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MINIMIZATION OF DHU% OF MEN'S SHIRT CATEGORY IN APPAREL INDUSTRY

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Abstract —*Demand of the quality product in the Apparel Industry is increasing rapidly and to survive in today's competitive market it is the prime target of most of the brands to keep the right product constantly in the market. But at the same time keeping the profit margin at higher side, reducing lead time and increasing the productivity is the toughest challenge of most of the apparel manufacturers. This research paper includes detail study of all the minute factors of higher DHU (Defect per hundred units) in Men's shirt apparel manufacturing, scientific data collection, analysis and application of the suitable mythology to reduce the DHU% at the minimum level.*

Keywords- *DHU %, Product Quality, Men's shirt, Operation, Re-work, Productivity, Pareto Chart, Fishbone diagram.*

I. INTRODUCTION

Textile and Apparel is still one of the major export goods of the developing countries and engages large manpower in this sector. Most of the operations of the manufacturing operations of this industry is still depends upon the manpower only. So apart from the other factors defects generation is at higher side due to human error, this is because of the unskilled and casual mindset of the workers. In the apparel manufacturing rejected garment at the final stage is a major issue which leads to an increase in the cost of production because of Re-work. At the same time most of the defective garments are not re-workable and even after re-work the garment is not of a fresh class. We all know that "Quality is never an Accident" and if you have a lousy product or service, good luck selling it. There's a reason many companies aren't around anymore. So to minimize the DHU% an experimental study is carried out at a men's shirt manufacturing company located at Gurgaon, Haryana (India). In this experimental study most of the section of the shirt manufacturing is included the pre-data collection of the defect generating section is taken and a set of action is applied for better outcome and reduction of the DHU%.

II. RESEARCH MYTHOLOGY

The ideas which are used in this project are aimed at identifying analyzing and implementing the new quality tools in various sewing sections of men's shirt to reduce the DHU% at an optimum level. The research includes the theoretical idea of different operations, various defects, the defects occurring position, Pareto chart, cause-effect diagram. In this Project scientific way of data collection is done in all the sewing sections at existing quality set-up of the factory. Analyzing and identifying the major defects contributing in higher DHU% by using Pareto chart and providing the proper action plan and intensive checking and follow-up. Later on in the same way as data collection analyzing and finding the DHU% is done & Comparison with the previous DHU% is done.

III. DATA COLLECTION AT EXISTING QUALITY SET-UP

The factory of Men's shirt manufacturing this was decided to cover all the major sections. Date wise number of defects, total production, and Pass and alteration pieces are noted down and DHU% is found. For the reference purpose the front sections full data is shown as below.

Details of Defects, section wise at exixting quality set-up (June-2018)									
Front Section		Back Section		Sleeve Section		Collar Section		Cuff section	
Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects
Needle marks @ button hole plkt	656	Slant main label attached	410	Open stitch	371	uneven top stitch	495	Uneven top stitch	365
Skip stitch @ button hole plkt	424	run down @back yoke top stitch	260	Uneven box height	275	Uneven SPI	327	Visible down panel	315
Open stitch	411	Insecure label attached	254	Uneven diamond shape	237	Uneven peak	252	skip stitch	250
Check mismatch	245	Uneven Back yoke Panels	243	Slant sleeve plkt attached	227	Uneven collar point	246	joint stitch	170
Wavy stitch	219	uneven SPI	240	Needle marks	220	Skip stitch	159	open stitch	141
Pocket slant and missplace	181	needle mark @ label	230	Skip stitch	164	Uneven Piping visible	127	Uneven Cuff width	139
Freying @ button hole plkt	102	Down stitch @ main label	152	Run down stitch	157	Pinching	73	Logo placement improper	116
Broken stitch @ (button Hole) plkt	75	Uneven dart length	104	Unmatched Check	139	fullness	63	Uneven Cuff diamond shape	115
Run down stitch	72	Wrong side dart	21	Pinching-	119	uneven Collar patch	60	Needle mark	55
Uneven Top stitch	41	Wrong side Labels	3	Uneven SPI	118			uneven Cuff hemming width	0
puckering	41	CV	0						
CV	32								

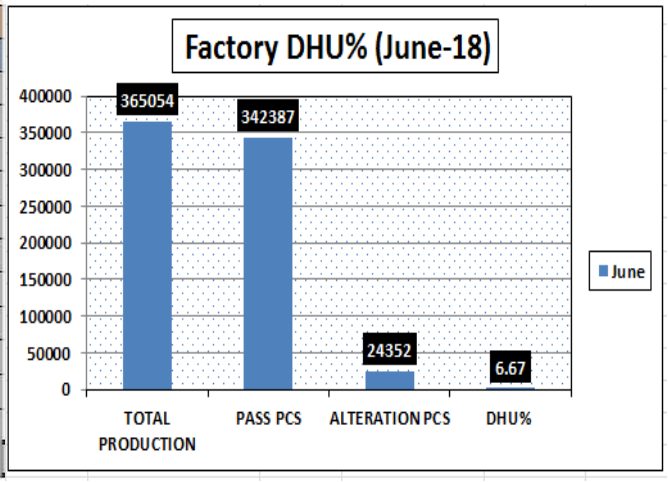
Details of Defects, section wise at exixting quality set-up (June-2018)									
Assembly-1 Midline Section		Assembly-1 Endline Section		Assembly-2 Midline Section		Assembly-2 Endline section		Assembly-3 Midline Section		Assembly-3 Endline section	
Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects	Name of Defects	Total Defects
Skip stitch	459	run down @ cuff	1190	Skip stitch	175	run down @ cuff	613	Skip stitch	285	run down @ cuff	950
joint out	355	Run down stitch @ collar	821	joint out -Pcs	144	Run down stitch @ collar	569	joint out	284	Run down stitch @ collar	695
uneven top stitch	325	run down @ bottam hem	476	Needle mark	142	Pinching	243	Open Stitch @ sleeve	248	Pinching	324
Open Stitch @ sleeve	233	Pinching	443	uneven top stitch	134	run down @ bottam hem	106	uneven top stitch	234	Missing ID label	281
Roping/ Puckering	178	Wrong Size label	321	Open Stitch @ sleeve	113	Wrong Size label	77	Needle mark	203	Wrong Size label	232
Pinching	169	Missing ID label	275	Roping/ Puckering	110	Missing ID label	53	Pinching	181	Sleeve pleat gap not same	191
Needle mark	88	Frying @ FOA	266	Pinching	90	Frying @ FOA	47	Roping/ Puckering	179	run down @ bottam hem	172
Run down stitch	70	Sleeve pleat gap not same	148	raw edge(A/H,freying)	66	Sleeve pleat gap not same	35	Run down stitch	136	Needle mark	165
ID label Wrong	37	Needle mark	105	ID label Wrong	53	joint out	28	ID label Wrong	76	Frying @ FOA	147
raw edge(fraying)	23	joint out	69	Run down stitch	22	Needle mark	21	raw edge(fraying)	12	Wrong kaj button possition	125
CV	0	Uneven sleeve plkt	57	CV	0	Wrong kaj button possition	20	CV	7	Collar and back label center out	94
		Wrong kaj button possition	53			Uneven sleeve plkt	18			joint out	54
		wavy shoulder top stitch	34			wavy shoulder top stitch	13			Uneven sleeve plkt	42
		center out	14			center out	10			wavy shoulder top stitch	13

