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Waste Management & Quality Assessment of Footwear Manufacturing Industry in Bangladesh: An Innovative Approach

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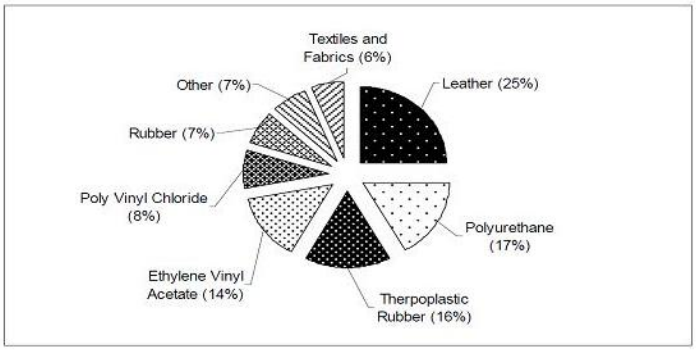
ABSTRACT

Globally, the manufacturing industries have incredible contribution in the global economic growth and ithas wide recognition in the area of poverty alleviation. The manufacturing sector is also considered as one of the significant economic contributor in the Asian sub-continent since last 1900 century.The management of solid waste has become an urgent problem. Product quality meansthat a product will accompany its producer from cradle to grave; prevention, recycling anddisposal of waste are part of a theory of the firm. Lean manufacturing tools areone of the most influential & most effective methodologies for eliminating wastes (MUDA), controlling quality, and improving overallperformance of any machine, system or process in any industry with the complete assurance of large annual profit margins. This research work has been carried out in aleading footwear manufacturing industry in Bangladesh to show how to eliminate its wastage and improve its quality by using Lean tools. This paper related to work isnot only applied to footwear manufacturing industry but also in any other types of organizations. By implementing Lean toolsa perfectsynchronization among cost, quality, production time and control time will be observed.

Keywords-- Waste Management; Quality Assessment; Labor Waste; Casual Shoe;Pareto Chart; Footwear industry

I. INTRODUCTION

The footwear industry of Bangladesh produces in excess of 50 million pair of footwear each year, of which 70 percent has a leather upper material. It has been estimated that this process generates 5,000 tonnes of leather waste, most of which is disposed of by landfill or incineration. However, increasing legislation and environmental concern is resulting in these disposal options becoming moredifficult and hence more expensive. The Footwear industry is already under price pressure from South America and Europe and increasing costs due to waste disposal will hinder the ability of a company to compete on the worldmarket. The demand of processed footwear is rapidly increasing in the busy World and consequently, it seems a rapid expansion of footwear industry in Bangladesh as like as other countries [1]. An industry wide approach would help to identify viable means of recycling leather, particularly finished leather. This would benefit not only footwear manufacturers but also industries such as leather products, leather tanning, furniture, and automobiles. In Bangladesh, the leather industry is well established and ranked fourth in terms of earning of foreign exchange [2]. Efforts have already been made to recover useful materials from waste leather, such as chromium compounds by chrome recovery techniques and proteins by chemical digestion, or to use it as filler in bricks and concrete, but these have not yet led to significant commercial processes. This study, therefore, sought to recycle waste leather with minimum pretreatment to produce commercially viable novel materials that could be used in the industry which generated the original waste, or other industrial sectors using similar materials.For manufacturing a Shoe, different types of materials are used such as leather, synthetic materials, rubber and textile. There are approximately 40 different materials used in the manufacturing of a shoe.However, the common material composition of a typical shoe is presented in Figure 1 [3].



The footwear industry over the last 20 years hasplaced significant effort in improving materialefficiency during the production phase, as well aseliminating the use of hazardous materials in shoeproduction. However, the environmental gainsmade in production are being overtaken by theconsiderable increase in the demand for footwearproducts. Worldwide footwear consumption has doubled every 20 years, from 2.5 billion pairs in 1950 to more than 20 billion pairs of shoes in 2005 (Table-1)[3].

