Residue Reduction and Reuse in Wooden Furniture Manufacturing Industry

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ABSTRACT— A small amount of something that remains after the main part has gone or been taken or used is residue. Wooden residue means the small remainder parts left after any operation done on a wooden piece in any wooden company such as saw-mills, wooden furniture industries, pallet-mills etc. There are certain reasons for residue formation. Residue formation affects the unit price of a wooden product as well as the break-even point as well as the economic situation of a wooden furniture industry. In this project, types of wooden residues, effect of residue formation on a wooden furniture industry, the reasons behind residue formation, processes to remove the reasons are broadly discussed. The effects on the economic situation of the unit price of a wooden product before applying the processes and after applying the processes are also shown. Properly applying the discussed process will lead to lower unit cost, lower break-even point and higher profit. In this project the various ways of reusing the unavoidable residues which remain after the application of the various residue reducing processes are also discussed.

Keywords— *Furniture industry, Reuses, Wooden residue*

1 INTRODUCTION

WOOD based industries are covering a vast era in the economic sector of Bangladesh. Now Bangladesh has some very renowned companies like Hatil, Navana and Otobi which trades these wooden products globally. These companies annually produce thousand pieces of finished products but as a matter of fact that, they also throw away a considering amount of wooden residue. These untreated residues can cause many damages both economic and environmental. So, treating this residue is necessary. As an example at the sawmill, unused wood waste (off cuts, shavings and sawdust) can be utilized as an energy source or recycled back into other wood based products [1]. When there is preservative treated waste and residues, this is disposed of in approved landfills. Studies have found that carbon continues to be stored in wood for a period of time after it has been transported to landfills Sawmills may have some limited approvals to burn small quantities of treated wood waste. Over the years many mills have regarded wood waste as a troublesome by-product of the sawmilling operation, resulting in its being disposed of as landfill or incinerated in Wigwam burners or the like.

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However, both have recently become contentious environmental issues and, combined with the rising costs of energy, mill owners have been forced to seriously consider the merits of using the residues as an alternative fuel source this has also coincided with the increase in demand for the residue as furnish for paper-pulp and panel board manufacture, due to the rising cost and increased competition for solid wood. Moreover nowadays most wood processing plants being built in developed countries in order to safeguard against certain and costly fossil fuel supply. In this project we are trying to find out the ways of less residue production and reusing them in sufficient manner.

2 OBJECTIVES

The project is aimed for the following research-

1) Finding out the types and amounts of wooden residue produced in furniture industry.
2) Economical effect of these residues on product price and production cost.
3) Determining the possible causes that can reduce the amount of residues.
4) Looking for the sectors where and how this residues can be reused.
5) Measuring the economic profitability of reducing and reusing this residue.

3 WOODEN RESIDUE AND ITS TYPES

Residues are materials that have passed through the production process consuming inputs, wearing machinery and tools, using manpower, participating in the company's fixed costs, although have not been converted into products [2]. They require spending on storage, transportation, treatment and final disposal and end in reduction of company profitability, increased risks; promotion of damage in corporate image, and can stay for long periods as

environmental liabilities. In the wooden furniture During the production process a large amount of residues of various types of formed.

Types:

Types of residues varies according to types of factories such as residues from sawmills, residues from plywood mills, residues from wooden furniture factories. Among all these residues some are similar, some are difference. So, According to factories different types of residues are listed below [2]-

1. Sawmills:
   a. Slabs
   b. Listings
   c. Thin boards
   d. Sawdust
   e. Planer shavings
   f. Chip dust, &
   g. Barks.
2. Plywood mills:
   a. Chain sawdust
   b. Log trims
   c. Peeled cores
   d. Green veneer trims
   e. Dried veneer trims
   f. Plywood edges, &
   g. Barks.
3. Wooden furniture:
   a. Chip dust
   b. Thin boards
   c. Planer shavings, &
   d. Barks
   e. Course residues
   f. Cores
   g. Sawdust
   h. Sander dust
   i. Particleboard waste

These residues are described briefly below-

Bark: Which makes up some 10 to 22 percent of the total log volume depending on size and species, can in itself represent a serious waste disposal problem unless it can be used as a fuel or removed prior to log preparation.

Fig.1.Bark Residues

Coarse residues: Such as slabs, edgings, off-cuts, veneer clippings, sawmill and particleboard trim, when reduced in manufacturing industry the main raw material is wood and size, make ideal fuel, especially when dry. They also have a resale value as pulp and particleboard furnish.

Cores: Produced from plywood peeler logs, are generally sold to sawmills or lumber or as pulp chips.

Fig.2. Cores

Sawdust: Being a product of all mechanical wood processing operations, particularly sawmilling, is generally not regarded as a prime pulping material due to its small size, although it proves to be acceptable for the manufacture of particleboard.