Table:-3.1 Section wise daily defects data of June Month

3.1 Factory DHU% at existing quality set-up

The factory DHU% at existing quality set-up is 6.67 which is higher side because of numerous reasons. Details of the same are provided as below:-

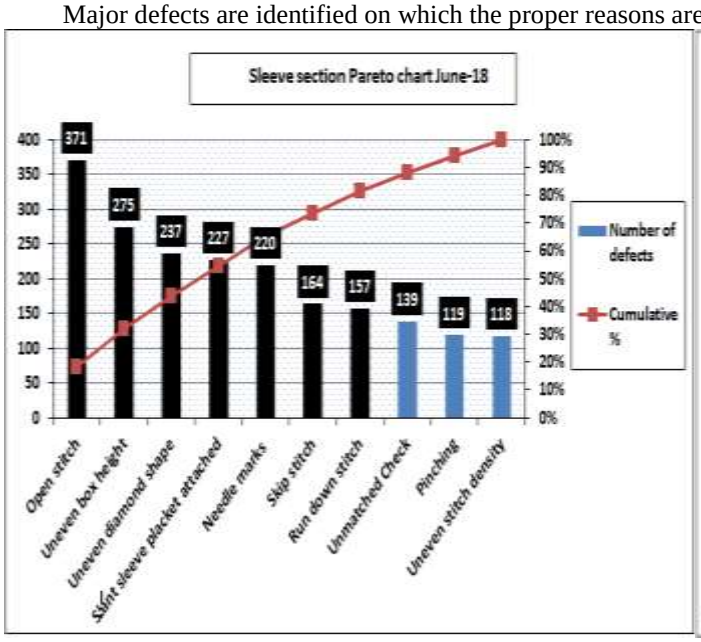
Factory DHU% Details (June-2018)				
SECTION	TOTAL PRODUCTION	PASS PCS	ALTERATION PCS	DHU%
Front	52193	49694	2499	4.82
Sleeve	51116	50560	2027	4.03
Back	60042	58125	1917	3.27
Collar	48151	46349	1802	3.79
Cuff	47467	45801	1666	3.76
Assembly-1 Midline	19518	17581	1937	9.91
Assembly-1 Endline	22893	18835	4272	19.21
Assembly-2 Midline	12080	11031	1049	8.73
Assembly-2 Endline	12258	10405	1853	15.03
Assembly-3 Midline	19918	18073	1845	9.46
Assembly-3 Endline	19418	15933	3485	18.25
Total	365054	342387	24352	6.67

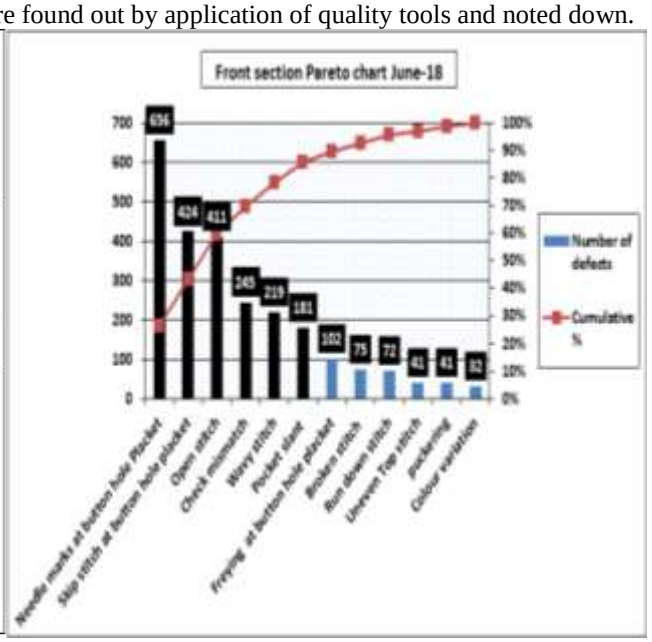


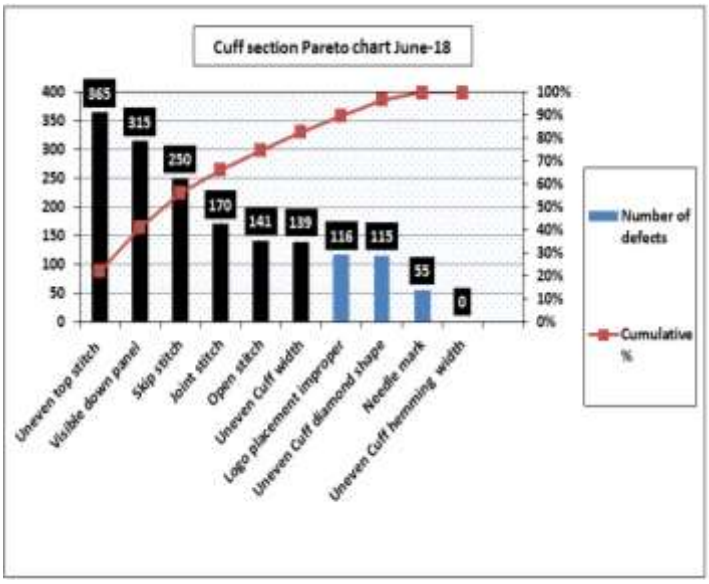
Graph:-3.1 Factory DHU% at existing quality set-up (June-18)

