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Scientific and Technical Approaches to Minimizing the Yarn Waste of Tufting Carpet Manufacture and Develop A Method to Reuse it for Manufacture of Textile Floor Covering Fluffy

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ABSTRACT

The textile floor covering industry has developed in recent years a great development, especially Mechanical Carpet industry which ranks the center fore of textile floor covering and this Great development had by means of modern technology applied methods, machinery, raw materials, processing and other which prominent impact in this development of the industry. The present method applied in Tufting carpet factories Result in some yarn waste of up to about 3%.

The study aims to Scientific and Technical Approaches to Minimizing the Yarn Waste of Tufting Carpet Manufacture And development of a new method for the production of textile floor covering fluffy and convert yarn waste into value-added.

To achieve these objectives, Plan was set to minimize the yarn waste of Tufting Carpet, development of a new method to produce textile floor covering, and select samples Specification which implemented by new developed method and testing of samples produced to make sure the standards of textile floor covering achieved.

The most important results of the study is reducing the waste carpet yarns industry "Tufting" from 3.2% to 0.67% , develop a new method to produce textile floor covering piles , producing 36 samples from waste carpet yarns with different specifications in fibers ,backing , density and pile height , All samples passed the tests of The Australian Carpet Classification Scheme (ACCS).

Included results of the study applied to minimize the yarn waste of Tufting Carpet All data which set schedules by Excel Program and Filter has been done on every kind of yarn, each quality and each design and Study has been the root causes of yarn waste of Tufting carpet by using a statistical representation of the data using 6 Sigma (Barito – Fish Bond), after analyzing causes of this waste, Found four sources caused waste (Man – Machine – Material – Method) are called "4 M System " .

Status for each cause corrective action to improve performance and reduce waste, the study also included steps to manufacture samples by method Creator and the results of tests made on samples and the extent of matching the samples to the specifications of the Textile floor covering and a comparison of results of the samples to each other.

The study recommends reducing tolerance difference weight between all yarn cones in the same creel (one operation) from suppliers, so that a maximum tolerance is ± 250 linear meters thread or equivalent by grams according yarn count used in case production of carpet with level pile, with doing necessary action to adjust all gauge parts which making pile form, yarn feeding system and yarn cones holder in Tufting machine with the need to use a special cutting (die tool or laser) to cut weight sample to know correct quality weight/square meter.

KEY WORDS: Textile Floor covering, Tufting carpet, Brush machine, yarn waste, 6sigma, 4 M system

INTRODUCTION

With the steady increase in the use of textile floor covering (Tufting carpets and weaving carpets) and the increasing rate of consumption has led to the great variety in production methods between mechanical production methods and handmade production method (10), the mechanical textile floor covering is divided to textile floor covering without pile such as (Needle punch – Kilim - weaving plastic mat – weaving planets mat – Alsomak) (15), and textile floor covering with pile (fluffy) such as (weaving carpet – Tufting carpet – knitting carpet – flock carpet – coir mat) .(2)

The research problem: is the current method used in the production of carpet (Tufting) factories results in some yarn waste up to about 3% for various reasons, including:

a- **Result of using a large numbers of yarn cones according to the Gauge and Width of Machine for example:**

Total number of yarn cones for machine **=** gauge (number of needles per inch) **X** 39.4 (inches/meter) **X** width of machine (meter).

- Machine width 4 meter, gauge 1/10, have 1580 yarn cones.

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- Machine width 4 meter, gauge 1/8, have 1270 yarn cones.
- Machine width 4 meter, gauge 5/32, have 1020 yarn cones.

Where the yarn cones for same creels supplied from supplier could not be equal in yarn weight or length on it by 100% but found some tolerance agreed between supplier and factory reach to ±1% from weight of yarn cone weight demand and therefore after run and finish yarn creel (operation), there are some empty cones and some other cones still have yarn reach up to 3% from total creel weight , In view of the production data in a company producing carpets in Egypt, who are using around 1520 tons per month of carpet yarn to producing 4250000 square meter / month, there you find yarn waste of 45 tons per month which is equal to 3.2% from yarn used .

b- Result of product some 2 pile or 3 pile or multi pile height designs for example:

- Machine 2 pile heights Cut/ Loop (high Cut – low Loop), Fig.1
- Machine 2 pile heights Loop/ loop (high Cut – low Loop), Fig.2
- Machine 3 pile heights Cut/ Loop (high Cut –Medium Loop - low Loop), Fig.3
- Machine 3 pile heights Loop/Loop (high Loop –Medium Loop - low Loop), Fig.4
- Machine Multi Pile Heights Cut/Loop (High Cut – Multi Loop),
- Machine Multi Pile Heights Loop/Loop (Multi Loop) , Fig.5

