CHAPTER 3

Implementation of the introduced methodology in Company X

3.1 Issue Finding

Industry was Selected which delivers the product or service as follows. There is special requirement in the Hexagonal Nut and Bolt Manufacturing Industry as its future is very uncertain with the market competition and lower margins. Therefore, it is selected as the industry for this study in Sri Lanka. Then one organization was selected for the case study which delivers the product or service. Company X is selected as the organization due to easy access to obtain data and carry out activities with the permission form the ownership. And also it has both hot forging and cold forging Nut and Bolt manufacturing processes.

Thereafter, interviews were carried out major issues were listed in the organization. The following information found at the initial interview with the Chairman, former Factory Manager, Finance Manager, HR Manager, Commercial Manager, Production Manager, Senior Technical Officer and 5 workers.

- The Profit margin was decreasing. (23% in 2008/2009 but 2009 first quarter 12.4%) Therefore the future of the business was uncertain.
- There was no productive inventory control system to minimize the costs.
- At raw material Purchasing and delivery of the finished goods transport supply was not utilized productively. Capacity of the vehicles were not considered at delivery plan
- Large amount of scrap was generated frequently.
- Production reworks were very high.
- Dies of the machines were broken very frequently.
- Machine break downs were not frequent.
- Galvanizing Plant had been temporarily closed.
- Delay charges were paying due to the late deliveries to the customers. Although customers satisfied with the quality of the products they were not satisfied with the delivery.

- Labour Productivity at certain sections were very low

Then Cleaner Production Techniques were used and found the wastes and losses as follows

❖ Designated the project team

Initially the project team was designated as follows

1. Factory Manager
2. Production Manager
3. Senior Technical Officer
4. Finance Manager
5. Chief Commercial Manager
6. Quality executive
7. Purchasing Executive
8. Production assistant
9. A Machine operator
10. External experts

❖ Listed Process steps

The steps of the process of manufacturing cold forging hexagonal nuts & bolts were as follows

1. Raw material receiving
2. cutting
3. Lubricating (Pospating)
4. Wire Drawing
5. Wire cutting and Heading
6. Trimming
7. Threading
8. Galvanizing
9. Re-tapping

10. Packing

The steps of the process of manufacturing hot forging hexagonal nuts & bolts were as follows.

1. Raw material receiving
2. Drawing
3. Cutting
4. Heating
5. Heading
6. Trimming
7. Grinding
8. Thread Cutting
9. Galvanizing
10. Re-tapping
11. Packing

❖ Assessment focus was selected as follows.

Table 01: Level of difficulties at each step in Cold Forged Nut & Bolt Manufacturing Process

Process step	High	Moderate	Low
Raw Material Receiving		X	
Cutting			X
Lubricating	X		
Wire Drawing			X
Wire cutting and Heading	X		
Trimming			X
Threading			X
Galvanizing	X		
Re-tapping			X
Packing		X	
Other Processes			
Tendering	X		
Purchasing with cash payment	X		
Cash collection with Invoicing			X
Transport		X	
Documentation			X
Quality assurance		X	
Inventory control		X	