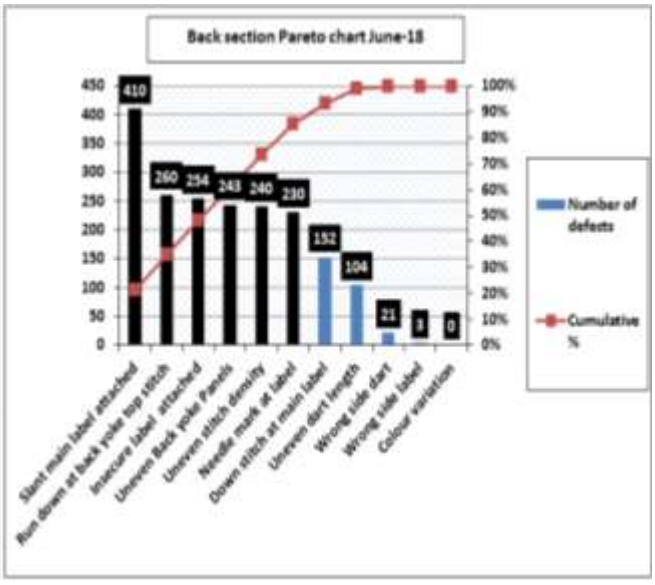
3.2 Analysis of collected data by using Pareto-Chart: -

For proper identification of the major defects contributing to higher DHU%, Pareto chart is plotted against every section. Major defects are identified on which the proper reasons are found out by application of quality tools and noted down.









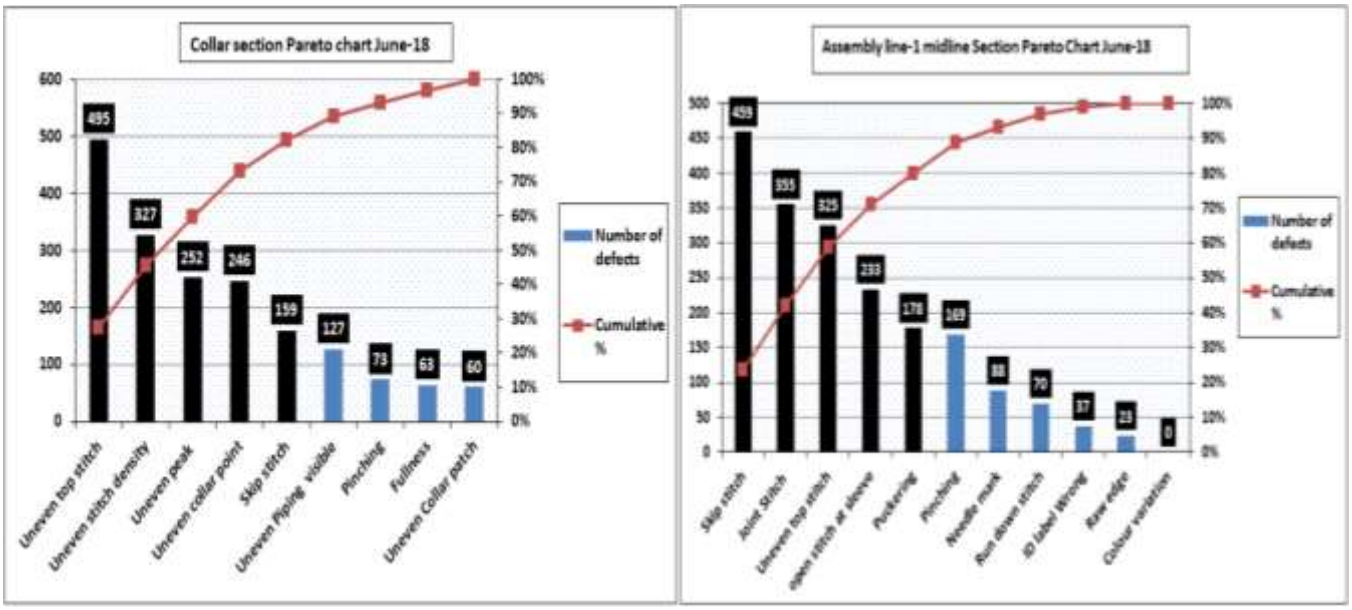
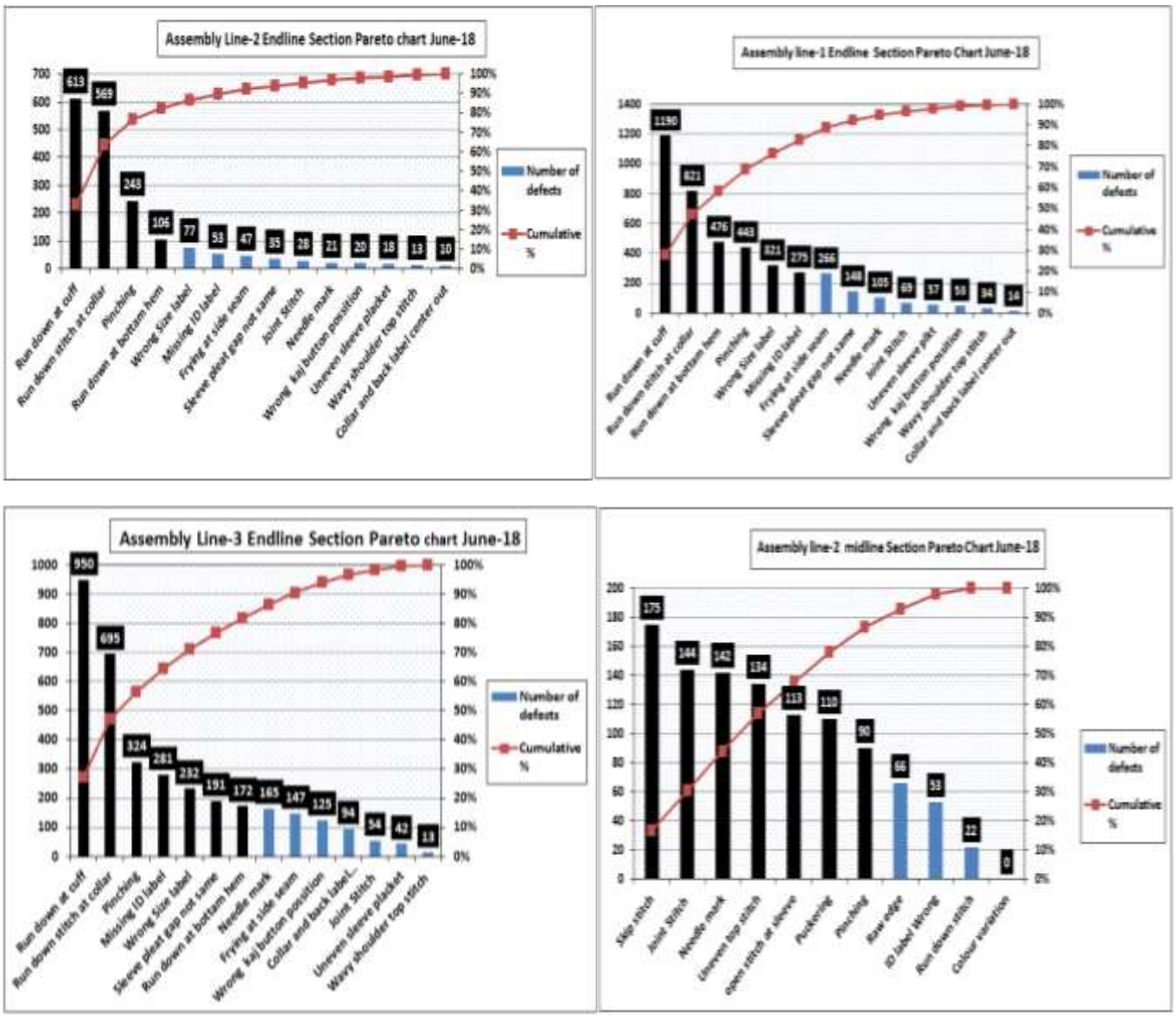