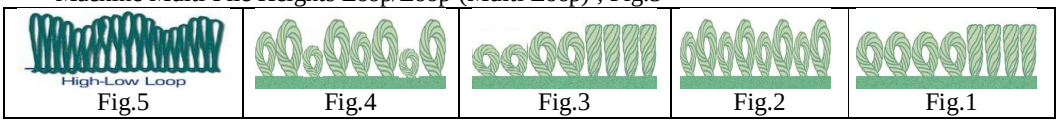


Fig.5 Fig.4 Fig.3 Fig.2 Fig.1

These results show remaining yarn on cones to be different from one to another , the cones which run high pile heights finished before the low pile height , also yarn consumption in design is different from one to another and due to this we can find 8% to 12% yarn waste according to the design .

Due to the machine width and the large amount of yarn on a cone, this plays a major role in the percentage of yarn waste. Also this requires a high number of employees and a large amount of space.

Recent studies have confirmed that the high cost factor one in the cost of Tufting Carpet production, is one of the important in the range of factors that affect on the productivity of factories and Studies stressed on the interest of the raw materials waste, **hence arose a research problem,**

<u>"Scientific and Technical Approaches to Minimizing the Yarn Waste of Tufting Carpet manufacture and develop a method to reuse it for manufacture of textile floor covering piles".</u>

The problem of the study is formulated in the following questions:

1. What's the possibility of the development of Scientific and Technical Approaches to Minimizing the Yarn Waste of Tufting Carpet Manufacture?
2. What's the possibility of creating a technological method to take advantage of this yarn waste in the manufacture of textile floor covering with pile (fluffy)?

The importance of search to:

1- Identify the ways which have increased the cost of production, and try to produce a product at a lower cost with a high specification.
2- Development of Scientific and Technical Approaches to Minimizing the Yarn Waste of Tufting Carpet Manufacture.
3- Development of a new method for the production of textile floor covering fluffy with high quality, without defects and at the lowest possible cost.

Research objectives: the aims to

1- Study the various methods used in the production of Textile Floor covering fluffy and comparison between them.
2- Formulation vocabulary and technology of the Textile floor covering fluffy industry (which are exclusive to this day, and secrets of the those who hold them) In the form of a scientific reference for those interested in this field In an attempt to link the research centers and centers of industry to prepare a generation able to deal with the technology of this industry Graduates from colleges and specialized institutes and those who want to invest in this field.
3- Development of a method to to minimizing the yarn waste of Tufted Carpet Manufacture.
4- Development of a new method to produce Textile floor covering fluffy.
5- Convert the waste of textile raw materials into value-added.
6- Open scope for small industries to invest in this field.
7- Create new employment opportunities to solve the problem of unemployment.

Previous Studies focused on studying in waste and recycling

Study Azza Abdel-Halim Sarhan (year 2000), entitled (Economics of manufacturing clothing from the waste of factories and the receptivity of students to this type of clothing) the aim of this study is how to deal with the

waste inside the garment factories and the extent of the effect of this waste on the environmental and economic these factories, to try to reach the optimal use of waste to produce a "vest" as a model for pattern cloth essential for young men and women in addition to some Accessories clothing from shoes, belts and bags. The survey found that the largest proportion of factories put their waste up for sale. Where also waste caused terrible economic problems for many of the factories. The results also indicate that largest percentage of factories see that the "classic" designs result in more waste during the cutting process, and this study agrees with our study in the waste conversion to value-added products and agrees with health and environmental conditions for use of man. (14) ، study Adel Mohamed El Hadidy (year 2001) entitled (to Protect the environment from pollution by recycling of waste) When the new system was introduced to overcome the waste problems the solutions came in two kinds, First kind non-technological solutions that do not require from them any benefit from burning the waste, Burial and Stacking.

The second kind of technological solution Is to minimize waste within the production processes, because to minimize the waste to the greatest extent possible. Contributes significantly to the decreased size of the problem from the start and re-use, use of the textile waste and Consequently make maximum use of all the elements of production, Restoring recycling of waste requires available technological solutions and other required, With the addition a lot of ideas and experiments, research, and mechanical processes necessary, with using advanced technologies, and then a good employ for products, Work of basic researches, In terms of the economic aspects, Environment, As well as health, For the use of these products produced from textile waste. This study agrees with our study in terms of minimizing waste to the maximum extent possible Then optimize the use of waste by the a new technology with employed product well employ (11), study Adel Mohamed El Hadidy (year 2001) entitled (Benefit from waste in the manufacture of industrial textile fabrics) Where the study is to minimize the percentage of cutting waste by using mixed marking and the way of design of experiments and waste remaining with suggested System to deal with it, This study agrees with our study in terms of minimizing waste to the maximum extent possible and reuse waste to produce healthy product (12), Study Zeinab Ahmed Abdul Aziz (year 2004) entitled (Recycling of textile solid wastes, in the garment industry, and its effect on the environmental and economic), This study aims to identify the methods used for the management of non-returned textile waste.