Fig.3. Sawdust

Planer shavings: Result from dimensioning and smoothing lumber, plywood and particleboard with planers during the finishing stage. They are considered ideal for particleboard production and are particularly good for heating kilns and dryers.

Fig.4. Planer Shavings

Sander dust: It is produced during the abrasive sanding of lumber, plywood and particleboard during the finishing stage. Due to its size and very low moisture content it is well suited for direct firing.

Fig.5. Sander dust

Particleboard waste: being in the order of five percent, is negligible compared to that generated in other mechanical wood-based industries, as it is largely recycled within the production process. In fact the waste from sawmilling and plywood manufacture make up a large part of particleboard furnishes.

Fig.6. Particleboard waste

4 CAUSES OF INCREASE IN RESIDUE FORMATION

Residues are formed for various reasons in a wooden furniture industry. Some of these causes can be minimized and the others are unavoidable. The cause's are-

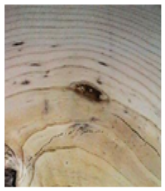
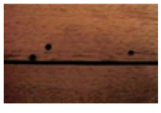
1) Defective raw materials
2) Low performance of workers
3) Faulty Machineries
4) Lack of design efficiency
5) Faulty production process flow
6) Unavoidable causes

These causes are elaborated below.

4.1 Defective Raw Materials

Defective raw materials lead to wastage of wood because of bad quality products which is non-conforming. Moreover from a lot of defective raw materials a small portion is used in production whereas the rest results in wastage or residue. Some common wood defects are stated below along with their effects and solutions.

TABLE 1
TYPES OF DEFECTS FOUND IN WOODEN RAW MATERIAL

Wood Defect	Features	Pictorial example	Effect	Solution
Blue Stain	A bluish graydiscolora tion on the woods surface.		Discoloration of wood	Can be cut off, placed out of sight, or concealed with a dark stain.
Check s or Splits	Breaks at the end of a boardthat run along the grain.		Can affect the strength andappearanc e of the board.	Should be cut off orworked around.
Cup	Warping along the faceof a board fromedge to edge.		Stock can be difficult to work with. Trying to"force it flat" can cause cracking along the grain.	Allowing the board to dry at the same moisture content under pressure, rip it into smaller pieces on a table saw, or use a jointer to remove the high spots.
Dead or Loose Knot	A dark, usually loose knot.		Can mar the appearance of the wood, fall out, become loose, or weaken stock.	Should be cut out, around, or glued in place and filled with a wood putty.
Sap	Accumulatio ns of a resinous liquid on thesurface or in pockets below the surface of wood.		Accumulation s of a resinous liquid on thesurface or in pockets below the surface of wood.	Should either be cut or scraped out and filled.
Tight Knot	A know which is tightly integrated into the surrounding wood		Can effect strength or appearance.	May be removed for appearance purposes.
Worm holes	Small holes in the wood.		Can simulate old or wormy wood.	Cut around worm holes or uses as is for decorative purposes.

4.2 Low Performance of Workers

Amount of residue is also dependent on the performance of workers greatly .Most of the time a huge amount of residue is formed for the low performance of the worker. There are some reasons for low performance of worker such as lack of training, lack of carefulness, wrong work distribution etc. An unskilled operator often makes more residues than a skilled operator. The worker who does not have proper training on operating any machine can't perform any operation properly. An unskilled operator removes more wood to get the desired piece from a plank. For an example, if it is possible to make two desired pieces from a single plank, an unskilled operator may make one piece out of one plank. There are some workers who don't care about the goal of the industry. They just care about the salary. So, lack of carefulness about the goal of the industry brings lack of carefulness in work. As a result the operation is not operated properly. In that case, there is a huge chance for the amount of the residues to be increased. For the previous example, if the worker is skilled but careless, it does not affect his mind, that how many plank should be used to get desired output or the input could be optimized. It may results in increase amount of residues. Another but minor cause of low performance of workers is wrong distribution of work to the worker. Any operation if given to the wrong worker may increase residue. For example, if the work of carrying any part from one operation table to another is given to a physically weak worker and the parts are heavy, the worker may drop out the part in midway. As a result the part may be damaged as well residue may increase. There are also some other minor reasons. Such one is psychological situation of the workers. Psychological situation of the worker has impact on work. Worker cannot pay proper attention to operation with a bad psychological condition. Family problem, financial problem etc. can cause bad psychological condition. So, working with a bad mental condition may increase residues.

4.3 Faulty Machineries

Faulty machineries play an important role in increasing residue formation in a wooden furniture industry. In this industry the machineries are used for cutting, surface finishing, attaching different pieces etc. Faulty machine equipment lead to the following problems-

1) Blunt cutting tools generate more residue and waste.
2) Unsatisfactory surface finishing.
3) The work piece can be broken during operation.

