TITLE: The Influence of Applying BPR – Emphasizing on Six Sigma Included- on Enhancing the Performance of Carpet Industry

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ABSTRACT

Business Process Reengineering has gained a considerable attention in the world of change management during the past years. While more and more organizations embark on the BPR trend. It can be concluded, that the theoretical bedrock for BPR falls rather short of the concepts ambition of being a solution for a multiplicity of problems that many companies suffer from. The objective of this study was to explore the application of business process reengineering (BPR) with emphasizing on six sigma methodology for reducing the defect percentage in carpets manufacturing sector. A representative carpet finishing unit was selected for this study and it was found that by the suitable application of BPR tools, the performance level has been increased 19.15%.

Keywords: Business process reengineering (BPR), six sigma, DMAIC approach, Pareto principle, process flow, process selection criteria , ISO 9001:2008, KPI

I. INTRODUCTION

Business Process Reengineering (BPR) is not an unknown word to the business world. It has been more than two decades since it was introduced for the first time as a tool for change in American business sector. ***Hammer (1990)*** was the first person who introduced BPR and is considered as a father of BPR. (1)

BPR is a tool used for bringing radical change in the business process and was adopted initially by the private sector (US- based firms) in early 1990s as an replacement of total quality management (TQM, a Japanese approach) ***(Hammer and Stanton (1995)***). BPR is said to be a new approach for the process management that brings radical change (improvement) in organizational performance. (2, 3)

1.1 literature review:

In other definition for BPR we could see ***Frederick Taylor (1880)*** is saying: Observation and analysis through time study to set the optimal production rate. In other words, develop a science for each man's task a One Best Way. Scientifically select the best man for the job and train him in the procedures he is expected to follow. (4, 5)

Throughout this research BPR is applied in the carpet industry sector as a part of textile industries, Carpets industry is one of the most recognized industries in Egypt today.

The industry has grown to become the largest and fastest-growing industry in the world especially machine made rug.

Carpets industry is the acknowledged leader in design, quality and innovation within the Egyptian industries. With a simple vision it became a leading worldwide exporter and by far the largest player in the Egyptian market. (6)

2. EXPRIMENTAL WORK:

Reengineering concept is going to be applied with emphasizing on six sigma included in of the textile plants working in “carpets industry” A large factory for carpets industry was chosen to perform the experimental and practical work within it. After choosing the factory, as an overview of the current situation customer complains had been calculated within one year to have an exact idea where to start.

After collecting the complaints which have been received within the selected period from January 2013 till January 2014 the result was about 124 complaints (average 2480 m^2 of carpets) which represents about 0.018 % from the total shipped amount for the customers which was about (13629720 m^2).

Then we started to analyze the current status throughout these customer complaints as one of the considered KPIs within the factory in four criteria’s (using the Pareto principle) (7):

1- Highest period of complains
2- Highest defects type
3- Most concerned department
4- Highest complained collections

Which enables us to address the root causes and find the needed corrective actions to eliminate or even minimize them by assuming the right solutions based on factual figures as shown in (tables from 1 till 3) and figures (from figure 1 till figure 3) , then testing the solution and implement it. Consequently, standardize the results in order to enhance the performance in general and to achieve the sustained customer satisfaction.

Table (2-1) Cumulative Complaints percentage on monthly basis within the selected period (Jan 2013: Jan 2014)

Date	Complaints	Complaints Percentage	Cumulative Complaints	Cumulative Complaints percentage
J-13	4	3.23%	4	3.23%
F-13	3	2.42%	7	5.65%
M-13	6	4.84%	13	10.48%
A-13	10	8.06%	23	18.55%
M-13	12	9.68%	35	28.23%
J-13	14	11.29%	49	39.52%
J-13	15	12.10%	64	51.61%
A-13	14	11.29%	78	62.90%
S-13	11	8.87%	89	71.77%
O-13	18	14.52%	107	86.29%
N-13	9	7.26%	116	93.55%
D-13	7	5.65%	123	99.19%
J-14	1	0.81%	124	100.00%