Fig: - 3.2 Pareto chart section wise of major defects



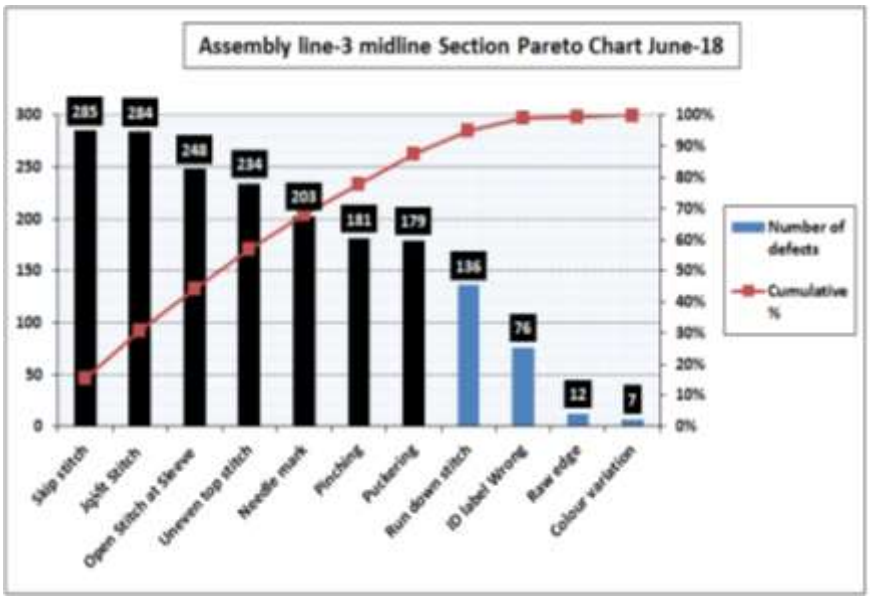
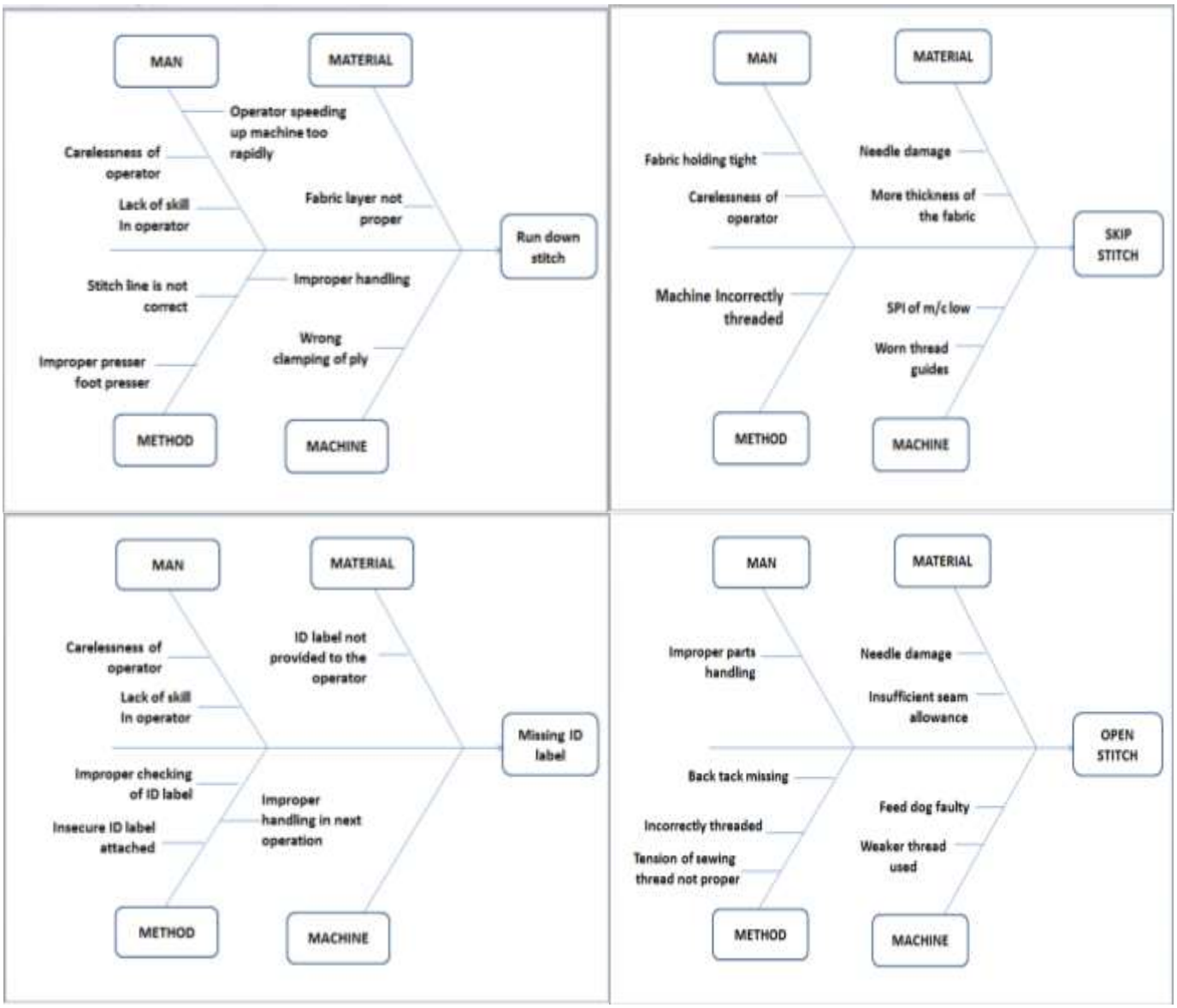