For operation in the garment factories, and suggest some technological methods that lead to reducing the percentage of textile solid wastes So that our motto is prevent pollution and not treatment of pollution, and suggest some practical ideas to take advantage from these emission and waste directly in creating new products by establishment an integrated plan for how to manage these wastes, and exploitation of the remains of textile solid wastes which remaining from the previous step for recycling and use it in the production of non-woven fabrics Suitable for industrial purposes and new environmental , and transfer garment industry from industry with harmful effects in environment to a clean Industry and environment friendly.

The study reached to Possibility of minimizing the waste at source by Technical preparation department and Patron Worker, and Reached to the possibility of benefit from the waste in the manufacture of many products, can also establish a new industry in Egypt (garment and it's accessories industry from clips and waste) (9). Study Eman Awad Seraj Aly (year 2006) entitled (Comparing job performance of Blankets producing from different types of Fibers and recycle Materials), Aim of this study to study the effect of using different percentages from fibers and recycled blended raw materials on the efficiency of blankets performance, and try to study the properties by sense and comfort, the study has reached that there are strong moral relations between the physical properties (warps/10 cm – wefts/10cm – weight/mt2) and using fibers and recycled materials, also find strong moral relations between the mechanical properties and using fibers and recycled materials, also find strong moral relations between the heat properties and using textile recycled fibers(5) . Study Abeer Mohammed Hassan Punjab (year 2008) entitled (Recycling of jute fabrics and using them in different uses), aim of this study is to take advantage of the raw jute fabrics which found in large quantities as empty packaging not in use Which, if left over time accumulated constitute a large environmental burden and their disposal by burning or Burial lead to significant economic losses can be avoided by recycling of these fabrics to chart in different uses such as making bags , garment accessories, curtains fabric, Sheeting and paintings, The study reached to the use of dyed yarn In making embroidery on jute after bleaching with using different methods for printing in addition to merged with textile materials and different techniques Raise its value of art and economic, Where possible, employ raw jute in various fields such as making bags, garment accessories, curtains fabric, Sheeting and paintings (13). Study Jihan Mahmoud Abdel-Hamid (year 2008) entitled (The recycling of waste cutting stage and utilization in the production of some textile Craft), the aim of this study is to study how optimum use for waste cutting stage, the study implemented the different samples from the waste found it close in terms of weight with the factory sample in addition to equal the thickness of the sample under study with the factory sample, demonstrating the quality and validity of the raw material for use (6).

Practical experiments

a- DMAIC system is followed to reduce the yarn waste where:

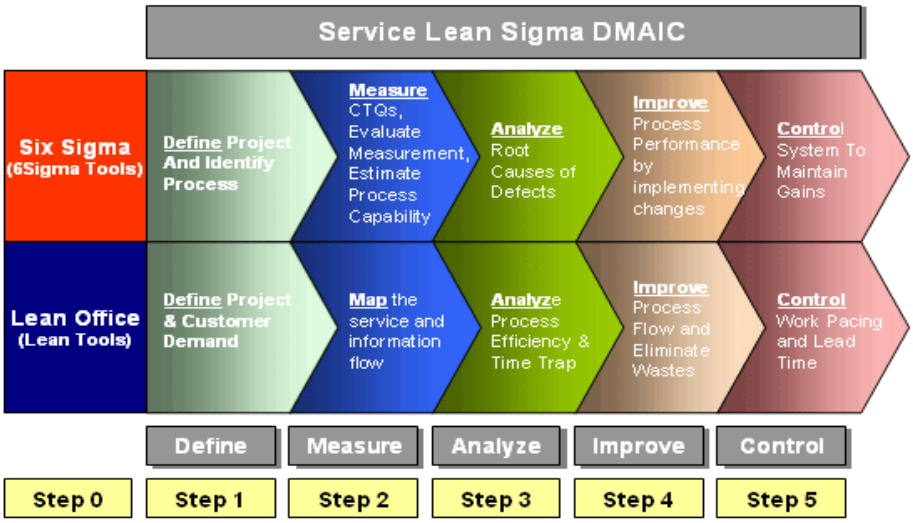


Fig. (6) Service lean Sigma DMAIC

b- Flow up chart process for Tufting production

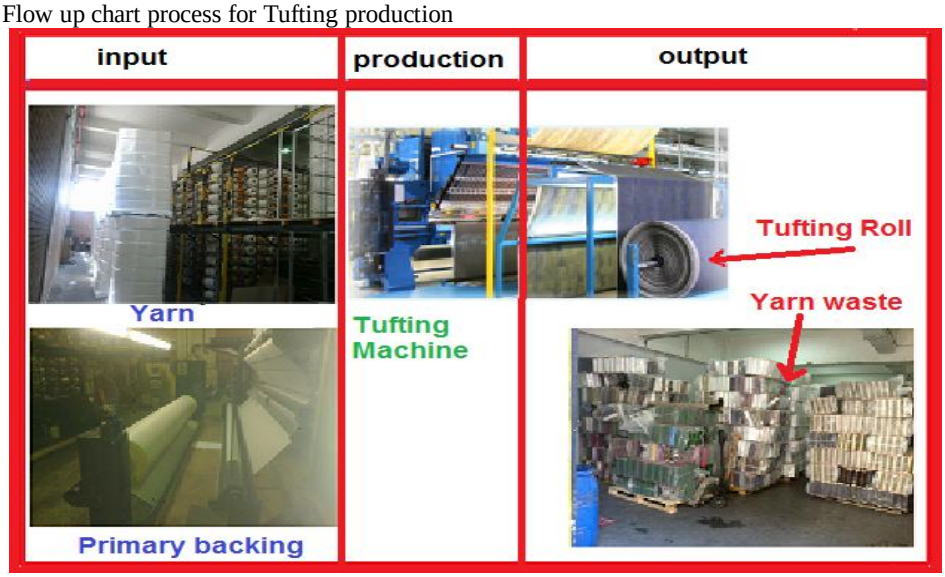


Fig. (7) Flow of Tufting process

c- Documented procedures and work instructions for each Tufting production process as the following:

1. When receiving yarn creel from supplier by warehouse and add its data to the computer system with the Batch Number, Material, color, supplier, permit number added, net weight and number of Yarn cones, and then placed label on each pallet of creel by permit number added for warehouse, therefore, when creel exchange conformity creel details ate same as computerized data.
2. calibrated counter of measuring the length of carpet roll every month and placing label on every machine have calibrated length of counter , In other words if the meter reading of 100 meters and actual length of production is 95 meters

That mean the length of the real roller = meter reading x 0.95.

3. Using cutting die or cutting device by laser to make weight sample to ensure the weight is as requested for the product.
4. Check Jerker height So that it is on the same at all points of Machine width
5. Make sure that the height of bed plate is level across the machine.
6. Weekly maintenance work to repair or change broken reed fingers.
7. Adjust reed finger So that it is in one level and the location of needles between them in the similar position for all needles.
8. Change of covering sand paper for feeding yarn rolls every 6 months Ensuring that all covering sand paper from same type and ensure that the sanding wrapped one level without air or space between sandy paper and body of yarn feed roll.

9. Adjust the pressure foot of the primary backing So that it is on the same height in all points of machine width equal thickness of one Tufting knife.
10. Adjust Needles or Needles Modules so that it is on the same height from primary backing and all in the same line and parallel.
11. Adjust loopers or loopers Module So that it is on the same level in all points of machine width from Needles and reed fingers and in the same line also takes into account all loopers from the same type and model.
12. Repair and adjustment all Needles for tension and feeding spike rolls of primary backing or change spike rolls to other new .
13. Use tubes which carry out the yarn from Cone holder on creel to collect board on Tufting machine with same diameter, supplier and antistatic.
14. Adjust direction and correct position of cone holder and spring on the creel at the front of the yarn input tube which carry out the yarn to collect board.
15. Receive the required number of yarn cones for creel and all must be equal in cone weight according to demand for all qualities with level pile, and in case supplier supplies cones with weight less than weight requested, they must supply extra of cones equal in weight to make up to the original request.
16. Reduce the tolerance of the difference in weight between cones of the same creel from supplier so that the maximum of ± 250 linear meters of yarn or what equal it by grams according the yarn count used.
17. When running qualities with multi pile heights, Consumption is calculated for each thread in the design by tuft design system program and therefore request yarn cones in different weights each of them is arranged on the machine So that they running on place allocated to its design, and therefore the yarn cones begins in different sizes and finish in the same sizes.
18. Development done on the Tufting brush and broom machine by changing some parts to become suitable to tuft on the Eave or rubber instead of plastic or wood and increasing area of tuft with changing feeding cut short fibers system to feeding continues yarn system .