Countries	Population (million inhabitants)	Footwear Consumption (1,000 pairs)	Footwear Consumption /Capita/Year
EU-25	463.5	2,355,667	5.0
Germany	82.5	320,800	3.9
France	59.6	335,500	5.6
UK	59.3	312,800	5.3
Italy	57.3	395,300	6.8
Spain	41.5	136,200	3.3
Netherlands	16.1	74,100	4.6
USA	289	2,007,899	6.9
China	1,287.1	2,900,000	2.2
Brazil	186.0	490,000	2.6
India	1,041.9	N/A	0.6
Vietnam	84.2	N/A	0.5

The leather sector has been playing an important role in the development ofcountry's economy [4].Moreover, the useful life of shoes is relatively short and progressively decreasing as a resultof rapid market changes and consumer fashiontrends. This creates a large waste stream at the endof the functional life of shoes, which are often beingdisposed of in landfills. Producer responsibility and other forthcoming environmental legislation, aswell as increasing environmental consumer demands, are expected to challenge the way the footwearindustry deals with its end of the production line waste. The world is verycompetitive where the basic concern of manufacturing companies is to increase their customers'satisfaction by constantly improving their delivery yet to keep quality at its best level [5].The initial part of the paper provides current trends regarding the amount of defects products produced by the footwear industry and waste management framework. Another sectiondiscussesthe quality assessment of end of the production line of this industryafter the implementation Lean tools.

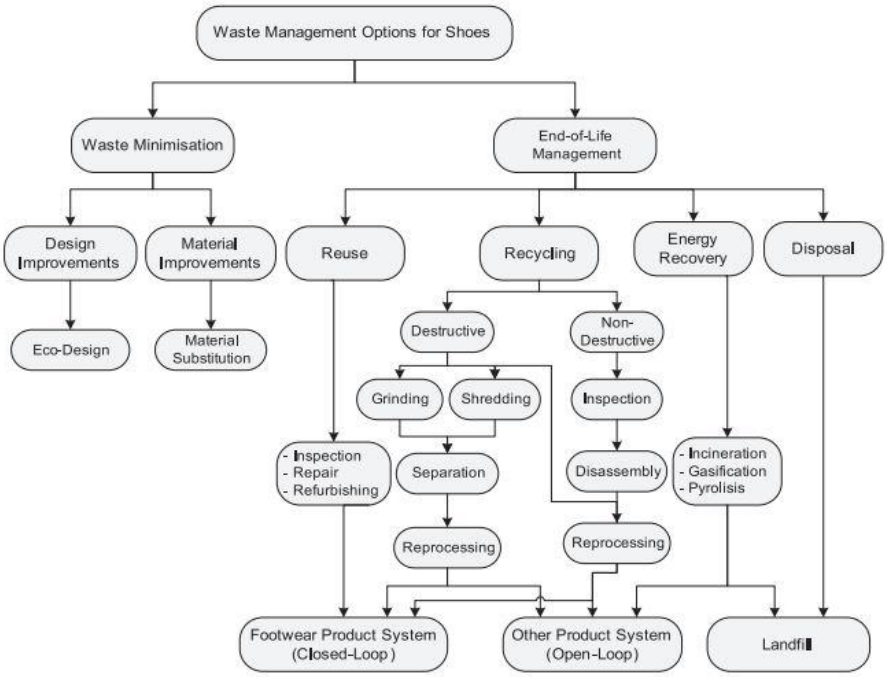
II. WASTE MANAGEMENT OF FOOTWEAR INDUSTRY

The footwear industry's response to the increasingproblem of internal & external consumer shoe waste has been negligible. In fact, only few shoe manufacturers have taken measures to manage its waste. The industriesrecycling program 'Reuse-A-Shoe' is the only product take-back andrecycling scheme currently established by a shoemanufacturer[6].

Integrated Waste Management

- Prevention
- Minimization/Reduction
- Reuse
- Recycling
- Energy Recovery
- Disposal

III. WASTE MANAGEMENT FRAMEWORK OF FOOTWEAR INDUSTRY



An integrated waste management framework forshoes has been developed and ispresented in Figure 2. This proposed framework dividesthe waste management options for shoes into twomajor approaches: proactive and reactive[7]. Proactive approaches include all measures that are takenwith the aim of minimizing waste during both the production and the end-of-life phase. In general, it makes far more sense to reduce or evenminimize waste than to develop extensive treatmentschemes and techniques to ensure that the waste posesno threat to the environment. Waste minimization activities range from product and material changes, toprocess changes, to changes in methods of operations[10]. Although there is a wide range of proactive wastemanagement activities, there are two major improvementmethods that could be applied in the footwear industry inorder to reduce or even minimize waste at the source,design and material improvements. On the otherhand, reactive approaches include all the other waste management options (such as reuse, recycling, energy recovery from waste and disposal) which act in responseto the waste problem when the useful life of the product has ended, and are hence referred to asend-of-life management.Total waste elimination is not possible. There will alwaysbe some waste that cannot be prevented at the source.Where waste material is produced, an optimal end-of-lifetreatment option must be selected with the lowestpossible risks to human health and the environment. Eachend-of-life management option brings different impacts todifferent parts of the environment like reuse, recycling, energy recovery from waste and disposal.