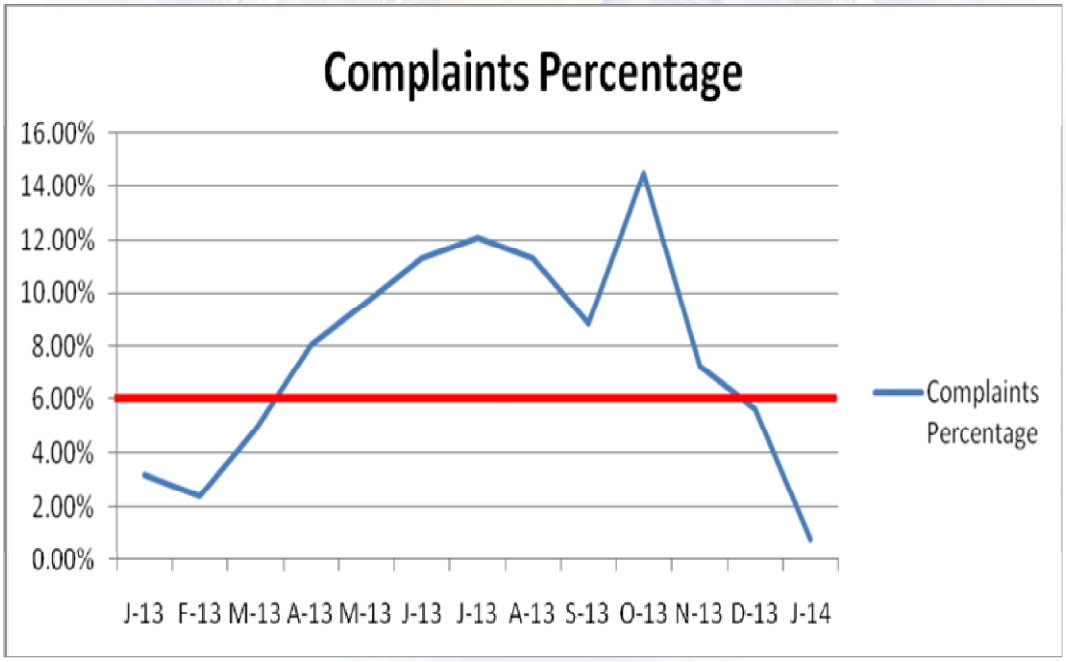


Figure 2.1 Cumulative Complaints percentage on monthly basis within the selected period (Jan 2013: Jan 2014)

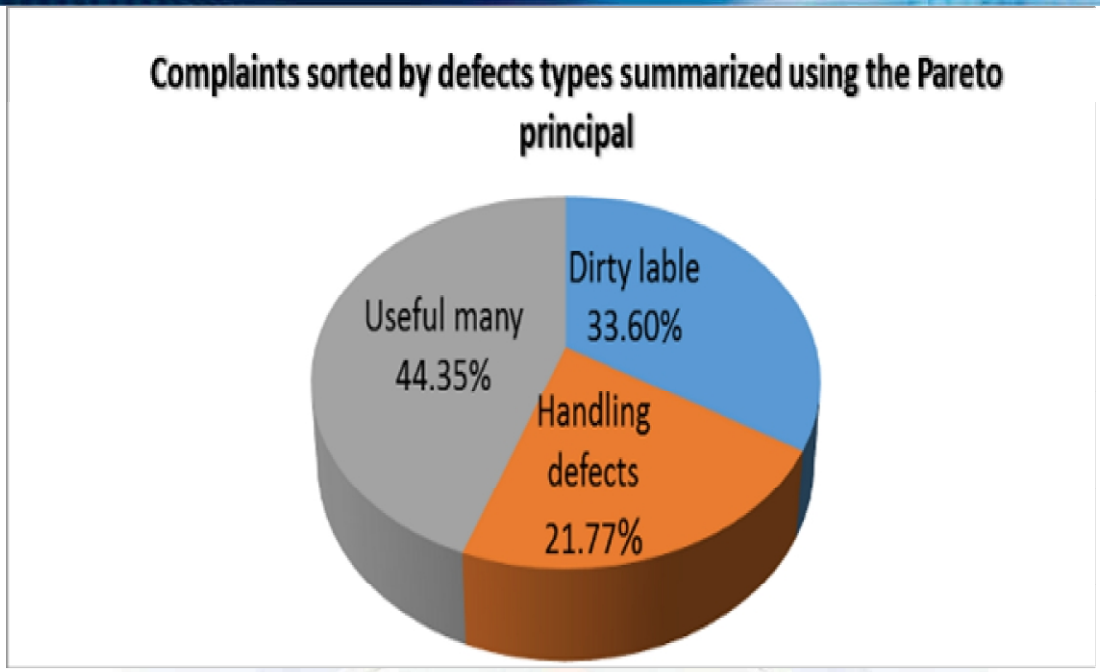


Figure 2.2 Complaints percentages sorted by defects types summarized using the Pareto principal within the selected period (Jan 2013: Jan 2014)

Table (2-2) the concerned department Percentage % from the total complaint within the selected period (Jan 2013: Jan 2014)

Concerned Department	Percentage	Complaints
Finishing	38.21%	47
Weaving & Finishing	21.95%	27
Export Team	12.20%	15
Back Coating	5.69%	7
Weaving	8.13%	10
Packaging	4.88%	6
Packaging & Yarn Material	3.25%	4
Packaging Material & CS	2.44%	3
Raw Materials	2.44%	3
Yarns Manufacturing	0.81%	1