RESULTS AND DISCUSSION

Part I: Minimizing waste to least extent possible

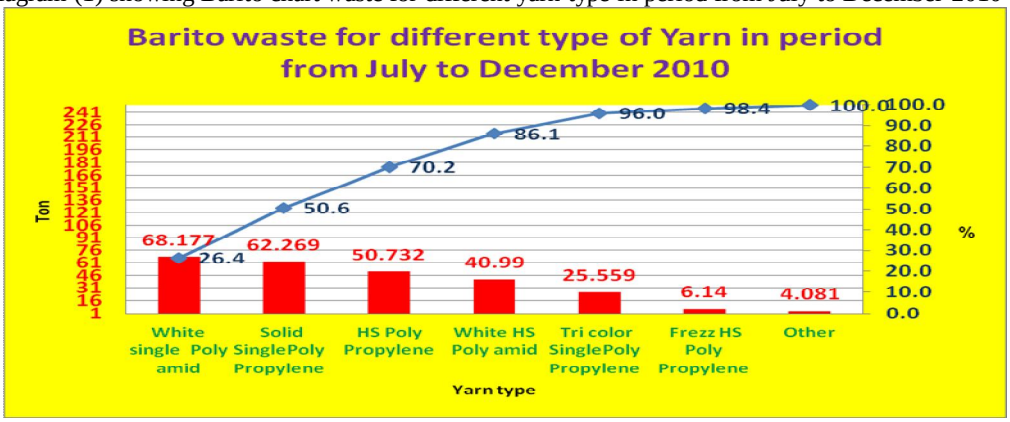
Results of waste for 6 months are taken as following:

The table (1) showing the total waste in period from July to December 2010.

Data Barito			The total period from July to December 2010.					Yarn Type
waste Ton	Upward	% from total input	%	Average waste /creel Kg	Waste Kg	Input kg	# of Creels	
68.177	26.4	26.4	2.3	166.3	68177	2908627	410	White single Poly amid
62.269	50.6	24.1	3.6	214.7	62269	1734880	290	Solid Single Poly Propylene
50.732	70.2	19.7	6.2	248.7	50732	823238	204	HS Poly Propylene
40.99	86.1	15.9	3.5	219.2	40990	1165019	187	White HS Poly amid
25.559	96.0	9.9	2.4	164.9	25559	1049855	155	Tri color Single Poly Propylene
6.14	98.4	2.4	3.3	146.2	6140	188289	42	Frizz HS Poly Propylene
4.081	100.0	1.6	5.9	272.1	4081	68952	15	Other
		100.0	3.2	198.0	257948	7938860	1303	Total

Table (1) the total waste in period from July to December 2010

The diagram (1) showing Barito chart waste for different yarn type in period from July to December 2010



The diagram (1) showing Barito chart waste for different yarn type in period from July to December 2010

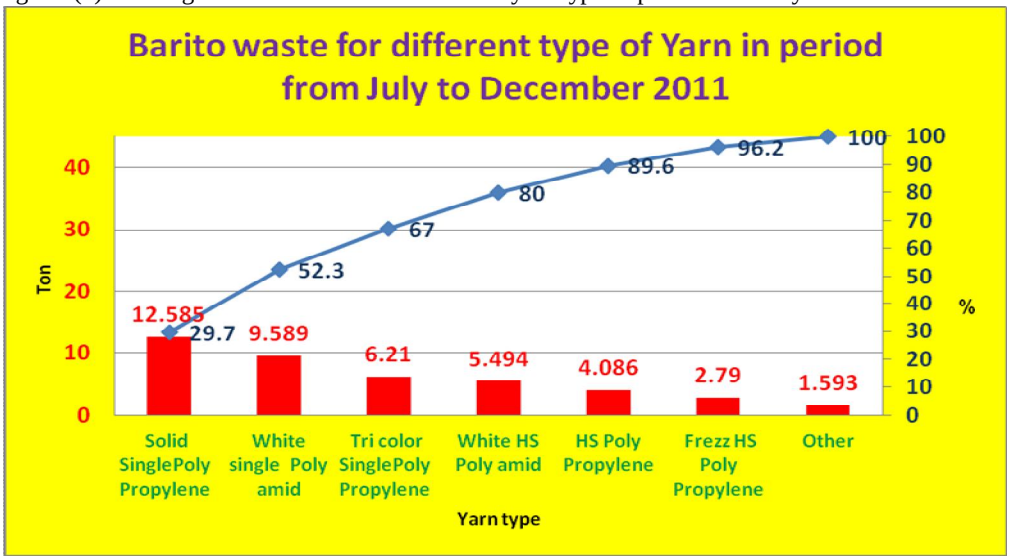
Corrective actions were implemented during the period From January 2011 to June 2011
Results were followed during the six months following From July 2011 to December 2011

The table (2) showing the total waste in period from July to December 2011.