Fig: - 3.3 Pareto chart section wise of major defects

3.3 Root cause analysis: -

Pareto chart provided the major defects and accordingly the fishbone diagram is plotted for proper root cause understanding of each and every defect. Below are the fishbone diagrams of major defects.



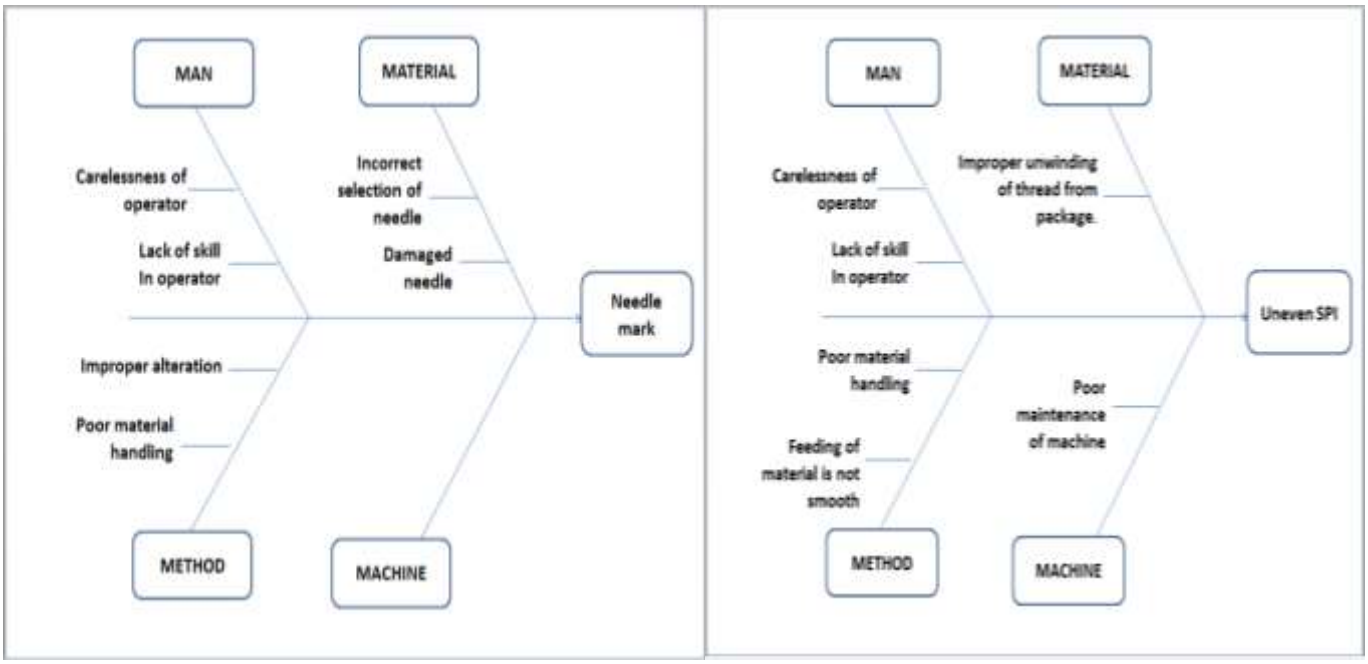


Fig:- 3.4 Root cause identification by fishbone diagrams of major defects

3.4 Major defects, Root cause and actions accordingly:-

As per the root-cause analysis and finding the major defects and its cause and plotting the fishbone diagrams of the same. It was the prime task to give intensive attensions on all the factors and take action plan accordingly. Below Table is prepared to explain the Cause and actions according to the Defect.

Major Defect contributing in higher DHU% their root cause and action plan		
Defects	**Causes**	**Actions**
Skip stitch	Needle damage.	New needle has to be replaced and further keep on checking if any needle issue.
	Carelessness of operator.	Improve supervision of operator.
Open stitch	Improper parts handling.	Provide proper training to the operators, how to handle parts at the time of stitching.
	Tension of sewing thread improper.	Tension of thread should be properly adjusted.
	Back tack missing.	Machine setting should be proper, and Maintenance of machine should be done periodically.
Run down stitch at cuff	Improper ironing of cuff part.	Parts should be properly ironed, Provided proper training to the operator for ironing.
Run down stitch at collar	Operator not properly following mark at the time of attaching collar to the body.	Provided proper training to the operator, and increased awareness to follow proper mark.