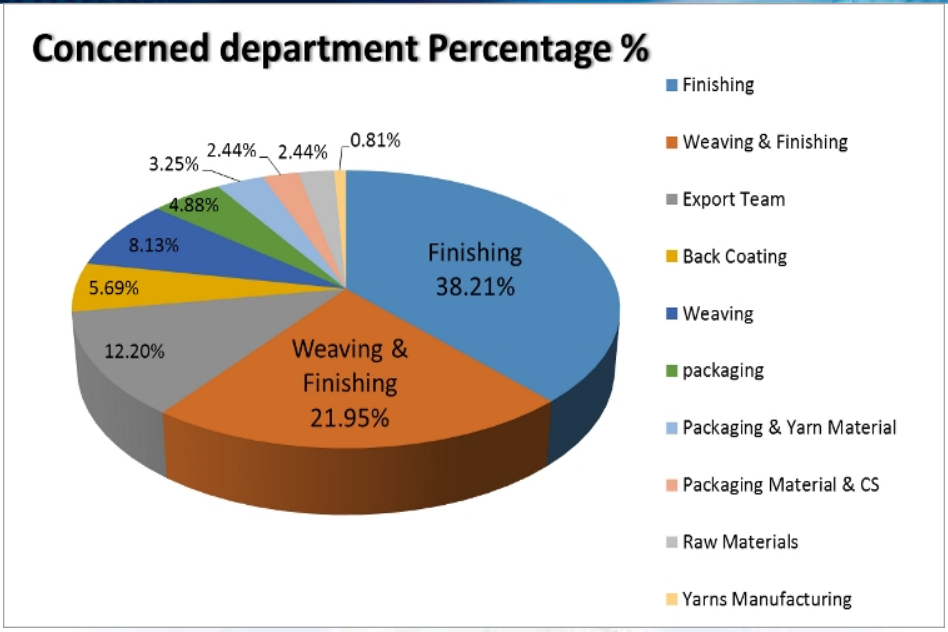


Figure 2.3 concerned department Percentage % from the total complaint within the selected period (Jan 2013: Jan 2014)

Table (2-3) the highest rankings based on Pareto concept (80% 20%) within the selected period (Jan 2013: Jan 2014)

Defects type	Complained Collections	Concerned department	Period of complains
Dirty Label	Collection X	Finishing	January 2013: January2014
	Collection Y		
Handling defects	Collection Z	Weaving & Finishing	

The picked factory is following ISO 9001:2008 requirements which stressing on the famous concept of "continuous improvement" (8), that's why it is desired to enhance the performance. And to follow this concept the business process reengineering (BPR) has been used as one of continues improvement methods.

So it was obligatory to study the mega process of this industry within the chosen factory to fully understand its processes, sub-processes, activities and even tasks, consequently define the most critical stage precisely and accurately then tackle and enhance its performance for better results and less deficiency.

The mega process in the machine-made carpets industry consists of 8 main sub processes as in our picked factory:

1- Production planning (upon customer request)
2- Weaving (semi-automatic looms)
3- Shearing and back coating (semi- automatic line)
4- Finishing & confection (manual & mechanical activities in the finishing halls)
5- Final inspection and product sorting into 1st and 2nd grades (manual & mechanical activities in the finishing halls)
6- Rolling and packaging (manual & mechanical activities in the finishing halls)
7- Storage and warehousing (manual & mechanical activities in the warehouse)

8- Shipping and delivery to the customer (manual & mechanical activities in the shipping area till the containers sealing)

It's clear from the above that three main sub-processes are taking place at the same place which is the "finishing halls" where also many manual & mechanical activities are being performed.

Which means there are many different parameters happening in this area or stage of the mega process with a big interference from the operators, this interface leads to many deficiencies or at least this stage from the mega process is the most probable to have excess.

From the above it has been decided to tackle this sub-process and dig further to see how to enhance the performance through this process and to eliminate the risk of having many deficiencies out of this stage pursuant to the principle of "continuous improvement" which was called for in the ISO 9001:2008

After analyzing the total mega process of the whole factory and divided them into different sub-processes, the most critical process to the number of applied steps on the rugs and the number of defects in the whole industry had been defined easily which was "finishing hall".

Then after filtering all the finishing halls in the factory and prioritize their importance according to the below

Criteria for Selecting Processes

- Broken process
- Bottleneck
- Cross-functional or cross-organizational units
- Core processes that have high impacts
- Front-line and customer serving - the moment of the truth
- Value-adding
- New processes and services
- Feasible (9)

So it has been decided to choose finishing hall (X) from all other finishing halls as it is:

1- Bottleneck for the production flow due to the delay and defects come out of this stage.
2- Value-adding process with very high impacts on the final product as within this stage the final product (carpet) is being finished, final inspected and packed just before storage and shipping.
3- The fact that is giving this stage extra importance that this is the front-line just before the product reaches the warehouse and the customer premises.
4- On the other hand this finishing hall X is the only place in where all products of the big customers are being processed, those customers are the most affecting customers on the whole company investment and market share.

And for further illustration of the finishing hall, the upcoming plan has been designed to show the process flow inside this hall, Figure (2.4) stating the current status of the hall (X).

