these materials can be directly sent to the rubber footwear/beach sandal section [3].

III. RESEARCH PROCEDURES

A. Crumb Rubber Blocks

Ribbed smoked sheets and crepe rubbers are graded and classified by visual comparison methods. Besides, this unscientific system is not helpful to the consumer in assessing the quality of raw rubber [3]. Synthetic rubbers are sold to manufacturers in solid block form in attractive packing. Besides, the grading of synthetic rubber is done by technical specification. Technically specified rubbers are largely block types made by adopting new methods of processing. All the new methods thus evolved can handle coagulam produced from latex and all forms of scrap rubber and involve practically the same unit operations which are given below [1]:

1) Size reduction
2) de-watering
3) dirt removal
4) drying
5) baling
6) grading

B. Size Reduction, De-Watering & Dirt Removal

In all the new processes usually these three operations are accomplished together. A variety of machines which can disintegrate the coagulum or scrap into granules, pellets or crumbs and at the same time able to remove dirt and water to considerable extent, can be used for this purpose. A suitable combination of the following machinery is used for each of the different processes at present. (1) Coagulum

cutters (2) slitting knives (3) granulators (4) hammer mills (5) pelletisers (6) expellers (7) shredders (8) choppers (9) creepers (10) crumblers. Material such as castor oil is also used in some processes to assist mechanical disintegration of rubber.

C. Drying

Drying of the crumbs, pellets or granules in all the new processes is carried out at about 373K. Drying time depends upon the size of the particles [5]. Usually 4-8 hrs are required for complete drying. The tunnel drier commonly used consists of a movable tray fitted under a stationary hood which contains an air circulating duct fan and heat exchanger. Temperature is regulated so as not to exceed 383K to prevent degradation and discoloration of the product [3].

D. Baling, Grading & Packing

The dried crumbs, pellets or granules are pressed when they are below 323K in a hydraulic press. 30 to 50 tonne pressure is generally used. Bales, preferably 25kg are generally prepared. Samples are then cut from a few representative bales and tests for technical specification are undertaken. The following tests are usually done:

1) Dirt content
2) ash content
3) volatile matter
4) nitrogen content
5) initial Wallace plasticity.

Based on the test results grading is done. The bales are then wrapped in polythene films, packed in HDPE bags and marketed.

This method of processing is a revolutionary departure from the conventional method particularly in the rapidity in preparation and presentation in high density polythene packed bales of rubber having uniform quality and in facilitating the production of rubber having special properties such as constant viscosity (CV) rubber, low viscosity (LV) rubber etc [11].

1) For Rubber Footwear & slippers/Beach Sandals:

The rubber sheets are laid out on slickers with proper cutting dies and given shape on slope cutting machines. The synthetic straps are fabricated separately on sticking machines. The cut soles are pasted along with straps and the footwear/final product is side buffed to give it a uniform shape. Some of the items are also screen printed to make it more attractive [4].

IV. FINDINGS & DISCUSSIONS

A. Details of machinery:

1) For Crumb Rubber Blocks

As this is the main purpose of the factory, the machines have to be selected very carefully by maintaining a deliberate balance between quality as well as economics of the system. The machines required for crumb rubber manufacturing include slab cutters, pre-breakers, bucket elevators, shredders, dryer, weighing machine, baling machine etc [9]. Here, cost of two vehicles for transportation as well as other establishment charges and other miscellaneous charges including the raw material charges are calculated [7].

SL. No.	MACHINES	Nos.	Amount(in lacs)
1.	Slab cutter	1	0.50
2.	Pre-breaker	2	0.25
3.	Bucket elevater	2	0.25
4.	Hammer mill	2	0.75
5.	Creeper	4	0.60
6.	Shrudder	1	0.60
7.	Dryer	1	1.00
8.	Weighing m/c	2	0.30
9.	Hydraulic press	2	4.00
10.	Transportation	1	40.00
11.	Raw materials	1	10.00
12.	Estb. Charges	1	5.00
13.	Misc.	-	5.00
	Total A		68.25

2) For Beach Sandals

Major machineries used for beach sandal manufacturing include: Hydraulic Sheet cutting press, Splitting machine, Auto Edge Grinding machine, Shearing machine, Stitching machines, Auto Riveting machine. Here, other office accessories like computer, air conditioners etc. are included [8].

SL. No.	MACHINES	Nos.	Amount (in lacs)
1.	Hydraulic Sheet cutting press	4	1.20
2.	Splitting machine	1	1.50
3.	Conveyor belts	2	3.25
4.	Auto Edge Grinding machine	1	0.60
5.	Shearing machine	1	0.35
6.	Stitching machines	25	2.75
7.	Roughing machine with dust collector	1	0.20
8.	Auto Rivetting machine	1	0.15
9.	D.G Set of 120KVA	1	3.75
10.	Electrical Transformers and its installations	1	2.50
11.	Computer	5	2.00
12.	Air Conditioner	2	0.50
13.	Other Office equipments,Typewriter,Stools,Racks, Table,etc.	-	3.00
	Total B		21.75
	Total of A+B=		90.00

3) Cost of Project

Cost of the project including the investment in fixed assets like land and machinery and other working capital requirements are calculated. Means of financing mainly include the cash in hand plus the term loan from the bank and the unsecured & other required capital from Directors/Shareholders [9].