Data Parito			The total period from July to December 2011.					Yarn Type
waste Ton	Upward	% from input	%	average waste /creel Kg	waste Kg	Input kg	# of Creels	
12.585	29.7	29.7	0.9	62	12585	1386312	204	Solid Single Poly Propylene
9.589	80	22.6	0.3	23	9589	2932583	424	White single Poly amid
6.21	44.4	14.7	0.8	47	6210	761940	132	Tri color Single Poly Propylene
5.494	57.4	13	0.8	47	5494	675119	116	White HS Poly amid
4.086	89.6	9.6	1.8	77	4086	229114	53	HS Poly Propylene
2.79	96.2	6.6	1.6	43	2790	174956	65	Frizz HS Poly Propylene
1.593	100	3.8	1.1	57	1593	145755	28	Other
		100	0.67	41	42347	6305779	1022	Total

Table (2) the total waste in period from July to December 2011

The diagram (2) showing Baritochart waste for different yarn type in period from July to December 2011



The diagram (2) showing Barito chart waste for different yarn type in period from July to December 2011

Comparing the results of the period from July to December 2011with the period from July to December 2010 as showing in Table (3)

Comparing between periods July to December 2011 and July to December 2010.						Yarn Type
%	average waste /creel Kg	Waste Kg	Input Kg	# of Creels	Year	
0.3	23	9589	2932583	424	2011	White single Poly amid
2.3	166.3	68177	2908627	410	2010	
0.8	47	5494	675119	116	2011	White HS Poly amid
3.5	219.2	40990	1165019	187	2010	
0.8	47	6210	761940	132	2011	Tri color Single Poly Propylene
2.4	164.9	25559	1049855	155	2010	
0.9	62	12585	1386312	204	2011	Solid Single Poly Propylene
3.6	214.7	62269	1734880	290	2010	
1.8	77	4086	229114	53	2011	HS Poly Propylene
6.2	248.7	50732	823238	204	2010	
1.6	43	2790	174956	65	2011	Frizzy HS Poly Propylene
3.3	146.2	6140	188289	42	2010	
1.1	57	1593	145755	28	2011	Other
5.9	272.1	4081	68952	15	2010	
0.67	41	42347	6305779	1022	2011	Total
3.2	198	257948	7938860	1303	2010	

Table (3) Comparing between periods July to December 2011and July to December 2010.

The diagram (3) showing the results of yarn waste for July to December 2011and July to December 2010.

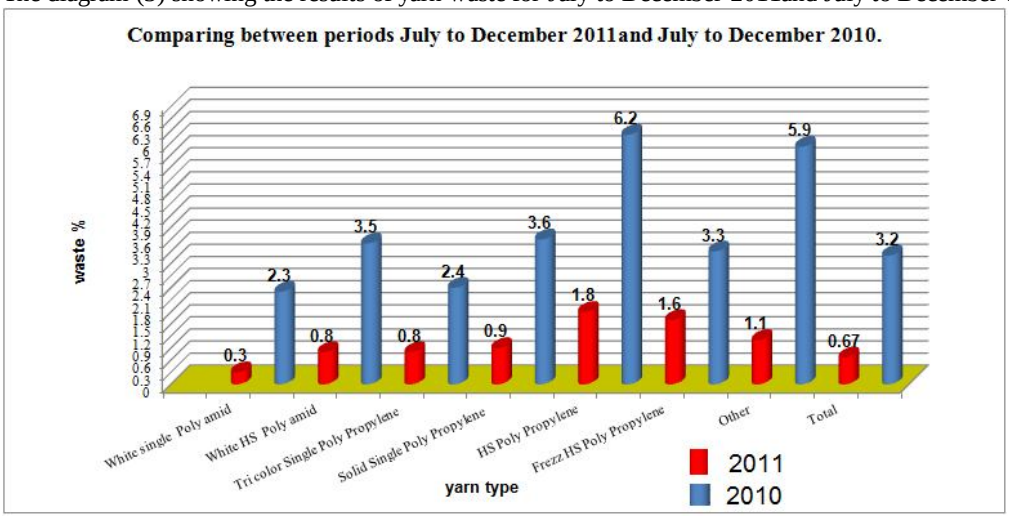


Diagram (3) the results of yarn waste for July to December 2011and July to December 2010.

The table (4) showing the waste amount and Percentage Reduced from 2010 to 2011

Total	Other	Frizzy HS Poly Propylene	HS Poly Propylene	Solid Single Poly Propylene	Tri color Single Poly Propylene	White HS Poly amid	White single Poly amid	Waste Kg
42347	1593	2790	4086	12585	6210	5494	9589	2011
257948	4081	6140	50732	62269	25559	40990	68177	2010
215601	2488	3350	46646	49684	19349	35496	58588	KG reduced
84	61	55	92	80	76	87	86	% Reduced

Table (4) the waste amount and Percentage Reduced from 2010 to 2011

Part II: development mechanical and manual method to producing textile floor covering fluffy from yarn waste.