IV. ENVIRONMENTAL CONCERNSINTHE FOOTWEAR INDUSTRY

There are a number of environmental concernslinked with the footwear industry. These occur bothin the production of raw materials and within footwear manufacturing itself and include the useofhazardous materials and chemicals in shoes, the airand water emissions, and the solid waste generatedduring the production process. In particular, theuse of chromium as a tanning agent, which is highlytoxic and a suspected carcinogen, has been a majorenvironmental concern for the footwear industryover the last few decades.However, the most important environmentalchallenge that the footwear industry is currentlyfacing is the enormous amount of waste generatedat the end-of-life phase, with most shoes beingdisposed of in landfills. Landfill sites can result inserious environmental pollution of groundwaterand rivers, caused by landfillleachate[8].According to Bangladesh government Waste management Law 2011;Bangladeshi landfillhas only accepted biodegradable municipal waste that has been either incinerated or undergonemechanical and biological treatment.Thismeans that certain types of biodegradable materialsuch as leather, natural textiles, natural rubbers,etc., which are extensively used by the footwearindustry, will soon be required to be reused orrecycled instead of directly disposed of in landfillsites.

V. MANUFACTURING WASTE OF CASUAL SHOE PRODUCTION LINE

There are different types of manufacturing wastes like overproduction, defect, waiting, unnecessary processing, unnecessary inventory, unnecessary transportation between work sites and unnecessary motion in the work place. In a single production line, all types of wastes could not be seen. Base on the nature of production the manufacturing wastes was varied. Among these manufacturing wastes, defect production was very common in the Casual shoe production line[9, 10]. In this processing floor defect product was considered as the defect production. The amount of defect shoe was documented in table 2.

Table 2: Wasted products calculation of Casual shoe production line

Different stages of production	No of observation	Rejected shoes per batch	Average rejected shoe per batch	Average rejected shoe per batch (per day 12 batch)	Rejected shoe per million opportunity	Gap at Six Sigma level	Remarks
Sewing	1	22					Contains at three sigma level
	2	20					
	3	18	20	120	714	711	
	4	21					
	5	17					
Pre-Lasting	1	195					
	2	187					
	3	120	170	1020	6071	6068	
	4	160					
	5	190					
Post-Lasting	1	208					
	2	210					
	3	215	206	1236	7357	7354	
	4	197					
	5	201					
Finishing	1	3					
	2	3					
	3	2	3x24=72	432	2571	2568	
	4	3					
	5	3					
Total			468	2808	16713		

From table 2, it seems that the total defect product of Casual shoe production line was 16713 per million products of the production line which was considered as the three Sigma productions.

VI. LABOR WASTE OF CASUAL SHOE PRODUCTION LINE

The unnecessary motion of labor on the production floor was considered as one of the most common the manufacturing wastes which was also most common on the production floor of Casual shoe production line. After the implementation ofLean tools, it was expected that a number of labor could be eliminated from the production line. The expected number of eliminated labor was documented in table 3.