Run down stitch at bottom hem	Improper handling.	Provided proper training to the operator.
	Operator speeding up machine too rapidly.	Provided training to run at optimum speed of the machine.
Pinching at collar	Wrong marked point.	Given proper template for marking and following the same.
	Not following standard procedure.	Provided training and increased awareness to follow standard operating procedure.
	Carelessness of operator.	Improve supervision of operators.
Joint stitch	Poor maintenance of machines.	Maintenance of machines should be done periodically.
	Damaged needle cause thread break.	New needle has to be replaced and further keep on checking if any needle issue.
	Carelessness of operator.	Improve supervision of operators
Puckering	Poor handling.	Provided proper training to the operators.
	Thread tension too high.	Set thread tension at optimum level according to the thread and fabric quality.
Needle mark	Damaged needle.	Needles have to change at regular intervals.
	Minimize producing defects pieces.	Provided proper training to the operators and aware them about defects.
Missing ID label	Improper handling in next operation.	Be aware in next operation, provided them training and Improved supervision of operator.
	ID label not provided to the operator.	According to cut order quantity ID label should be provided to the operator.

Table 3.2 Root cause of major defects and actions accordingly

Uneven diamond shape	Machine setting not proper.	Machine setting should be proper, and Maintenance of machine should be done periodically.
	Operator speeding up machine too rapidly.	Provided training to run at optimum speed of the machine.
Run down stitch at sleeve placket	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
Slant main label attached	Carelessness of operator.	Improve supervision of operator.
Insecure label attached	Back tack missing.	Machine setting should be proper, and Maintenance of machine should be done periodically.
Uneven Back yoke Panels	Taking improper margin at the time of stitching.	Provided proper training to the operators.
Uneven SPI	Poor handling.	Provided proper training to the operators and aware them about defect. Feeding of
	operator.	should be provided to the operator.
Wrong Size label	Wrong size ID label.	ID label should be checked properly.
	Carelessness of operator.	Improve supervision of operator.
Uneven top stitch/wavy stitch	Damaged pressure foot.	Provided new pressure foot. Maintenance of machine should be done periodically.
	Missing guides.	Provided proper guide according to requirement.
Sleeve pleat gap not same	Carelessness of operator.	Improve supervision of operator.
Check mismatch	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
	Carelessness of operator.	Improve supervision of operator.
Pocket slant	Improper ironing of pocket.	Provided proper training to the operators and aware them about defects.
	Carelessness of operator.	Improve supervision of operator.
Uneven box height	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
	Carelessness of operator.	Improve supervision of operator.
Slant sleeve placket attached	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
	Not following standard procedure.	Provided training and increased awareness to follow standard operating procedure.

		material should be smoothly.
Uneven collar peak	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
Uneven collar point	Improper handling.	Provided proper training to the operator, Observed sewing operators for right manner of material handling technique.
Visible down panel at cuff	Improper ironing.	Provided proper training to the operators and aware them about defects.
Uneven Cuff width	Taking improper margin at the time of cuff run stitch.	Provided proper training to the operators.

Table 3.3 Root cause of major defects and actions accordingly

3.5 Data collection after implementations of proper quality actions: -

After the implementation of proper quality action plan and significantly follow-up of all the desired changed. The scientific way of post effect data is collected in the same previous manner. For the example back and front section data of a month is provided as per below:-

Back Section Data collection after implimentation of proper quality action (July-2018)

Date	Slant main label attached	run down @back yoke top stitch	Insecure label attached	Uneven Back yoke Panels	uneven SPI	needle mark @ label	Down stitch @ main label	Uneven dart length	Wrong side dart	Wrong side Labels	CV	Total Production	Pass Pieces	Alteration Pieces	DHU% Back section
5-Jul-18	10	16	0	7	5	0	9	7	0	10	0	3155	3091	64	2.03
6-Jul-18	6	8	0	0	9	10	9	3	0	0	0	2510	2465	45	1.79
7-Jul-18	10	6	0	14	5	6	0	6	0	0	0	2655	2608	47	1.77
9-Jul-18	13	9	0	11	9	0	0	8	0	0	0	2600	2550	50	1.92
10-Jul-18	5	4	10	0	6	0	12	7	0	0	0	2720	2676	44	1.62
11-Jul-18	5	11	0	13	5	0	0	6	0	0	9	2854	2805	49	1.72
12-Jul-18	4	7	9	9	0	0	12	10	0	0	0	1819	1768	51	2.80
13-Jul-18	5	0	0	2	1	0	22	8	0	0	0	2312	2274	38	1.64
14-Jul-18	1	11	0	0	0	4	0	13	0	0	0	1498	1469	29	1.94
16-Jul-18	14	13	0	7	6	0	0	6	0	0	0	1900	1854	46	2.42
17-Jul-18	7	8	0	11	7	10	0	5	0	0	0	2180	2132	48	2.20
18-Jul-18	9	18	0	6	10	0	16	9	0	0	0	2890	2822	68	2.35
19-Jul-18	3	8	0	0	4	16	0	5	0	6	10	2650	2598	52	1.96
20-Jul-18	4	11	0	10	5	0	10	4	0	0	0	1980	1936	44	2.22
21-Jul-18	6	0	4	8	3	0	10	6	0	0	0	1868	1831	37	1.98
23-Jul-18	4	16	0	2	8	0	10	19	0	0	0	2030	1971	59	2.91
24-Jul-18	6	5	0	10	5	3	10	7	0	0	0	2560	2514	46	1.80
25-Jul-18	19	9	0	11	8	0	0	6	0	0	0	2540	2487	53	2.09
26-Jul-18	4	9	1	1	9	0	6	17	0	0	0	2655	2608	47	1.77
27-Jul-18	2	9	4	13	5	10	0	6	0	0	0	2854	2805	49	1.72
28-Jul-18	15	5	0	0	5	3	0	7	11	0	0	2560	2514	46	1.80
30-Jul-18	4	16	0	2	8	0	10	19	0	0	0	2030	1971	59	2.91