1) Critical design cannot be achieved accurately.

All of these problems reduce productivity and increase the number of residue.

4.4 Lack of design efficiency

The production of wooden furniture depends on how the design is made and how well the procedures are followed. Sometimes the design may have to be changed according to the raw material available. This change should be taken place if only it does not hamper the quality of the product. Moreover going to achieve critical design with incompetent machineries and workers can lead to bad quality production. So design efficiency should be taken care of in order to produce less scrap and residue.

4.5 Faulty production process

Every product needs an efficient production flow process. The better the production flow is designed the better the quality of the product is gained. This phenomenon also leads to optimize the resource that one has. In wooden furniture manufacturing industry the steps to produce wooden furniture are-

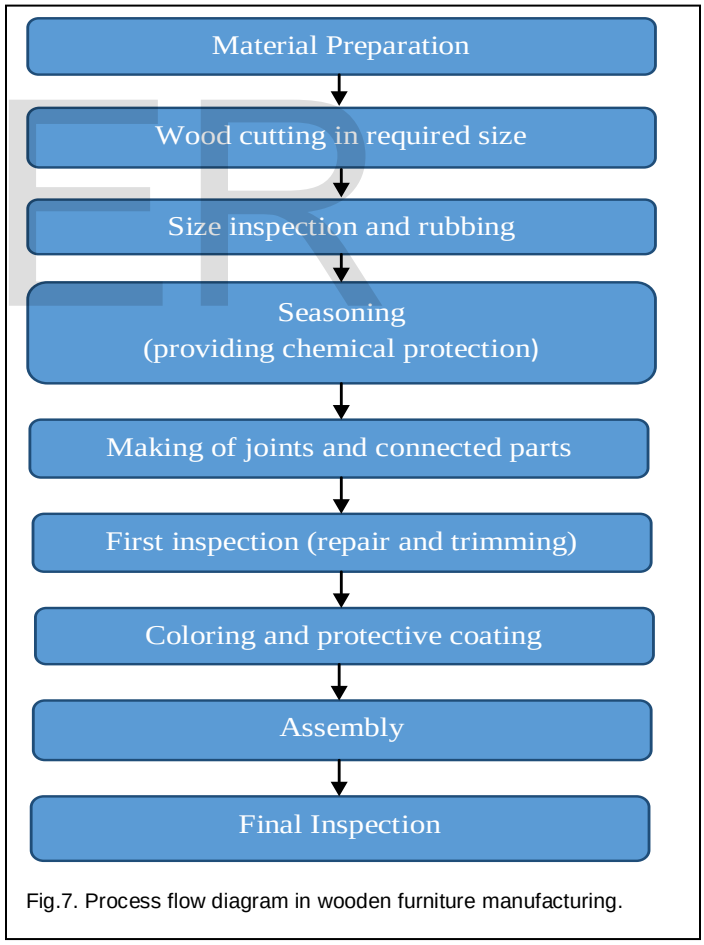


Fig.7. Process flow diagram in wooden furniture manufacturing.

Any discrepancy or irregularity in these steps results in excess residue formation.

5 SOME WAYS OF RESIDUE REDUCTION

There is a Japanese term called 'Kaizen' vastly used in various production processes, which means 'Continuous improvement'. It means hundred percent improvements are not possible. There is always a chance to improve production system. So, the amount of residue formation can be reduced by taken care of the reasons for increasing residue as discussed before. So, some ways are given below which can be applied to reduce residue formation-

a) High quality raw material;
b) Better performance of workers;
c) Better machineries;
d) Robust design;
e) Better production process.

These ways are briefly discussed below-

5.1 High Quality Raw Material

As discussed before, there are many defects found in the raw wooden materials which arrive to the industry for being processed. The defected parts are removed to get a better finishing in the product. As the number of defected parts increase, the amount of residues also increases. So, to reduce residue formation, the number of defects must be reduced as much as possible. But as wood is a biological product, so the process to decrease defects in woods will be very difficult and quiet a lengthy process, which is nearly impossible. So, at most it can be done that, raw materials of better quality can be purchased from renowned suppliers. And while the supplies of raw material are being received, sampling must be done properly. If this is done properly huge amount of residue can be prevented from being formed.

5.2 Better Performance of Workers

Performance of workers greatly deviate the amount of residues. As better the performance as lower the residue formation. According to the reasons for lower performance of the workers as discussed above, some steps must be taken to make better the performance. Such steps are providing training to the operators, motivating the workers, proper work distribution etc. These steps are briefed below-

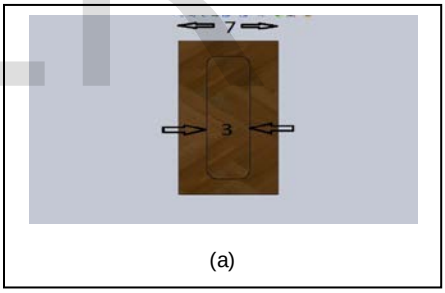
As untrained operator is one of the reasons which are responsible for increased amount of residue, training must be provided to the operators. If proper training is given, the operators can operate the machineries properly. Chance of making mistake will be reduced. Thus the performance of the operators will be better than previous. As a result, the number of residue formation will be reduced at a greater extant.