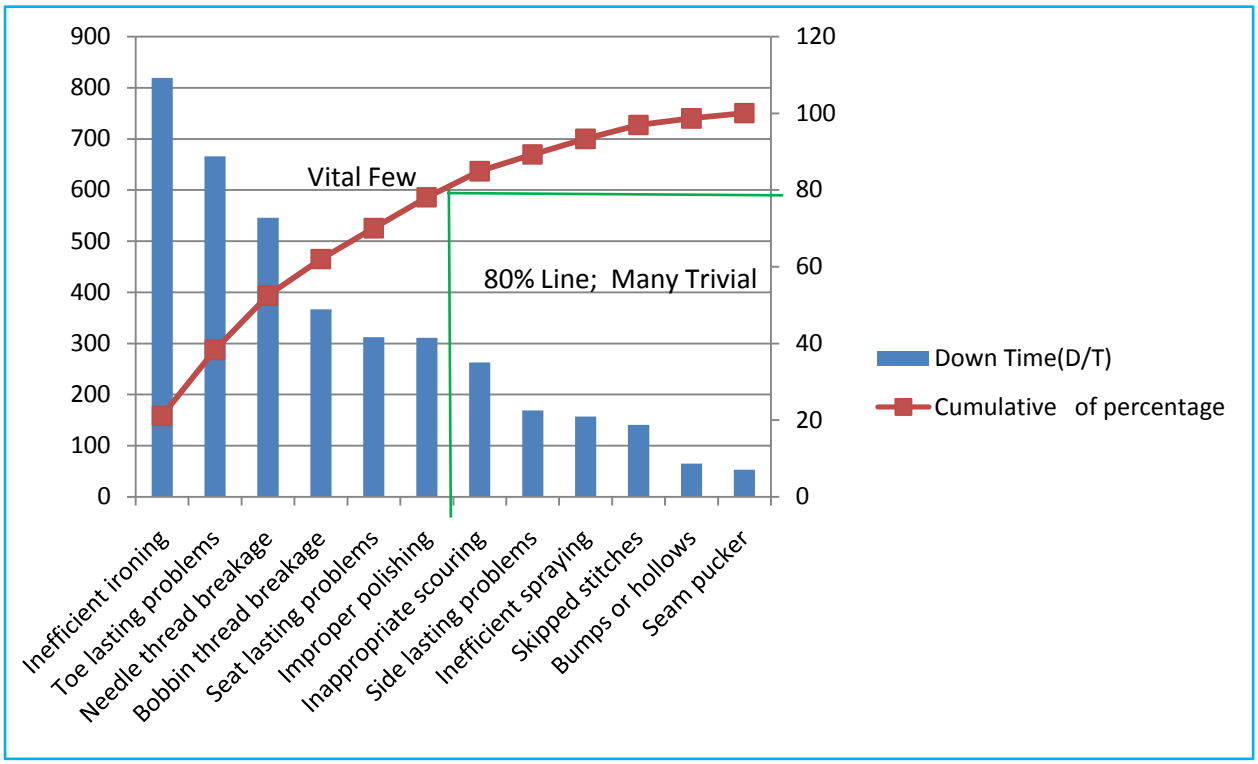
Table 3: Present and expected labor of Casual shoe production line

Different stages of production	No of labor at present state			No of labor at future state		
	O	AO	W	O	AO	W
Cutting	1	1	3	1	0	3
Fitting & Assembly	1	1	1	1	0	1
Sewing	1	1	2	1	1	1
Pre-lasting	0	0	4	0	0	2
Post-lasting	1	1	3	1	1	1
Finishing	1	0	2	1	0	1
Total	6	4	15	5	2	10

At present state, from table 3, it was seen that throughout the different production stages of Casual shoe production line, total labor were 25 where the operator (O), the assistant operator (AO) and worker (W) were consecutively 6, 4 and 15. At future state, after the implementation ofLean tools, it was expected that different types of bottlenecks and non-value added activities will be reduced.Thus, the present number of labor will also be reduced because of a number of unwanted labor were engaged to manage the different types of bottlenecks and non-value added activities.

VII. PARETO ANALYSIS

It is a statistical technique in decision making that is used forselection of a limited number of tasks that produce significant overalleffect.It uses the Pareto principle – the idea that by doing 20% of work, 80% of the advantage of doing the entire job can be generated [11].The Pareto Principle is also known as the "80/20 Rule" which is the idea that20% of causes generate 80% of results [12-14]. In this study, by using this tool it was tried to find out the 20% of causes that is generating80% Non-value added (NVD) activities. This tool focuses on themost damaging causes on a project (Figures 3). In this essence, the application of the Pareto chart consisting of causes for downtime orNVD activities along the X-axis while the Y-axis represents thecumulative percentage of downtime. Most of the NVD activities were documented on sewing, pre-lasting, post-lasting and finishing stepswhere these were frequently observed due to different causes. Thehighest frequency of NVD activities that derived the down time wasfound for mainly toe lasting problems while the lowest frequency wasvaried.



VIII. CONCLUSION

Forthcoming legislative requirements and marketpressures are expected to force the footwear industrytowards measures to deal with its end of the production line waste.This paper presented an integrated wastemanagement framework for the footwear industry basedon proactive and reactive waste management options.From the study done in the manufacturing industries in the 21st century, we conclude that Lean tools are indeed an organization strategy that can provide a continuous/breakthrough improvement in this competitive area[15]. Thus the proper use of tools and technique give an effective and great benefit to the organizations.

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