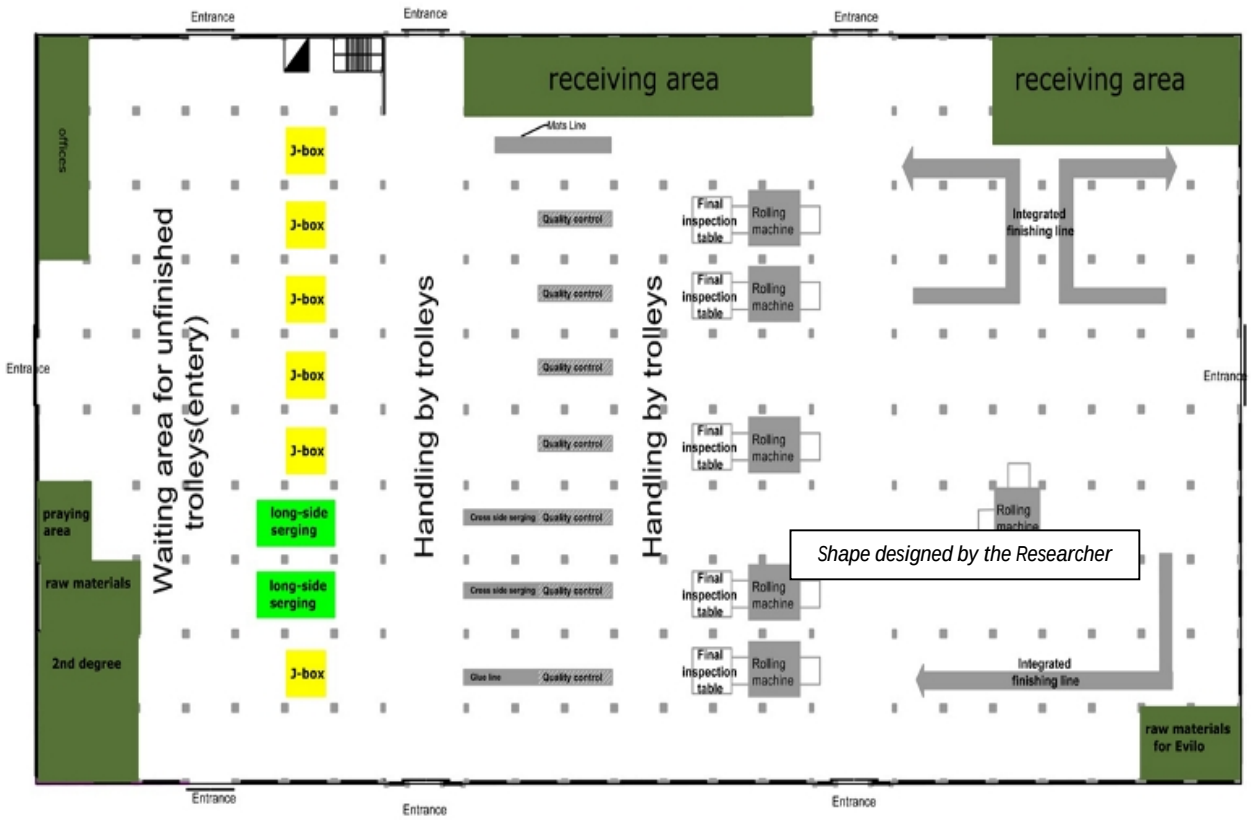


Figure 2.4 Current status of finishing hall (X)

From figure 2.4, it is seen that the hall is divided into main three parts with two main corridors in-between.

Also we could see the workflow through the hall is horizontal within the first two parts while the exit of the hall is vertical which means that the exit of the hall is perpendicular on the work flow inside, also there are many handling processes needed to maneuver the products through the successive stages.

The third part which is integrated finishing lines have a different flow system due to its automatic way of working which makes the entrance (input) to the line and the exit (output) of the line going directly with its own successive flow according the line installation shape without any extra handling processes between the different stages on the whole line.

The first part holds the J-boxes and long side over-edging lines on which the carpets' sheet is being finished from the long side and also cut into separate pieces (carpets), second part is mainly for the cross-side finishing, QC, final inspection, rolling and packing.

As mentioned before the third part is for the integrated lines, in which carpets are being finished from the two sides, inspected, rolled and packed in a semi-automatic way of working.

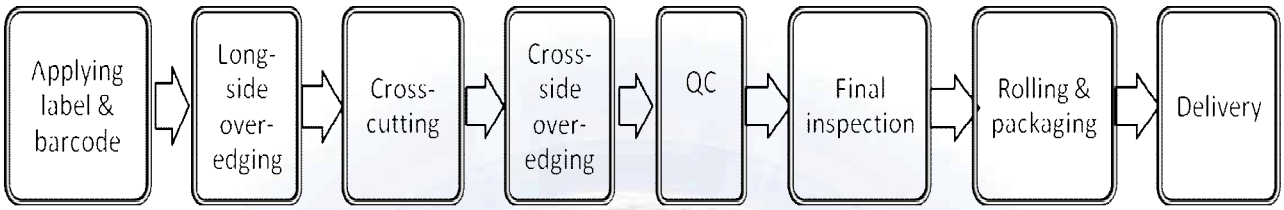
At the top of the plan (finishing hall) there is the receiving area where the finished rugs is being collected and so ready to be delivered to the warehouse for storage until their shipping date according to their customer order.

The receiving area is perpendicular on the work flow inside the hall, the fact which is rotating the workflow with 90 degrees which leads to extra maneuvering to the products inside the finishing hall.

After illustrating the layout of the finishing hall, every process happening through this hall has been defined in a serial way that can enables digging further for process analysis and to explore all the deficiencies through the hall

The sub processes had been analyzed and results in three different routings:

1-



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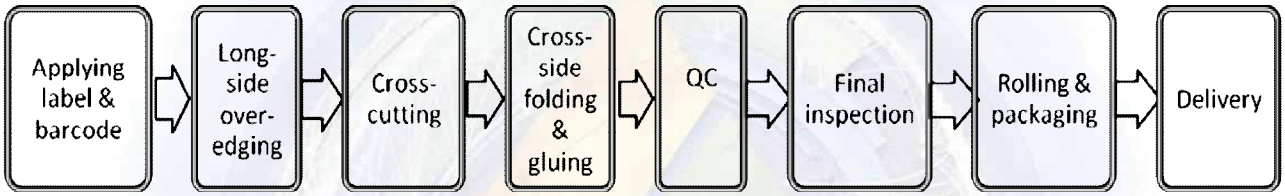
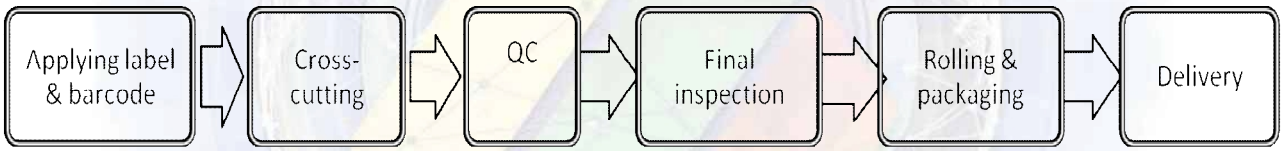


3-



Those three different routings delivered three different types of finished rugs as the below:

1- Four-side serged rugs.
2- Two-side serged and the other sides are folded and glued rugs.
3- Non-finished rugs and mats (only four side cut rugs).