Total Investment	Rs in lacs	Means of Financing	Rs. In lacs
Land	6.0	Capital	40
Building &site development	20.0	Term Loan	80

Plant & machinery	40.75	Unsecured & non-working capital from Directors/Shareholders	21
Other fixed Assets	49.25		
Working Capital Requirements	25.00		
Total	141.00	Total	141.00

4) Raw material cost

Here, the estimated raw material cost is aound Rs.1000/- considering the worst case scenarios. Per shift we plan to obtain atleast two hundred blocks of crumb rubber and this way it will approximately continue for 300 working days in a year. Similarly, we plan to manufacture around 2000 pairs of beach sandal a day. This figure may vary with respect to the interest the company is showing in crumb rubber manufacturing rather than beach sandal manufacturing [8].

a) Total Raw material cost (Estimated)

Per block of crumb rubber Rs. 1000/-

Per shift production: 200x300x1000= 600 lacs per annum

Packaging material= 200x300x1=60,000 per annum

Total A =600 lacs+60,000 = 600.6 lacs

b) Total Raw material cost (Estimated)

Per pair of Beach sandals/slippers : Rs. 29/- per pair

Per shift production: 2000(prs) x300(days)= 6.00 lacs per annum

x29/-(Rate) = Rs. 174 lacs per annum

Packaging material: 2000x 300 x3 = Rs.18 lacs per annum

Total A : Rs. 192 lacs per annum

Total of A+B= 792.6/- lacs

5) Salary and Wages

a) Direct:

As of now totally salary calculations are done for 135 personnel who include both direct as well indirect employees with respect to production system. The former mainly includes designer, supervisors, skilled and unskilled laborers. The latter contributes everybody including the director, manager, accountant, clerk, peon, chowkidar, etc [8].

Salary & Wages	Per month	No.	Amount(Rs.)
Designer	15000	1	15000
Supervisors	10000	6	60000
Skilled	8000	10	80000
Unskilled	3000	60	18000
Semiskilled	5000	40	200000
Total			535000

b) Indirect:

Director	25000	2	50000
Manager	15000	4	60000
Storekeeper/Accountant	8000	3	24000
Clerk/Typist	5000	4	20000
Peon/Chowkidar	3000	5	15000
Total			169000

Net Total (Direct & Indirect) : 7, 04,000/-

10% Fringe Benefits : 70,400/-

7, 74,400/-

x

12

92, 92,800/-

c) Utilities

Mainly the running cost of the D.G set is calculated here along with other utilities like electricity and water.

Electricity 50000kWh x 12 x 6 = 3600000

Water 200 Kl/PM x 12 x 1 = 24000

Fuel for D.G set (4-6 hrs daily) = 500000

41,24,000.00

Different overheads like administration (Repair & maintenance of M/c., office vehicles, Postage & Stationery, Printing, Telephone, Staff welfare & Office expenses , Insurance, Legal & Administrative exp.) selling (Cartage outward expenses, Advertisement, Dealer Commission) , depreciation (depreciation for Building, Machinery, Office Equipments),tax liability and cost of production and profitability is calculated below [8].

B. Administration Overheads

	Rs. in lacs
Repair & maintenance of M/c., office vehicles (1% of fixed assets)	4.925
Postage & Stationery, Printing, Telephone	5.00
Staff welfare & Office Exps.	5.00
Insurance	10.00
Conveyance & vehicle running	5.00
Legal & Administrative exp.	3.00
Total	32.925

C. Selling Overheads:

Cartage outward expenses	6.00
Advertisement @ 2.5% of sales	25.65
Dealer Commission @ 2.5% of sales	25.65
Total	57.3

D. Financial Expenses:

Interest TL80 @ 14%:11.2 lacs

1) Depreciation:

	Value	As per Rate	Books	As per Rate	Income Tax
Building	26	10%	2.6	10%	2.6
Machinery	40.75	15%	6.1125	33.33%	13.4475
Office Equipments	9.25	10%	0.925	10%	0.925
Total			9.6375		16.9725

2) Tax Liability:

	Rs. in lacs
Profit before Tax	213.694
Add depreciation provided	9.637
	223.332
Less : Den. As per Income Tax	16.9725
	206.359
Less : 30% tax holiday	61.9078

	144.452
Tax liability @ 55%	-79.45
	65.00

E. Cost of Production & Profitability:

	Rs. in lacs
Raw Material purchased	600
Less:Closing stock of S.F & F.G	- 10
	590
Consumable & other stores	10
Salary & Wages	92.928
Utilities	41.24
Overheads	57.3
Depreciation	9.6375
Interest & Bank charges	11.2
Total	812(approx)

F. Sales:

By sales of CRB/year

100 x 300 x 2500 = 750 lacs

(Actually production is of 200 blocks. Here, half of blocks are diverted for sandal/footwear making).