5.3 Better Machineries

Proper machineries play a vital role in wooden manufacturing industry as this industry put a great effort upon the aesthetic view of the products. As discussed above several operations are done on the raw material to get the output. So, different types of machines are needed to operate these operations. But among all the operations cutting is the major operation. So, it is very important for the cutting tool to be perfect as well as sharp enough to cut the plank in first stroke. Besides cutting tool, the whole body of the machine must be set up strongly to make sure that it will not vibrate during operation. Regular maintenance is needed to check if the cutting tool as well as the total machine is performable or not. By following these steps residue formation can be reduced.

5.4 Robust Design

As aesthetic appearance is very important fact in furniture industry, design has a great importance as well. Robust design is an important fact, by which maximum profitable output can be gained from optimized input. Robust designing is a designing which indicates the best design that can be implemented to a product. In another word robust design is strong and healthy design. The concept of robust designing in reducing residue formation can described as an example given below-



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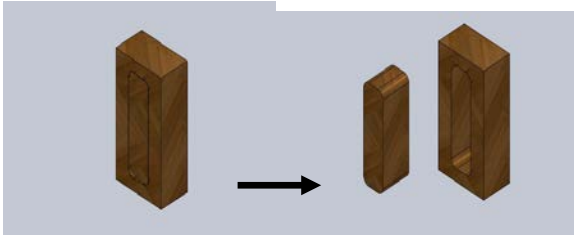
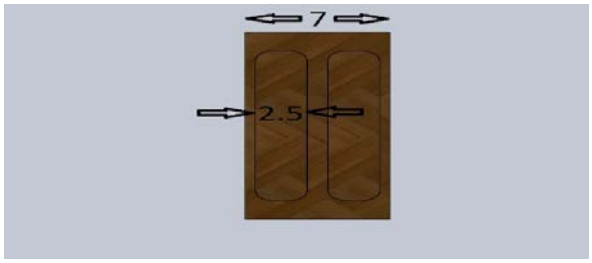


(b)

Fig.8. Cutting a slab (wrong design)

From the above design a slab (the back support of a chair) cutting is shown. The slab is designed to be 3 inch in width whereas the pallet is 7 inch. To get the slab with this requirement one has to provide an allowance for cutting, surface smoothing and burnishing. So to cut a slab of 3 inch from 7 inch pallet he has to cut actually 3.5 inch (say). So as a result only one slab can be cut through the pallet. This procedure will lead to excess residue formation.



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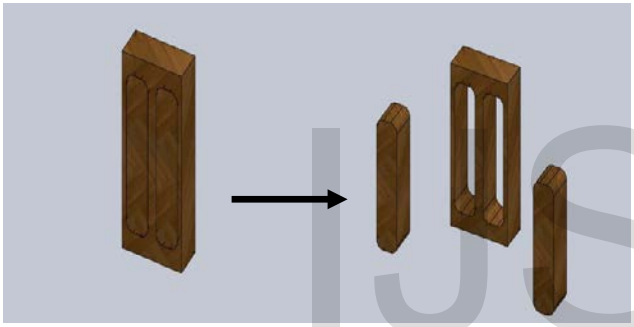


(b)

Fig.9. Cutting a slab (reviewed design)

Now in the cases where the design of the width of the slab does not have a vital impact upon the support system or strength of the furniture, this design may be changed to get the highest output possible. In the case above if the design is reviewed and changed to 2.5 inch from 3 inch then two slabs can be cut which increases productivity and reduce the amount of residue formation.

6 SOME WAYS TO RESIDUE REUSE

As we can see that the amount of wooden residue produced in wooden manufacturing industry is massive it has a huge opportunity to reuse it. Reusing the residue in both cases help the ecological conditions and economic state of the industry. This re-usage of the residues can be internal (inside the industry) and external (outside the industry). Both cases are described with their individual sector below -

1) Industrial wood processes can use bark and waste wood from their processing to create heat and steam that's required in the industrial process.
2) Wood pallets which is sawdust and shavings which have been recompressed back into a little pallet that looks a bit like chicken feed and those can be used in domestic or commercial fireplaces.
3) Use in making hardboards.
4) Use in packaging
5) Wooden residue as bioenergy or biofuel [3].