FIRST: THE MECHANICAL METHOD

We changed and developed the Tufting brush or broom machine to producing Textile floor covering fluffy, as any hand-broom or brush consists of basic which made from wood or plastic and filling with fibers from natural or synthetic and that is significantly similar to production of Textile floor covering fluffy Where the basic doing the same work of primary backing and secondary backing for Textile floor covering fluffy and the filling material of brush or broom doing same yarn piles of Textile floor covering fluffy, from this point we get idea to development Tufting brush and broom machine to producing Textile floor covering fluffy.

Initial experiments were made on brush Tufting machine by small size in a style interlock to ensure View segment after compaction sample next to each other appear, as if the piece.

Fig (8) showing 4 pieces for basic of brush carpet before and after interlock

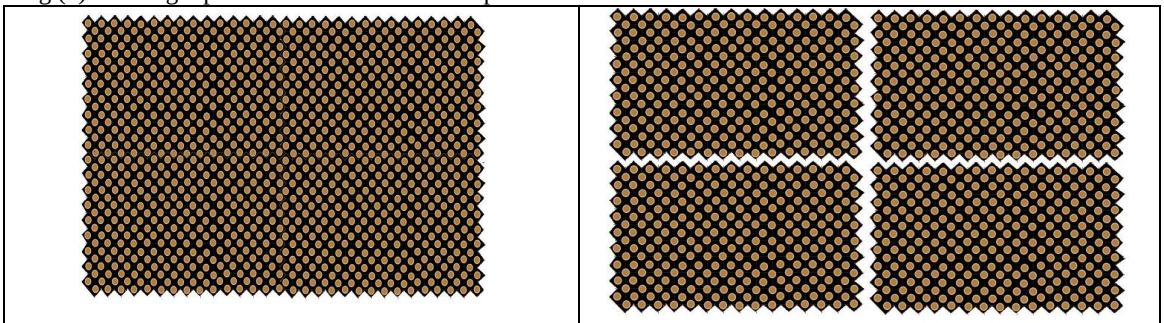


Image of pieces after interlock together	4 pieces for basic of brush carpet before interlock

Fig (8) 4 pieces for basic of brush carpet before and after interlock

And noticed that the pieces after interlock together, appear as one piece, therefore, when the compaction the multiple pieces of them can cover any area of ground same as tiles, rug and Tufting carpet , fig(9)showing the brush and broom Tufting machine

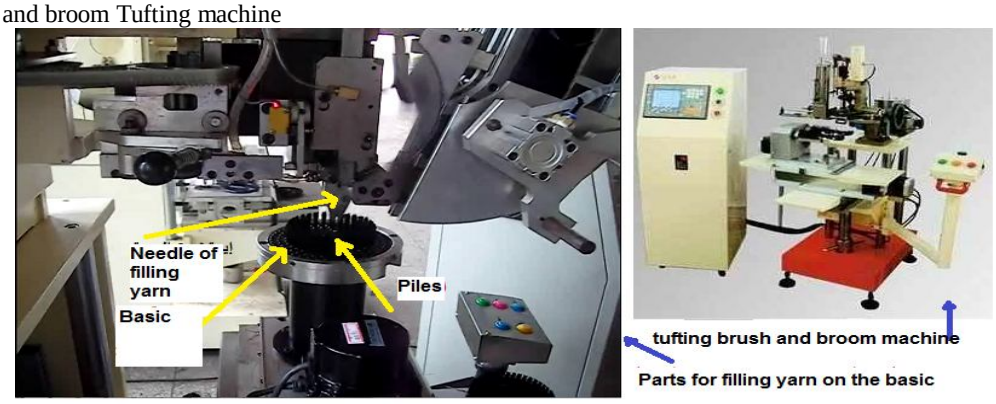


Fig (9) brush and broom Tufting machine

Samples were manufactured in small sizes and interlock together as showing in fig (10).