Data collection after implimentation of proper action for improving quality (July-2018)									
Sleeve Section		Collar Section		Cuff Section		Assembly-1 Midline Section		Assembly-1 Endline Section	
Name of Defects	No. Of Defects	Name of Defects	No. Of Defects	Name of Defects	No. Of Defects	Name of Defects	No. Of Defects	Name of Defects	No. Of Defects
Pinching	309	uneven top stitch	176	Cuff top stitch wavy	201	uneven top stitch	170	Run down @ cuff	384
Needle marks	177	Uneven peak	161	Uneven Cuff diamond shape	178	Roping/ Puckering	123	Run down stitch @ collar	340
Run down stitch	155	fullness	147	Needle mark	163	raw edge(fraying)	113	Needle mark	226
Uneven box height	143	Uneven Piping visible	145	Uneven top stitch	155	joint out	112	Missing ID label	152
Slant sleeve plkt attached	129	Pinching	144	Uneven Cuff width	155	ID label Wrong	112	Pinching	144
Uneven diamond shape	110	uneven Collar patch	113	uneven Cuff hemming width	96	Skip stitch	95	Run down @ bottam hem	135
Unmatched Check	105	Uneven collar point	106	Visible down panel	88	Pinching	79	Wrong Size label	131
Open stitch	75	Skip stitch	81	joint stitch	76	Needle mark	77	joint out	95
Skip stitch	65	Uneven SPI	53	Logo placement improper	68	Run down stitch	65	Uneven sleeve plkt	90
Uneven SPI	47			skip stitch	61	Open Stitch @Sleeve	51	wavy shoulder top stitch	56
				open stitch	61	CV	0	Sleeve pleat gap not same	50
								Frying @ FOA	49
								Collar and back label center out	16
								Wrong kaj button possition	12

Data collection after implimentation of proper action for improving quality (July-2018)							
Assembly-2 Midline Section		Assembly-2 Endline Section		Assembly-3 Midline Section		Assembly-3 Endline Section	
Name of Defects	No. Of Defects	Name of Defects	No. Of Defects	Name of Defects	No. Of Defects	Name of Defects	No. Of Defects
Uneven top stitch	139	Run down @ cuff	272	Run down stitch	140	Run down stitch @ collar	419
ID label Wrong	96	Run down stitch @ collar	240	uneven top stitch	135	Run down @ cuff	397
Roping/ Puckering	85	Needle mark	184	ID label Wrong	134	run down @ bottam hem	188
Needle mark	81	Missing ID label	100	Roping/ Puckering	127	Needle mark	185
Skip stitch	80	Uneven sleeve plkt	99	Needle mark	115	Pinching	179
Pinching	64	Wrong Size label	85	Skip stitch	110	Missing ID label	169
Joint out	59	Pinching	80	Open Stitch @Sleeve	108	Wrong Size label	130
Run down stitch	59	Run down @ bottam hem	57	Raw edge(fraying)	95	Uneven sleeve plkt	110
Open Stitch @Sleeve	44	Joint out	41	Joint out	78	Frying @ FOA	104
Raw edge(fraying)	30	wavy shoulder top stitch	35	Pinching	60	Joint out	104
CV	0	Collar and back label center out	24	CV	47	Sleeve pleat gap not same	92
		Sleeve pleat gap not same	11			wavy shoulder top stitch	67
		Frying @ FOA	11			Wrong kaj button possition	26
		Wrong kaj button possition	6			Collar and back label center out	0

Front Section Data collection after implimentation of proper quality action (July-2018)																
Date	Needle marks @ button hole plkt	Skip stitch @ button hole plkt	Open stitch	Check mismatch	Wavy stitch	Pocket slant	Freying @ button hole plkt	Broken stitch @ (button Hole) plkt	Run down stitch	Uneven Top stitch	Puckering	CV	Total Production	Pass Pieces	Alteration Pieces	DHU% front section
5-Jul-18	5	3	0	11	0	9	0	8	0	0	15	0	2078	2027	51	2.45
6-Jul-18	5	0	2	13	13	0	0	0	10	0	0	14	2843	2786	57	2.00
7-Jul-18	11	0	6	0	0	10	0	13	0	33	37	0	2770	2660	110	3.97
9-Jul-18	12	13	0	0	14	11	0	12	0	9	0	0	2268	2197	71	3.13
10-Jul-18	9	19	0	0	2	0	15	0	12	0	2	60	2285	2166	119	5.21
11-Jul-18	10	0	22	0	3	16	15	0	12	0	27	0	2560	2455	105	4.10
12-Jul-18	6	12	6	0	0	0	10	39	7	0	0	0	2998	2918	80	2.67
13-Jul-18	5	8	0	0	10	13	0	0	7	0	0	2	1430	1385	45	3.15
14-Jul-18	4	0	0	0	12	0	11	8	0	7	0	5	2499	2452	47	1.88
16-Jul-18	6	4	0	0	9	0	16	0	11	0	0	6	2017	1965	52	2.58
17-Jul-18	5	2	0	25	2	3	16	0	9	14	22	0	1845	1747	98	5.31
18-Jul-18	23	6	0	0	16	0	26	0	12	15	2	0	2669	2569	100	3.75
19-Jul-18	5	15	0	0	0	0	19	0	8	3	0	0	2242	2192	50	2.23
20-Jul-18	10	0	15	0	4	0	9	0	10	13	0	23	2725	2641	84	3.08
21-Jul-18	9	0	0	10	0	10	0	0	12	0	0	0	2041	2000	41	2.01
23-Jul-18	5	0	0	0	5	0	13	0	9	0	0	0	1280	1248	32	2.50
24-Jul-18	7	8	0	0	15	0	12	0	8	0	0	8	1692	1634	58	3.43
25-Jul-18	11	8	0	0	19	15	14	0	14	0	0	0	2642	2561	81	3.07
26-Jul-18	5	0	2	13	13	0	0	0	10	0	0	14	2843	2786	57	2.00
27-Jul-18	10	0	15	0	0	0	9	0	10	0	17	23	2725	2641	84	3.08
28-Jul-18	13	0	23	0	0	0	26	0	12	0	26	0	2669	2569	100	3.75
30-Jul-18	5	0	0	0	0	0	19	0	8	18	0	0	2242	2192	50	2.23