❖ Analyzed process Steps

- Part Flow Charts were Prepared

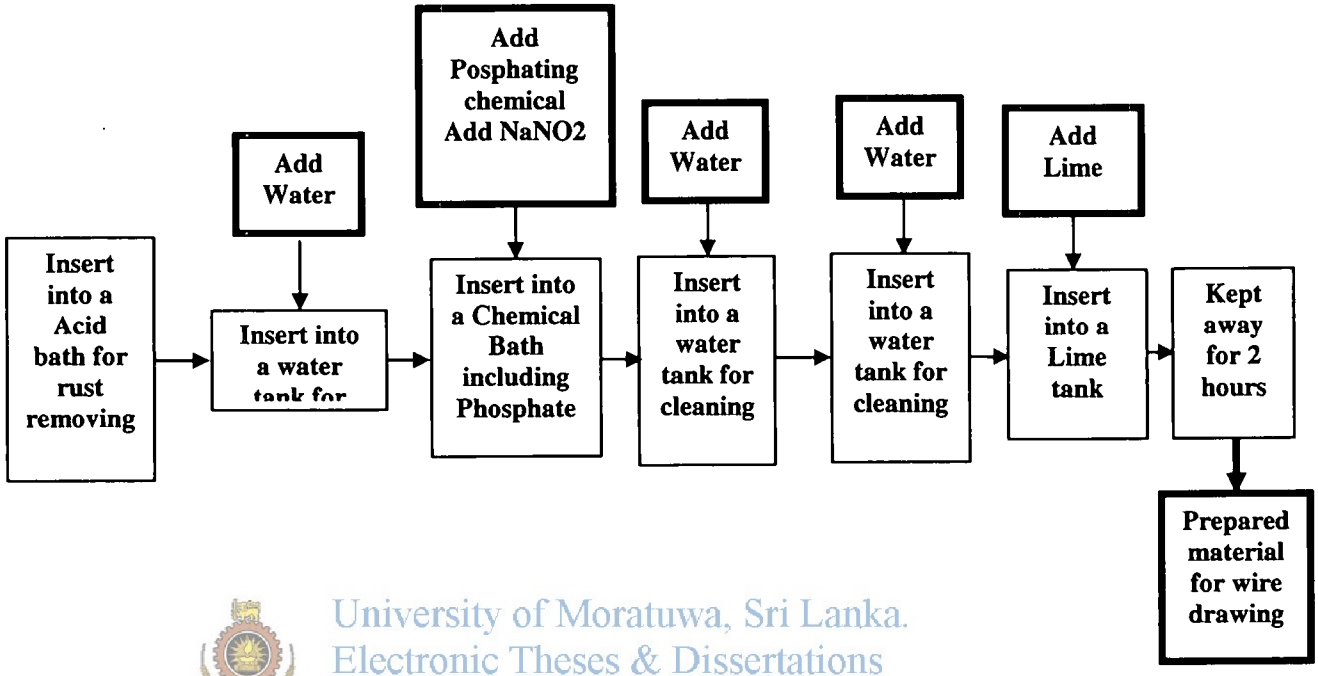

Fig 3.1 The lubrication process of Cold Forging Nut & Bolt Manufacturing Process.

- Make material and Energy Balances

Material Balance:

Incoming Material + Generated Material = Outgoing Material + Consumed Material

Energy Balance:

E.g. heat energy at lubrication process

Heat in - Heat out = heat losses in the process

Findings through the material balance and process study

- Dies of Heading machine are damaged more frequently Average of 1 die/ 50MT
- Lubricated and drawn wires are frequently rejected and lubricated repeated average 20%

- 2000 Litres of Water is consumed in each week
- Large amount of Electricity is consumed 1248 units per week
- No. of threads cut by one chaser die is only a maximum of 1200 No's
- Chaser die teeth are broken frequently. Average of 1 die/ 3days
- Large amount of scrap iron is collected each week. Average of 5MT / week

Make a questionnaire and get the details from the other companies. (See Annex C01, Annex C02, Annex C03)

The Percentages of answers Received for the questions are summarized as follows.

Table 02: The Percentages of answers Received for the questionnaire for Cold Forging Nut and Bolts

Index	Question	High	Moderate	Low
1.1	What is the Average No of dies damaged in the Heading machine?	100%	0%	0%
1.2	What is the frequency of rework at Lubrication?	100%	0%	0%
1.3	What is the water consumption per each week?	100%	0%	0%
1.4	What is the Electricity consumption at the lubrication process?	100%	0%	0%
1.5	What is the machine breakdown frequency?	50%	0%	50%
1.6	What is the amount of scrap iron collected weekly?	0%	0%	100%
1.7	What is the amount of reworks at Galvanizing?	0%	0%	0%

Table 03: The Percentages of answers Received for the questionnaire for Hot Forging Nut and Bolts

Index	Question	High	Moderate	Low
2.1	What is the frequency of breaking chaser dies?	60%	40%	0%
2.2	What is the amount of scrap iron collected each week?	100%	0%	0%
2.3	Are there machine hours idling?	20%	60%	20%
2.4	Are there labour idling hours?	40%	60%	
2.5	What is the frequency machine breakdown?	40%	40%	20%
2.6	Are there Buffer stocks in the process?	60%	40%	0%
2.7	What is the amount of reworks at Galvanizing?	0%	0%	0%

Table 04: The Percentages of answers Received for the questionnaire for Common Questions

3.1	Does the profit margin becoming a issue for you?	100%	0%	0%
3.2	Are there documentation system issues?	40%	40%	20%
3.3	Are there issues in optimum utilization of transport resource?	60%	20%	20%
3.4	Do you fail to optimize the financial facilities and minimize the finance cost	80%	20%	0%

Find the most important issues to be solved.