Creating heat and steam:

Wood residues can be used as a great source of natural fuel. In most of the wooden furniture manufacturing heat and stream is required for specific operations like heating the burnished furniture for long lasting, for seasoning(procedure for protecting wood from cavity or any insects) etc. In large industries this heat and stream production is carried out by burning the residues found in production. Moreover wooden residue may be used in boilers in factories too. This usage lessens the extra cost for fuel and as well reduces the amount of residue to be thrown in nature.

Domestic or Commercial fireplaces:

As we all know wood produces heat and thermal energy, a great amount of wood is used as heat producer and fuel throughout the year. To meet this demand wooden residue can be used but this residue will have to meet a certain procedures to be treated as all residues may not be proven hygienic or may produce a lot of smoke.

Use in packaging:

Wood packaging material or WPM is also called Non-Manufactured Wood Packing (NMWP) or Solid Wood Packing Material (SWPM). It is defined as hardwood and softwood packaging other than that comprised wholly of wood-based products such as plywood, particle board, oriented strand board, veneer, wood wool, wooden residue like pallets and slabs etc., which has been created using glue, heat, and pressure or a combination thereof used in supporting, protecting, or carrying a commodity (includes dunnage).
Examples of WPM include pallets, skids, pallet collars, containers, cratings/crates, boxes, cases, bins, reels, drums, load boards, or dunnage. Wood packaging made of exempt materials but combined with solid wood components must still be treated and marked.

Fig.10. Wood box made from wooden

Use in making hardboards:-

Hardboard (not to be confused with hardwood), also called high-density fiberboard (HDF), is a type of fiberboar which is a wood-product. This product is also know as Isorel or Masonite. It is similar to partic board and medium-density fiberboard, but is denser an much stronger and harder because it is made out exploded wood fibers that have been highly compresse Hardboard is comprised of exploded wood fibers that hav been highly compressed. This provides a greater density an strength than other fiberboard materials.

Most of the times it is made from wood fiber extracted from chips and pulped wood waste in the production process. Hardboard is a manufactured product made from wood. Ideally each piece should be perfectly uniform. Of course, perfect uniformity is never attained but the degree to which it is approached is one of the most important factors in determining the utility of particular types of hardboard. Certainly the over-riding quality control consideration in every hard-board plant is making a uniform product from an infinitely variable raw material.

Fig.11. Hard boards

There are two usual ways to produce hard boards from wooden residues. They are-

1) Wet- dry process manufacture
2) Dry process manufacture

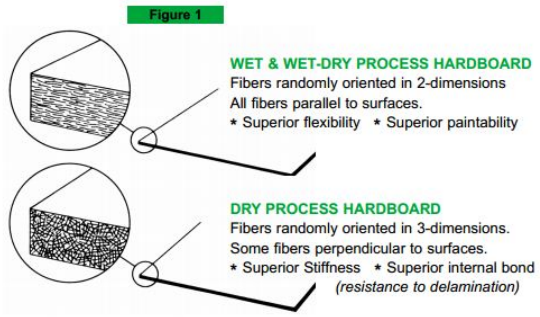


Fig.12. Hardboard process manufacture.

After manufacturing there are some procedures such as- Tempering Process -Tempering gives a harder, more paintable surface, greater strength and more resistance to liquid water.

The Humidifying Process-After pressing or heat treating all hardboard is bone dry. At this point moisture must be forced into the board to bring it to a level approaching that at which the board will stabilize when exposed to normal relative humidity [4].

Use as Bio-energy or Bio-fuel:-

Bioenergy is energy derived from organic material (biomass). Bioenergy can be used for power generation (such as electricity) and heat applications in all energy sectors including domestic, commercial and industrial purposes, and in the production of liquid fuels for transport. As a fuel it includes wood, wood waste, straw, manure, sugarcane, and many other byproducts from a variety of agricultural processes. One of the advantages of biomass fuel is that it is often a by-product, residue or waste-product of other processes, such as wooden furniture industry [5].

Bio-energy technologies from wood waste can:

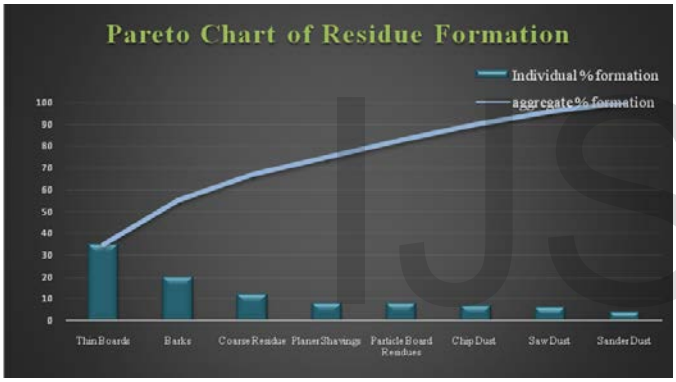
a) Produce heat, power or combined heat & power.
b) Process biomass into solid fuel
c) Refine biomass into liquid fuel