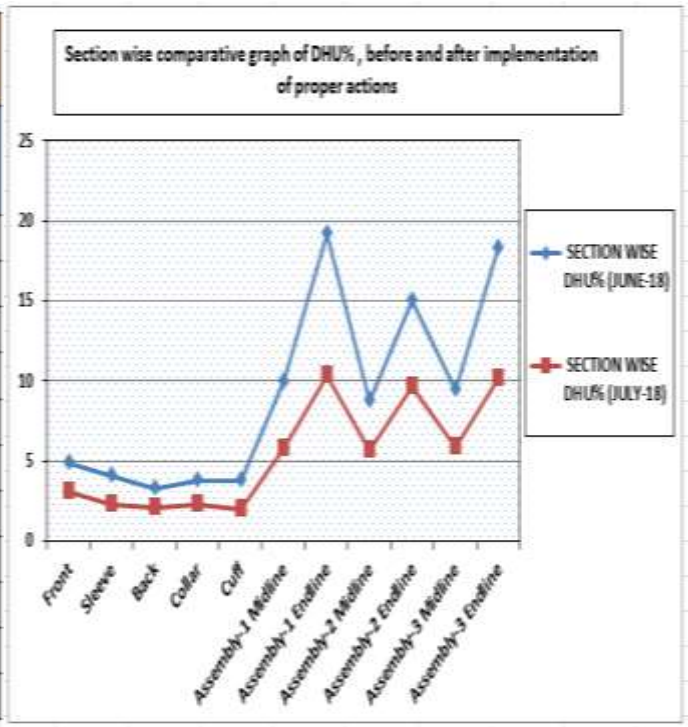
Table:-2.5.1 Section wise daily defects data of June Month

IV. RESULTS AND DISCUSSION

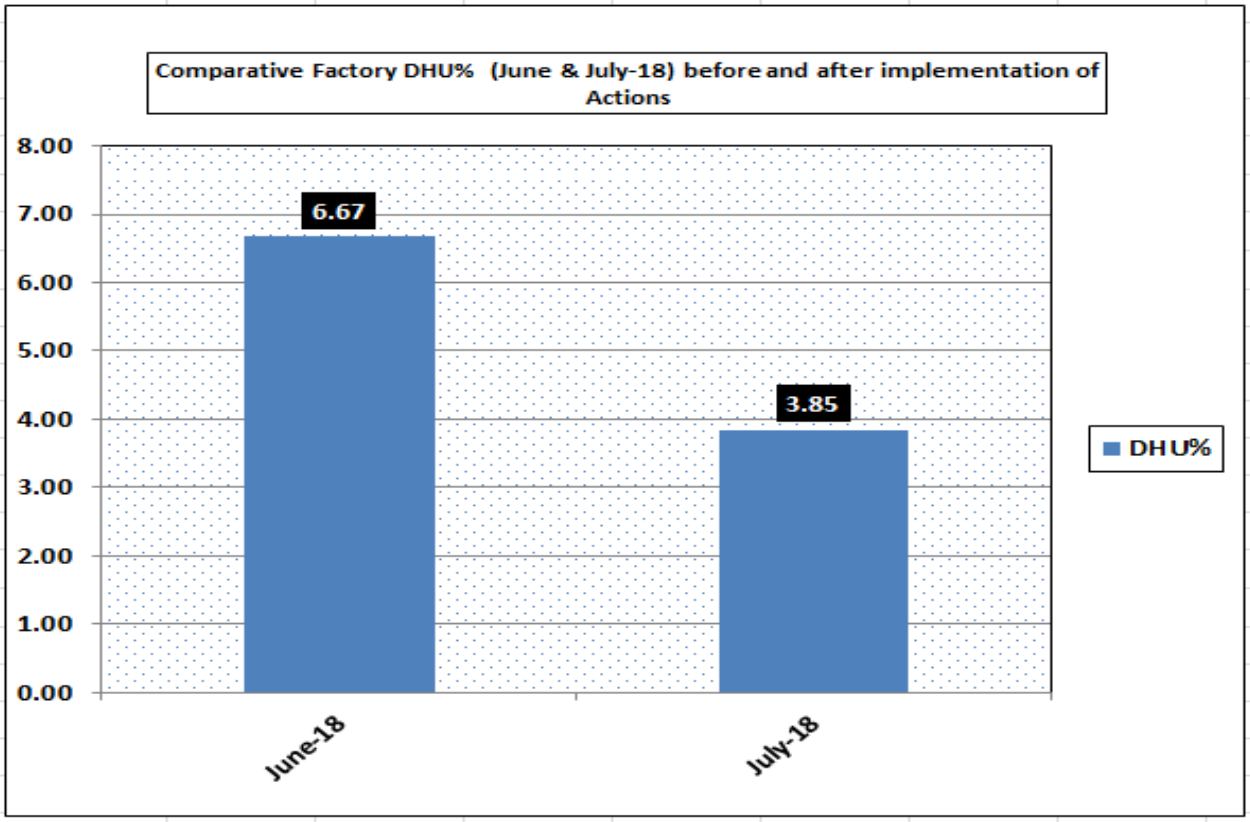
The final outcome of the research after the application of all the quality tools and statistical tools below are the results.

- Reduction in DHU% is more than 50% as compared to before and after the implementation of quality action plans. This is because of the reduction in alteration pieces in each and every section especially due to some particular defects.
- There is a wide gap in highest DHU%, and at the higher level of fluctuations in the DHU%, before and after implementation of quality action plans.
- Assembly sections were having above 10% of DHU% across the months whereas after implementation of quality action in next month's there is a sharp decrease in the DHU%.
- Highest DHU% is 19.21 of Assembly-1 End line section and lowest is 3.27 of the back section of the previous months (before implementation of quality action plans) whereas in next month after implementation of quality action plans the highest DHU% is 10.32 of Assembly-1 End line section and lowest is 2.03 of Cuff section.

Section wise comparative graph of DHU%, before and after implementation of proper actions		
SECTION	SECTION WISE DHU% (JUNE-18)	SECTION WISE DHU% (JULY-18)
Front	4.82	3.07
Sleeve	4.03	2.29
Back	3.27	2.05
Collar	3.79	2.33
Cuff	3.76	2.03
Assembly-1 Midline	9.91	5.79
Assembly-1 Endline	19.21	10.32
Assembly-2 Midline	8.73	5.67
Assembly-2 Endline	15.03	9.65
Assembly-3 Midline	9.46	5.9
Assembly-3 Endline	18.25	10.17



Graph:-3.1 Comparative factory DHU% before and after improved quality action



Graph:-4.1 Comparative factory DHU% before and after improved quality action

V CONCLUSION AND SCOPE

All the action plans in this research paper cover almost all the aspects of minimizing alteration and rejections in the sewing section of Men's shirt manufacturing. This can help significantly to the factory in the reduction of the DHU%. We know that quality is important to survive in the current competitive market but to maintain the quality it needs too much of attention from raw material to the finished garment and this needs the spend of money and time as well. Increase in the DHU% ultimately increase the cost of production because of Re-work and decrease in productivity.

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