And for further clarifications, new plan had been designed (Figure 3.5) that stating the current status of the hall (X) with high-lightening the critical paths where the handling processes taking place through the hall in which the delaying and other problems taking place

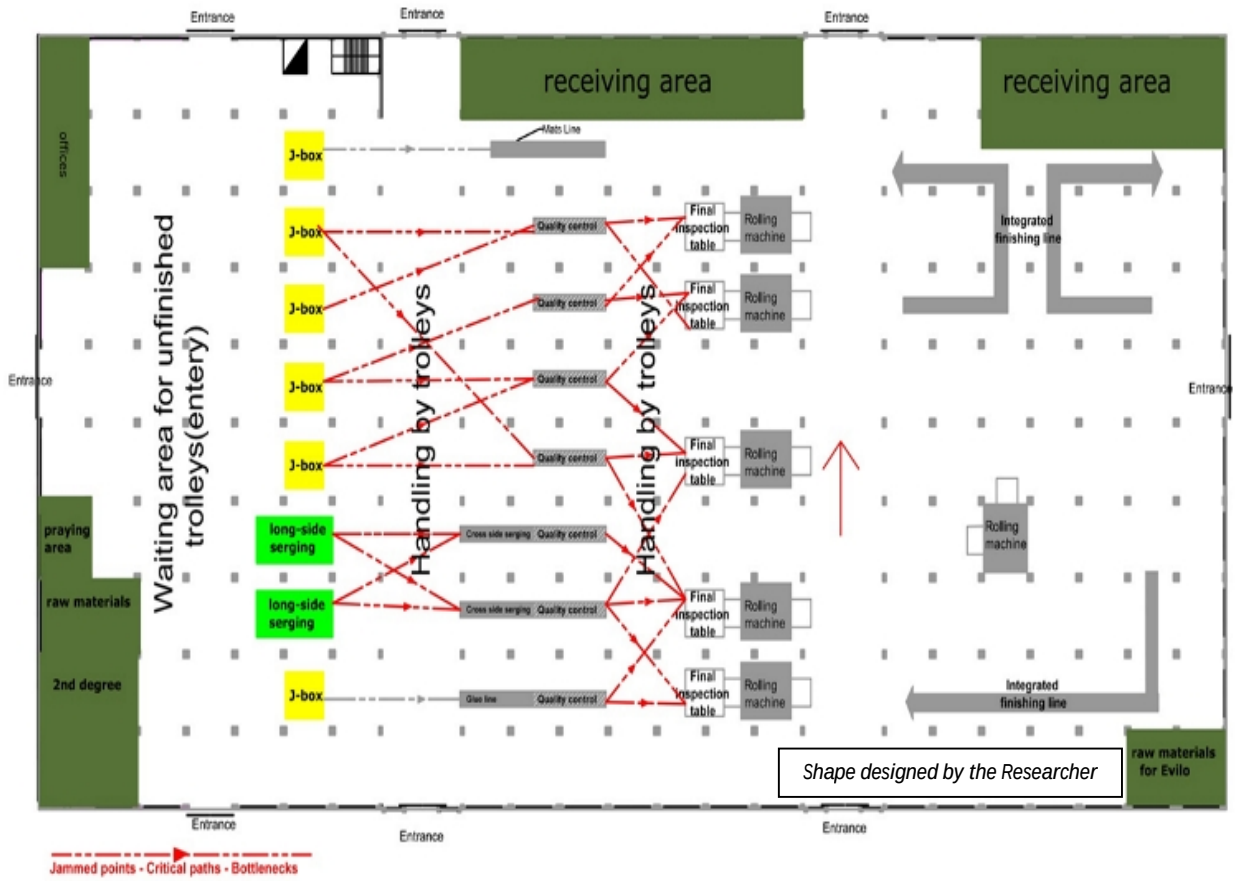


Figure 2.5 handling problems Of the current state

From figure 2.5, it's obvious now that there is a handling fatal problem in finishing hall (X) which is clarified through the red doted intersecting lines.

In these areas the trolleys of the semi-finished product (rugs) are waiting before moving to the next stages as there are jamming points in-between also different processes routings are scattered on different lines. Simultaneously the flow of the semi-finished rugs through the hall until being finished one (processes flow) is a horizontal flow while the last stage in the mega process inside hall(X) which is the delivery stage is vertical. Which means that the last stage is perpendicular on the production flow in the hall (X), this is the fact, which increase the problem of the handling through the finishing hall (X) whether it's finished or semi-finished rug?

DMAIC approach, one of the six sigma methodologies (Define – Measure – Analyze – Improve - Control) (10) is being followed to follow the problem and solve it after specifying the area in which the BPR will be applied in.