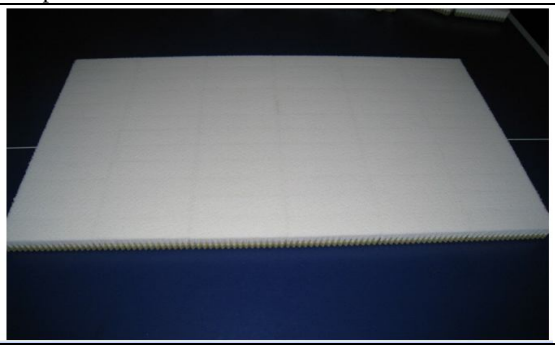


Image of samples after interlock

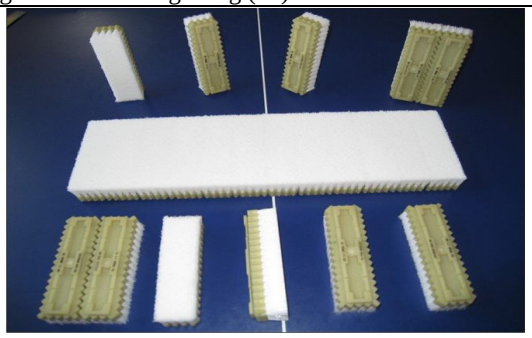
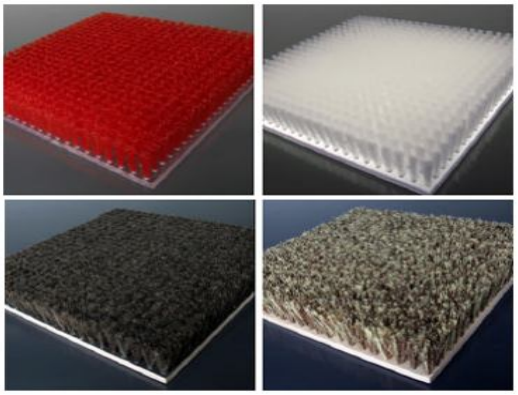


Image of samples before interlock

Fig (10) mechanical samples before and after interlock.

Fig (11) showing mechanical samples with big size on wood and Eava rubber basic

Images of mechanical samples on wood Basic



Images of mechanical samples on Eava rubber Basic

Fig (11) mechanical samples with big size on wood and Eava rubber basic

Second: The manual method:

1-Making holes in Basic Eva Rubber

Fig (12) showing types of Drill holes in Basic and sample Straight holes in basic Eava rubber

Straight holes in basic Eava rubber

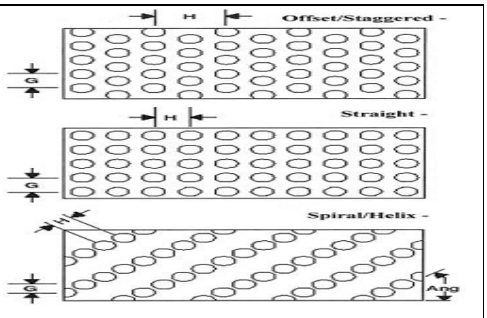


Fig (12 types of Drill holes in Basic and sample Straight holes in basic Eva rubber.

2- Insert yarn into a small tube with diameter equal holes diameter, which was making on Eva rubber, then cut filaments (yarn) with length equal required pile height plus base thickness.

Fig (13) showing the yarn after putting in tube and cut it with length required

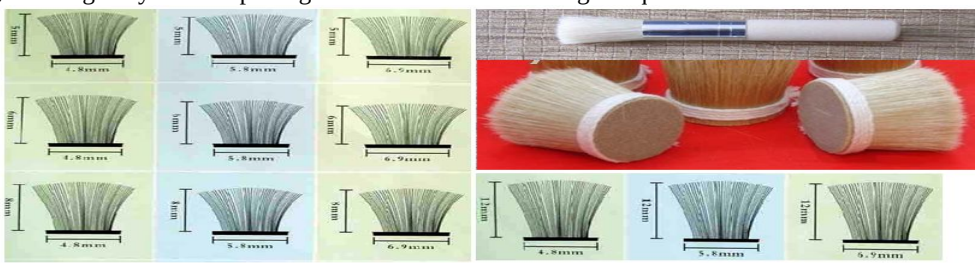


Fig (13) yarn after putting in tube and cut it with length required

3-Enter filaments pipe in the hole of Eva rubber after placing glue to install them, and after fill in all holes, we get a piece of Textile floor covering fluffy as tile.

SIGNIFICANT RESULTS

1- The study reached to the reasons that lead to increased wastes and established procedures and work instructions, which minimize yarn waste.
2- Minimizing the Percentage of waste from 3.2% to 0.67% of its total input running. Yarns.
3- Conclusion of a mathematical equation linking waste percentage and the cone weight for level piles qualities
   Y = -0.4917 X + 3.325
   Where: **Y** wa*s*te Percent, **X** cone weight in KGS
4- Conclusion of a mathematical equations linking waste quantity 'KGS' and the yarn count 'Dtex' for level piles qualities
   Y = 0.035X for yarn count 1400 Dtex.
   Y = 0.0525X for yarn count 2100 Dtex.
   Where: **Y** wa*s*te quantity in KGS, **X** Yarn count in Dtex.
   The Procedures and work instructions do not allow the worker to finish creel and start new creel before making sure that the percentage or quantity of waste as not increased from the calculation of the equation.
5- Implementing a number 36 samples with different specification in basic thickness (4 mm - 6 mm - 10 mm), pile height (8 mm – 12 mm – 20 mm) and Materials (Polypropylene - polyamide - Polyester - wool).and fig (14) shows some samples that have been implemented .

Fig (14) samples samples that have been implemented.

6 - All samples passing the tests of Textile floor covering fluffy; this proved that the samples are able to heavy Duty.

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