Find the weighted average by giving marks as follows

High - 3 marks

Moderate - 2 marks

Low - 1 mark

Calculation of Weighted Average

Weighted average = 3 x "High" Percentage + 2 x "Moderate" Percentage +
1 x "Low" Percentage

For the Percentages of answers Received for the questionnaire with weighted average for Cold Forging Nut and Bolts see Annex C04, Annex C05 and Annex C06

Rearrange the tables with descending order of the weighted average

See Annex C07, Annex C08, Annex C09

Major issues are taken as the weighted average value more than 2.25 (which is the 75% of maximum weighted average: 3)

When considering the cold forging manufacturing industries the following problems are major problems

- Damaging the dies of the Heading machine
- Rework at lubrication process
- High amount of water consumption at the lubrication process
- High amount of Electricity is consumed in the lubrication process.

According to the table when considering the hot forging manufacturing industries the following problems are key factors

- High amount of scrap iron collected each week
- High frequency of breaking chaser dies
- High amount of Buffer stocks in the process
- There is poor labour efficiency

According to the table when considering the common factors in manufacturing industries the following problems are key factors

- Profit margin is decreasing
- Financial resources are not utilized effectively
- Transport resources are not utilized effectively

In this study Assessments are focused on the manufacturing of cold forging and hot forging Nuts and Bolts. Common problems which are apart from the manufacturing process will be forwarded for the assessment in future

3.2 Cause Analysis and Solutions

Analyzing Causes for the wastes and losses.

Causes are analyzed using the Technical knowledge as well as holding Brain storming sessions

Table 05: Causes for the wastes and losses for Cold Forging Nut and Bolts

Index	Issue	Possible Causes
1.1	Damaging the dies of the Heading machine	1. Ineffectiveness's in Lubrication Process 2. Poor raw material Quality 3. design of the dies 4. Improper way it carried out
1.2	Rework at lubrication process	1. Ineffectiveness's in Lubrication Process
1.3	High amount of water consumption at the lubrication process	1. Ineffectiveness's in Lubrication Process set up at waste water management
1.4	High amount of Electricity is consumed in the lubrication process.	1. Ineffectiveness's in Lubrication Process set up at insulation 2. inefficiencies in Heaters

Table 06: Causes for the wastes and losses for Hot Forging Nut and Bolts

Index	Issue	Possible Causes
2.1	High amount of scrap iron collected each week	1. Poor Raw material procument system 2. defective items
2.2	High frequency of breaking chaser dies	1. Poor Raw material Quality 2. Poor design and manufacture of chaser dies 3. Human errors
2.3	High amount of Buffer stocks in the process	1. Poor layout planning 2. Labour inefficiencies
2.4	There is high labour idling	1. Unorganized labour handling 2. lack of knowledge 3. Inadequacies in skills 4. Poor Attitudes

Then the possible causes were analyzed deeply even with the external experts and finally exact causes were identified.

1. Lubrication process was not carried out properly. Correct steps were not followed with the required testing at each step. And also dipping of the coil was done by a fork lift. There is a threat of touching the bottom of the tank. After some time there is a deposition of chemicals in the Phosphate bath. Quality defects will be arisen when the coil touches these chemicals.

2. At the lubrication process Waste water management was not done effectively.

3. At the lubrication process Insulation was not done properly. Therefore large amount of heat was dissipated to atmosphere. This resulted not only higher electricity consumption but also poor quality of the lubrication process

4. Hot forging Nut and Bolt manufacturing raw material was not ordered by considering the wasting material. For example when a 1000mm round iron pieces needed, if purchased 5.8m bar from the market 800mm will be wasted

5. Chaser dies are broken due to the improper sharpening. Period as well as the way of doing. And also the operators defects also affect this

6. High amount of buffer stocks is caused by poor layout planning as well as labour inefficiencies.

7. Labour inefficiencies mainly caused by the attitude. There are some points the knowledge and skill of the labour also affected.

Solutions to the Causes found- for waste elimination and better productivity.