- **DEFINE**

From the last figures and their explanations it's already manifested that there is a big deal affecting the production and thus the product itself which is the handling process, so it was a must to define till which extent these problems do affecting the product.

- **Measure**

On this context three different types of the final product have been chosen, every one representing one of the three different routing in the finishing hall then we started to measure the KPIs for those three products in order to illustrate the problem in a figures factual concept.

Table (2-5) biggest participant (handling defects) in the 2nd degree defects/year (2013) of the chosen products (before implementing BPR)

Loom	Collection	Handling defects percentage ratios to the total 2nd degree
Loom 307	Collection 1	52.05%
Loom 408	Collection 2	81.99%
Loom 410	Collection 2	50.91%
Loom 412	Collection 2	72.67%
Loom 507	Collection 3	38.57%
Loom 509	Collection 3	25.62%
Loom 510	Collection 2	72.92%
Loom 510	Collection 3	41.01%
Loom 616	Collection 3	55.95%
Loom 620	Collection 3	63.43%
Loom 906	Collection 2	75.45%
Grand Total	All Collections	38.28%

- **Analyze**

While analyzing the collected data ,table (3.5) it has been found the biggest participant in the 2nd degree in the entire measured product were poor handling defects, also after analyzing figure 3.5 which is showing the handling problems happening in the finishing hall we could conclude that handling problems were mainly taking place in two places which are:

1- Before cross-side finishing.
2- Before rolling and packaging machines.

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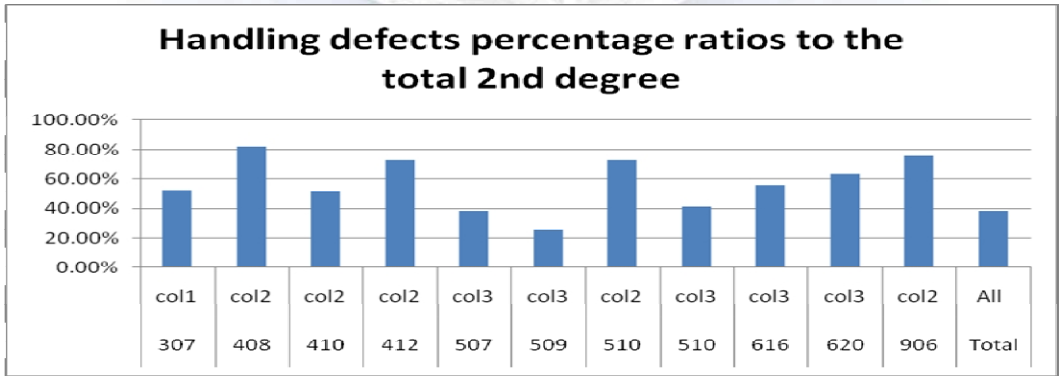

Figure 2.6 the handling defects percentage ratios to the total 2nd degree

Figure (2.6) supports what was already concluded from the previous stages, so that will lead us to find a solution in order to reduce handling through the finishing hall (X) and to enhance the processes flow in the hall.

- **Improve**

Different solutions had been foreseen until the best solution was addressed which was to redesign the whole finishing hall (X) to modify the work flow and to make all the stages in the same direction specially part 1 and part 2 in the finishing hall (X) where you can found the critical paths where handling defects takes place, this results is agreed with ***Davenport and Short (1990)*** as they have defined BPR as the analysis and design of work flows and processes within the organizations (1)

The work flow inside finishing hall (X) has been redesigned and the handling method also have been modified also to be conveyer belts instead of moving trolleys in order to avoid the previous stated jammed areas, figure 2.6