7 CALCULATION

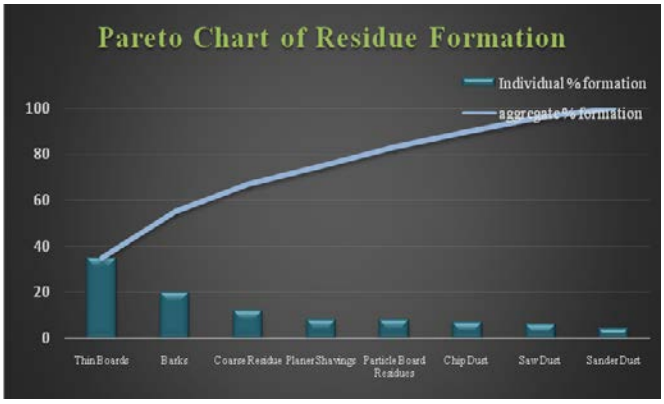
At first of the calculation we need to know that in a wooden furniture industry the amount of various residue formations. Below the usual amount of relative residue formation of various kinds are given [7].

TABLE 2
RELATIVE AMOUNT FORMATION OF RESIDUE

Name of the Residue	Relative Formation	Cumulative Percentage
Thin Boards	35	35
Barks	20	55
Coarse Residue	12	67
Planer Shavings	8	75
Particle Board Residues	8	83
Chip Dust	7	90
Saw Dust	6	96
Sander Dust	4	100



(a)



(b)

Fig.13. Pareto Chart showing the relative formation of residue.

revenue and variable cost per unit the following equations are made.

Break Even Point:

Total Cost (TC) = Fixed Cost (FC) + Variable Cost (VC)
again, VC = v X Q

Where,
Total revenue = R X Q

v = variable cost per unit
at BEP, Q = Quantity produced
Total revenue = Total cost

R = Revenue per unit
TR = TC
=> R X Q = FC + v X Q
=> Q = FC/ (R-v) (1)

The bill of materials for a VENUS CHAIR (a solo product of Brothers Furniture) is given below. In the bill the total cost along with the cost related to the residue is given.

TABLE 3
BILL OF MATERIALS FOR VENUS CHAIR (A PRODUCT OF BROTHER'S FURNITURE)

Work Order no	38
Carpenter Name	Soliman
Quantity	100

No	Parts Name	Cutting Size				sft/cft	sft/cft unit Price	price
		Length	Wight	Thickness	Quantity			
		2 Side Veneer						
1	Sit Rest	630	332	18	100	225.138	108.97	24533.282
						225.138		24533.282
				Residue	5%	11.257	5%	1226.664
					Total Sft	236.395	Total Price	25759.947
		18 mm 1 Side Veneer						
1	Sit	480	412	18	100	212.867	107.81	22949.201
						212.867		22949.201
				Residue	5%	10.643	5%	1147.460
					Total Sft	223.510	Total Price	24096.661

		Oak						
1	Back Leg	990	82	32	200	18.348	2530	46419.948
2	Front Leg	435	45	32	200	4.424	2530	11193.280
3	Side Rail	375	70	20	200	3.708	2530	9381.341
4	Front Rail	420	70	20	100	2.077	2530	5253.551
5	Leg Support	398	25	20	200	1.406	2530	3555.975
6	Back Rail	340	70	20	100	1.681	2530	4252.875
						31.643		80056.971
				Residue	10%	3.164	10%	8005.697
					Total Cft	34.807	Total	88062.668

		Gammary Wood						
1	Cona	90	90	30	400	3.433	1150	3947.473
						3.433		3947.473
				Residue	20%	0.687	20%	789.495
					Total Cft	4.119	Total	4736.968
	Hard Were				Qty	Typs	Unit Price	Price
1	Sutter Pin 25 mm				1800	Pcs	0.14	252.000
2	Sutter Pin 32 mm				1700	Pcs	0.15	255.000
3	Nail Gride				400	Pcs	0.98	392.000
4	38 mm Screw				1000	Pcs	0.46	460.000
5	1.5" Tarkata				800	Pcs	0.3	240.000
6	Glue				5000	Gram	0.128	640.000
							Total	2239.000
		Carpenter Wages						12000.000
		Total Wages						156895.244

Before calculation some data (only for the production of Venus chair) will be needed like the total initial investment (for land and setup factory) = 90, 00,000 BDT. The cost for machineries = 72, 00,000 BDT. Both of these investments will be pulled up within 5 years (equally by the revenue of three products – chair, bed and almirah)

From the above data for the production of 200 Venus chair per month

Fixed Cost (FC) = 156895.244 X 2 + % of initial investment + % of Cost of Machineries = 3,13,190.488 + [90,00,000/(5*12*3)] + [72,00,000/(5*12*3)] = 4,03,190.488 BDT.