By sales of sandals

2000 x 300 x 46 = 276 lacs

Therefore, total =1026 lacs

Profit: 1026-812.305 = 213.6945 = 214 (approx)

Tax @ 55% = 65.00 lacs

Net Profit = 148.6945 lacs

Profitability on Sales: Rs. 1026 lacs

Before Tax 213.6945/1026 = 20.8%

After Tax 148.6945/1026 = 14.49%

G. Fixed Cost per Annum Variables

Depreciation	9.6375	Raw Materials	590
Interest on Term Loan	11.2	Wages	74.343
Salaries & wages	18.585	Overheads	25.785
Overheads	31.515	Utilities	20
Utilities	21.24		
Total	92.1775	Total	710.128

1) Break-Even Point:

Contribution = Sales – Variable cost

1026-710.128 = 315.872 lacs

Fixed Cost = 92.1775 lacs

Fixed Cost/Contribution = 29.18 %

Break-Even point at 60% of installed capacity = 17.508%

The projected sales figure shows that XYZ Ltd. Has the potential to sell around 2500 blocks of crumb rubber in yearly basis which will yield around 750 lacs. Sales of sandals will contribute for another 276 lacs, thereby giving a profit of around 148 lacs approximately after tax. The profitability after tax will come around to 14.5% approximately. Further the break-even analysis will show that the break-even point at 60% of installed capacity will come out to be around 17.5%, i.e., with the given infrastructure XYZ Ltd. will achieve break-even within a single year.

V. IMPLICATIONS & CONCLUSIONS

This study clarified various strategic variables affecting the crumb rubber manufacturing. Based on such strategic variables, it has addressed the physical and economic feasibility of taking up this project. Although there are a set of procedures for obtaining natural rubber, our research results were quite unconventional. The findings clearly show that crumb rubber manufacturing in itself independently is feasible. This paper presents qualitative research that investigates the feasibility and prospects of crumb rubber manufacturing. Rubber in its commercial form is obtained from latex by a set of processes. The grading of synthetic rubber is done by technical specification.

Technically specified rubbers are largely block types made by adopting new methods of processing which include size reduction, de-watering, dirt removal, drying, baling and grading. The detailed financial analysis shows that the plan will make a profit of around 148 lacs in a year and the break-even point at 60% of installed capacity will be around 17.5%. Further research could examine other manufacturing processes from any other form of scrap rubber including used tyres. This study has practical implications for three groups: The Rubber Board of India, common rubber planters (large, medium and small) and industrialist or businessmen who see great business opportunity in case of crumb rubber manufacturing.

The practical implications of our findings as described for the first group are twofold. First, it provides a detailed economic study which will help the rubber board of India to expand crumb rubber manufacturing further from their basic model factory to many fold in suitable location where there is enough supply of raw materials. The detailed economic analysis will help rubber board to ponder on the fact to setup more and more crumb rubber manufacturing plants within the central Travancore region in Kerala, India and thus, to retain the monopoly of the board in rubber processing industry. In a sense financial as well as non-financial management and development criteria can be used to balance both quantitative and qualitative aspects of crumb rubber and beach sandal manufacturing.

Second, different" innovative styles" used in the study will help rubber board in clubbing their various business ventures like the Model TSR factory and RUBCO ltd. Also, this study will help rubber board in providing a start for a new tyre plant in the nearby future. Incase of the common rubber planter, the practical implications are of three fold. First, the planter identifies the value of scrap rubber or cup lump which earlier, either he used to avoid or gave it free of cost to the processing unit. Second, he/she recognizes the ongoing and upcoming boom in the rubber industry and this will further motivate them to invest more in rubber industry. Third, the study enables the rubber planter himself to think in the field of entrepreneurship. Especially large growers from the country will take up this project from business point of view seeing the visible returns which they will obtain after one year.The final beneficiary of this study is none other than industrialist or businessmen who are already into this or like to take up crumb rubber or beach sandal manufacturing as a business seeing the sparkling returns and the pace with which it captures the breakeven. Because of the detailed economic

study including all the direct and indirect costs, the paper will be a virtual guide for this segment of people.

To conclude, it has been past so many years since the dome of horizon of rubber industry has arisen, but since then nowhere we see it as a profitable industry. This method of processing is a revolutionary departure from the conventional method particularly in the rapidity in preparation and presentation in high density polythene packed bales of rubber having uniform quality and in facilitating the production of rubber having special properties such as constant viscosity (CV) rubber, low viscosity (LV) rubber etc. Our work, several visits and thorough analysis on XYZ Ltd shows that rubber industry in its various forms can be seemingly profitable and eco-friendly industry.

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