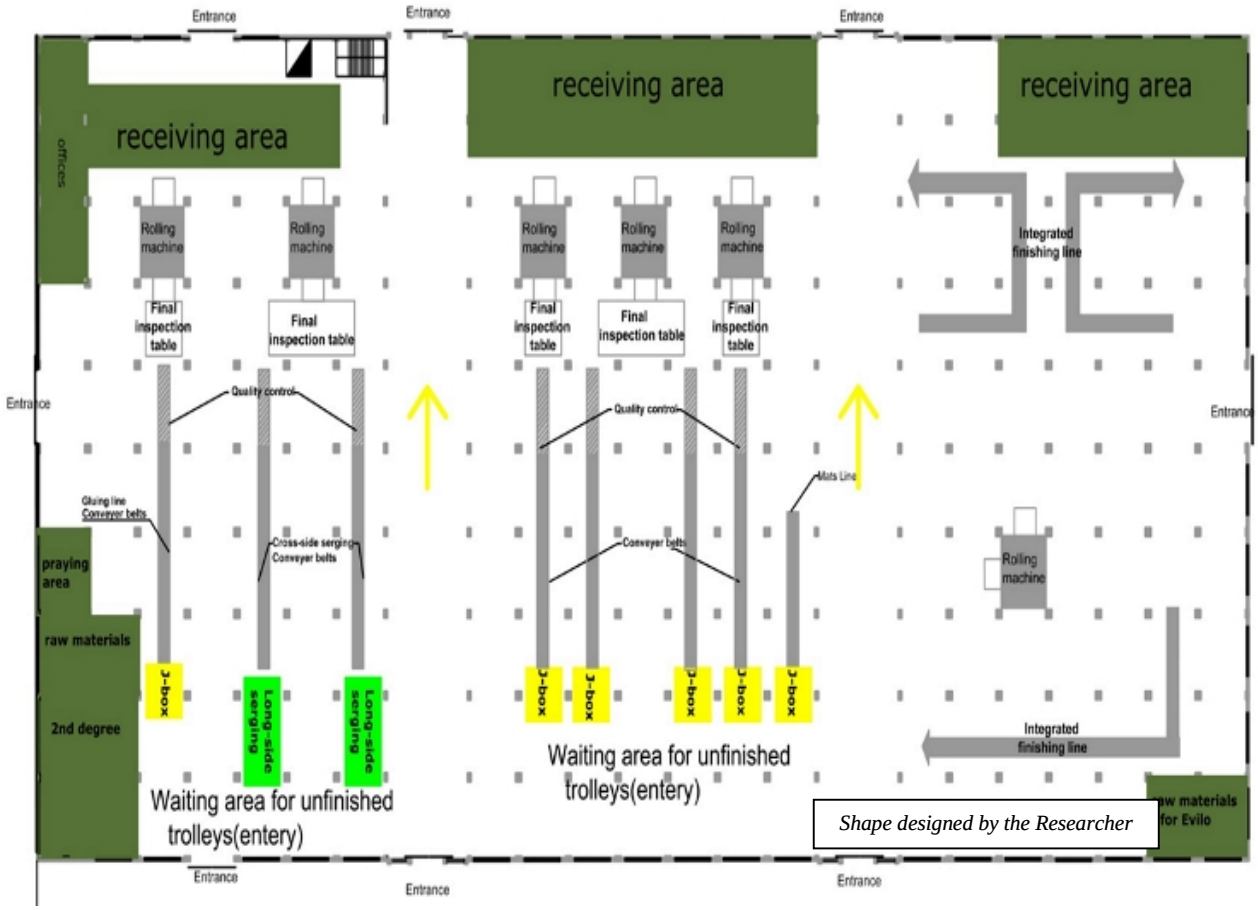

Figure 2.6 the New workflow has been designed

- **Control**

After measuring the two years KPIs for the same products (collections) with same fixed parameters, 2013 before applying the new design then 2014 after applying the new design of the new workflow (solution), we had been able to compare both two years data to measure the solution effectiveness, standardize the solution and control it

3. RESULTS:

A comparison between the handling defects in 2014 and 2015 has been performed to measure the difference between the performance before and after implementing the BPR, table 3.1 and figure 3.1 shows that the performance represented in the handling defects percentage has been enhanced in 2014 by reducing the handling defects percentage by 24.59% and table 3.2 shows the reduction in M^2 which was reduced by 1255.18 M^2

Another KPI has been used which is the 2nd degree in general which also has been reduced by 19.15% after implementing the BPR solution as shown in table 3.3 and figure 3.3

Table (3.1) handling defects comparison 2013 vs. 2014

Loom	Collection	Handling defects percentage ratios to the total 2nd degree 2013 (Before implementing the reengineering)	Handling defects percentage ratios to the total 2nd degree 2014 (After implementing the reengineering)	The difference between before and after implementing reengineering (2013 vs. 2014)
Loom 307	Collection 1	52.05%	40.00%	12.05%
Loom 408	Collection 2	81.99%	51.09%	30.90%
Loom 410	Collection 2	50.91%	32.61%	18.30%
Loom 412	Collection 2	72.67%	8.00%	64.67%
Loom 507	Collection 3	38.57%	34.52%	4.05%
Loom 509	Collection 3	25.62%	14.40%	11.22%
Loom 510	Collection 2	72.92%	41.99%	30.93%
Loom 510	Collection 3	41.01%	40.17%	0.84%
Loom 616	Collection 3	55.95%	43.17%	12.78%
Loom 620	Collection 3	63.43%	25.78%	37.65%
Loom 906	Collection 2	75.45%	15.16%	60.29%
Grand Total	All Collections	**38.28%**	**13.69%**	**24.59%**