Per month Variable cost per unit = 12 BDT. Revenue gained per unit = 3500 BDT.

Now from equation (1) we calculate Quantity in BEP

BEP_Q = 4, 03,190.488/ (3500-12) = 116 chairs.

TABLE 4
RECURRED AMOUNT OF RESIDUE IN DIFFERENT STEPS

Types of residue	Generally formed	Left after reducing	Left after reusing
Thin Boards	18.025	5.815	2.79
Barks	10.3	4.755	2.566
Coarse Residue	6.18	3.326	2.0978
Planer Shavings	4.12	2.7876	2.0282
Particle Board Residues	4.12	2.502	1.5759
Chip Dust	3.605	2.3887	1.5415
Saw Dust	3.09	1.72	1.04
Sander Dust	2.06	0.89	0.4175
Total	**51.5**	**24.1843**	**14.0569**

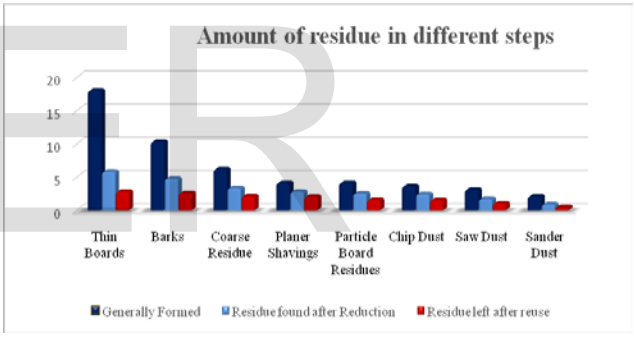


Fig.14. Gradual reduction in residue formation.

Cost saved due to residue reduction

Total amount of residue reduced = (51.5-24.1843) Sft & Cft
= 27.3157 Sft & Cft

TABLE 5
COST SAVED DUE TO RESIDUE REDUCTION

Part	Sft/Cft	Unit cost	Total cost (Bdt)
Sit Rest	11.94	108.97	1,301.26
Sit	11.29	107.81	1,217.15
Others	3.356	2530	8,790.68
Cona	0.728	1150	883.09
Total	27.3157		12,192.18

Cost saved due to residue reuse

Total amount of residue reused = (24.1843-14.0569) Sft&Cft
= 10.1274 Sft&Cft

If the recurred reuse cost is half than the buying cost then,

TABLE 6
REVENUE RECURRED BY REUSING RESIDUE

Part	Sft/Cft	Unit cost	Total cost (Bdt)
Sit Rest	4.427	54.485	241.21
Sit	4.1859	53.91	226.66
Others	1.244	1265	1573.66
Cona	0.27	575	155.25
Total	10.1274		2196.78

Cost saved due to residue reuse = 2,196.78 BDT.

Total Cost Saved per a lot of 200 chairs = 12,192.18 + 2,195.78
= 14,388.96 BDT.

So the reviewed Quantity in BEP again using equation (1)

FC = 3, 13,190.488+50,000+40,000- 14,388.96
= 3, 88,801.53 BDT.

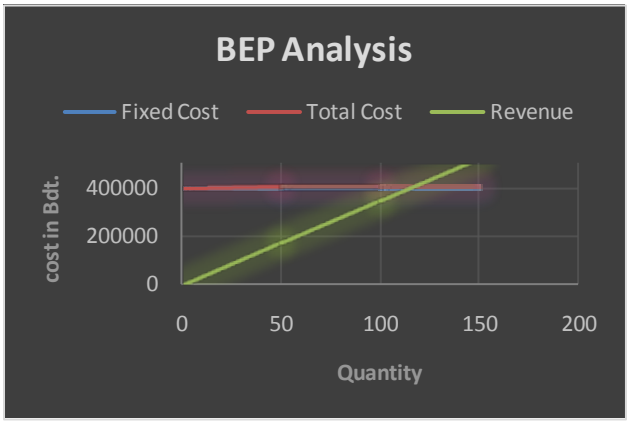
VC = 12 BDT.

Revenue per unit = 3500 BDT.

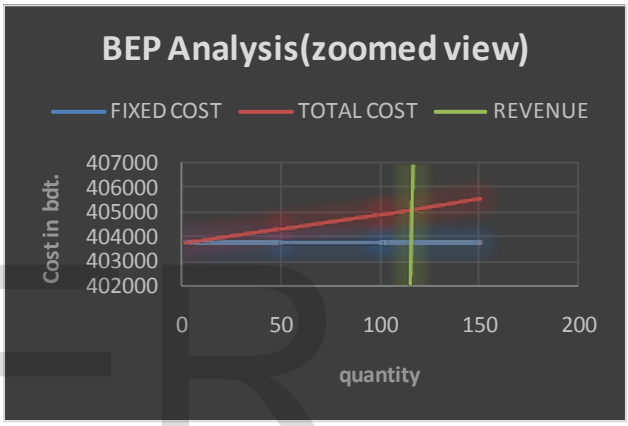
Now again from equation (1)

BEP_Q = 3, 88,801.53/ (3500-12)
= 110 chairs

So the number of chair that should be sold to recur the production cost has been decreased by 6.

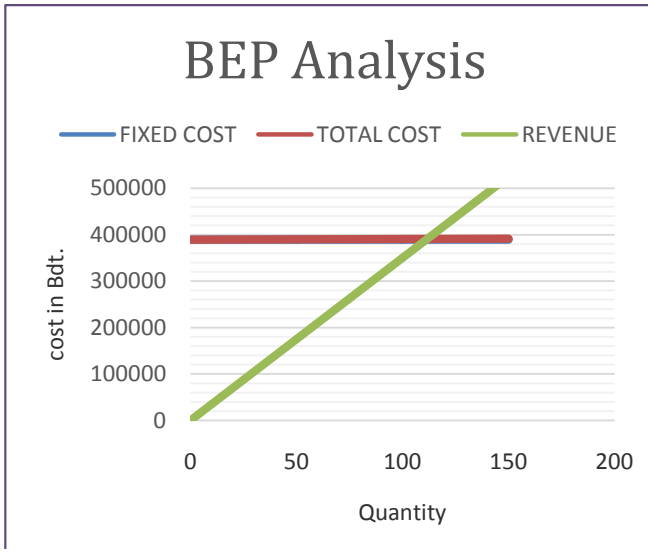


(a)

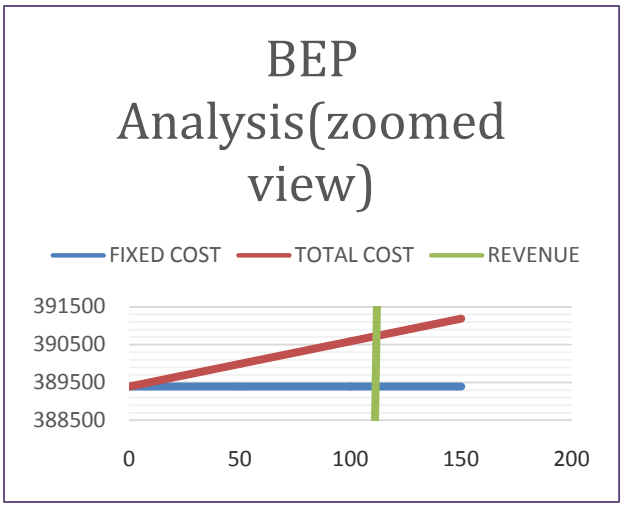


(b)

Fig.15. Break Even Point with generally formed residue.



(a)



(b)

Fig.16. Break Even Point with reduced and recycled residue.

8 RESULT AND DISCUSSION

In the completion of this project, the relative amount of residues was determined and the break-even point with the residues was found to be 116 units of Venus Chair (a solo product of Brother's Furniture, Bangladesh). Further applying the reduction method and reuse proposals it was projected to be decreased by 6 chairs in every 200 unit production of chairs i.e. the break-even point with reduced and reused residues was 110 units per month. . The proposal of this project had decreased the formation of residue from 51.5 Cft to 14.06 Cft.
The main objective of this project was to find out the residues, economical effect of it on pricing and production strategy and most of all searching out for ways to make this residue useful. Though the formation of residues is not much (approximately 10-15%), it can be vital if the industry is large enough to handle millions of cubic feet of wood.

9 CONCLUSION

Wood, by its very nature, is among the most recyclable, and reused materials. The fact that wood is renewable resource sets it apart from, and perhaps above, many other recyclable items. The reducing generation is the main strategy in the management systems of industrial waste. Considering the main factors generating residues in the manufacture of wooden furniture, it is recommended that the management plans for the sector prioritize the inclusion of quality control actions of raw materials and suppliers, product line diversification, and investment in training of manpower and technological modernization. Moreover reducing the residues and recycling them helps the nature to carry out the ecological balance. In the respect of wooden furniture industry a huge amount of wood raw materials are daily being processed to form finished products. This production also causes huge residue and increases the production and material cost [6].

10 APPENDICES

1) The data of Table-2 was found by multiplying the relative percentage formation of residues to the total value found for 200 Venus chair. The rule for finding these values were Amount of specific type of residue = total amount of residue X the relative percentage of the residue found in production process. As example- For generally formed residue column, thin boards were produced 35% of 51.5 Cft of wood. i.e 18.025 Cft.
2) The amount of residue reduction and reuse was projected under some real world inspections and measurements.
3) The monetary revenue gained by reusing the residue was determined on the basis of current circumstances of furniture industry.

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