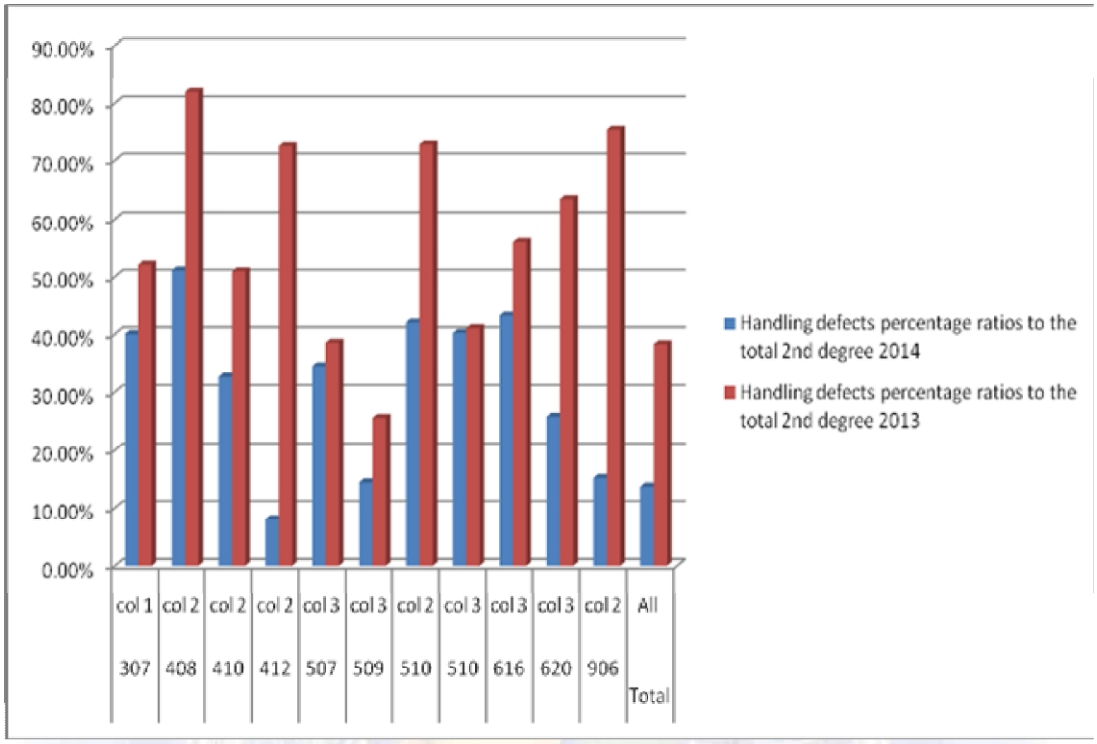

Figure 3.1 the handling defects percentage ratios to the total 2nd degree 2014 vs. 2013

Table (3.2) 2nd degree comparison 2013 vs. 2014

Loom	Collection	defected M² 2013	defected M² 2014	The difference
307	Collection 1	146	30	116
410	Collection 2	432.26	266.34	165.92
412	Collection 2	474.74	15.25	459.49
507	Collection 3	126.37	88.79	37.58
508	Collection 3	607.1	350.49	256.61
509	Collection 3	701.77	379.67	322.1
510	Collection 2	379.03	72.82	306.21
510	Collection 3	143.83	112.42	31.41
616	Collection 3	442.25	337.35	104.9
620	Collection 3	332.48	260.32	72.16
906	Collection 2	356.44	134.9	221.54
Total		5302.8	4287.14	1015.66

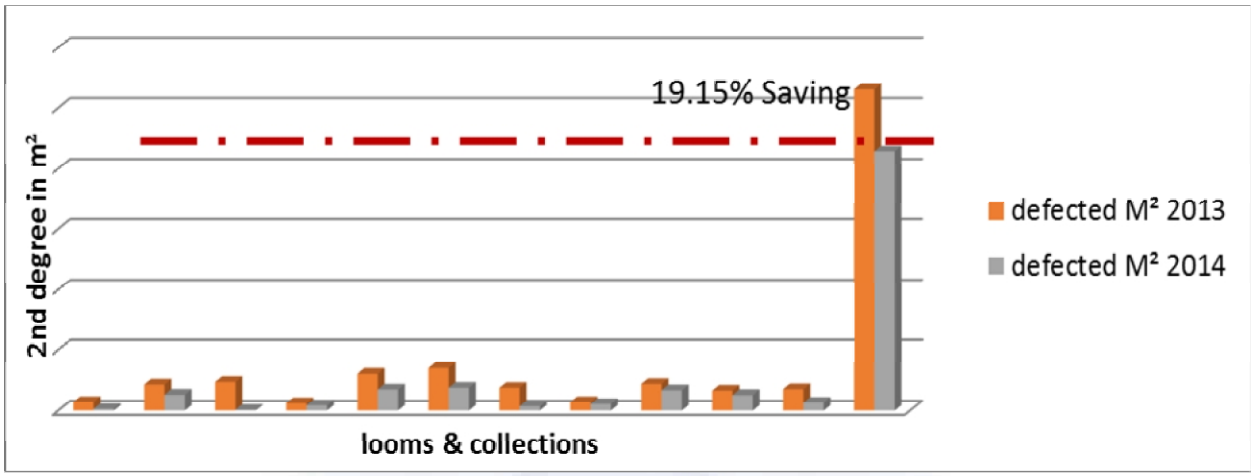

Figure 3.2 the total 2nd degree percentage 2014 vs. 2013

From figures 2.6, 3.1,2 and tables 3.1,2, we could conclude that:

1- Work flow has been enhanced to be all in one horizontal direction
2- Handling system has been changed to be on conveyer belts between the different stages instead of maneuvering with rugs' trolleys
3- Handling defects has been reduced by 24.59%
4- All second degree (defects) has been reduced by 19.15%

5. Conclusions & recommendations:

From what was stated in the above, one could notice that there are big positive modifications happened on the plant after applying BPR, the thing which emphasize on the research hypothesis of accomplishing great and radical improvements as a result from applying BPR basics on the defected or the poor plants, stages or even work stations

The fact that the performance has been enhanced by 19.15% in general and by 24.59% in the tackled problem which was the handling defect, is already supporting the paper objective.

Recommendations:

1- BPR is a very precious tool that could be applied on the potential areas to have radical improvements.
2- BPR is emphasizing on the six-sigma main concepts like the DMAIC approach and to have the most influent results one would have to work regarding both of them.
3- Continuous improvement is a must nowadays due to the revolutionary changes that are taking place in the textile enterprises or even in the entire industries.
4- One would have to collect data and deeply analyze it to find the most appropriate tool to use while improving any stage in the industry or even the whole plant.

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