Although solutions proposed in high capital investments to initiate the improvement the project is carried out with small Kaizen activities.

1. An expertise Engineer was brought from the chemical supplier from India to refresh the technology of the lubrication process and knowledge and skill was given to the workers by holding a workshop. Check list was given to the workers and a team leader was appointed to look after the carrying out of the duties.

   A new hoist system was proposed but initially not carried out as it is a capital investment.

   A six inch height wire mesh was made to avoid the coil touching the ground with chemical deposition as a Kaizen activity

   And it was scheduled to clean the deposits every week

2. Two water tanks had been refreshed paralleled. Therefore, it wasted much water. Therefore, more polluted tank's water is removed and water is replaced by the better tank. Then the better tank is filled with new water. This saved 50% of water.

3. For the insulation better tanks are needed. As an initiative a cover made of wood is used to cover the tanks. On the other hand a good quality regulator was used to control the current.

4. Discussions were held directly with the suppliers and purchased the raw material according to the actual requirement. When a 1000mm round iron pieces needed, if purchased 5.8m bar from the market 800mm will be wasted (13.79%). Purchasing at SLR 100.00 and sold as scrap at SLR 45.00 otherwise needed to be kept aside until an order comes in usable size.

SLR saving with the reduction of scrap iron.

(According to the prices in 2009 September)

Value of one MT of a mild steel wire	=	110,000.00
Value can be obtained from scrap	=	45,000.00
Saving with reduction of 1MT of scrap iron	=	65,000.00

Let us compare the generated scrap in two ways for the requirement of 100,000 No's each from 665 mm length and 930 mm length

Two sizes of rods needed for manufacturing products

665mm, 930mm

Z - Waste of the rod

$Z = L - (665X + 930Y)$

$665X + 930Y < 5800$

$X > 0, Y > 0$

At $Y=0$, $665X < 5800$

$X < 8.72$

At $=0$, $930Y < 5800$

$Y < 6.24$

To find the minimum scrap value for both situations

$Z_{ij} = (aX_i - bY_j)$

Minimum of [Mode of $(aX_i - bY_j)$]

Where a = 665

b = 930

X_i = Number of parts of X cut by a length (X_i= 1,2...8)

Y_j = Number of parts of Y cut by a length (Y_j = 1,2...6)

Table 07: Scrap value of the bar in mm

X_i / Y_j	1	2	3	4	5	6	7	8
1	-265	400	1065	1730	2395	3060	3725	4390
2	-1195	-530	135	800	1465	2130	2795	3460
3	-2125	-1460	-795	-130	535	1200	1865	2530
4	-3055	-2390	-1725	-1060	-395	270	935	1600
5	-3985	-3320	-2655	-1990	-1325	-660	5	670
6	-4915	-4250	-3585	-2920	-2255	-1590	-925	-260

Minimum of [Mode of $(aX_i - bY_j)$] = 5

This occurs at X_i = 7 and

Y_j = 5

Required lengths = maximum of [7*665, 5*930]

= 4655 mm

Let us compare the generated scrap in two ways for the requirement of 100,000 No's each from 665 mm length and 930 mm length

Weight of a 5.8 m 16mm diameter MS bar = $\pi D^2/4*5.8*$density of MS

= $\pi*(0.016)^2/4*5.8*7850$

= 9.158 kg

No of 665 sizes getting from 5.8 length = integer of (5800/665)

= 8 pieces

No of 5.8 lengths required for 100,000Nos of 665 lengths = 100,000/8

= 12,500 bars

Waste as scrap from each 5.8 length = 5800-665*8

= 480 mm

Total waste for 100,000 No's of 665 pieces With 5.8m lengths = $480*12500*\pi*(0.016)^2/4*7850$

= 9473.83 kg

Like wise

Total waste for 100,000 No's of 930 pieces With 5.8m lengths = 5789.68

Total waste for 100,000 No's of 665 pieces

Total waste for 665 and 930 items with 5.8 length = 15263.51 kg

	=	5.71%
With 4.655 m lengths	=	0
Total waste for 100,000 No's of 930 pieces		
With 4.655 m lengths	=	157.9 kg
Total waste for 665 and 930 items with 4.655m length	=	157.9 kg
	=	0.06%

Therefore,

Generated scrap with new size = 0.06/5.71

= 1%

Prevented scrap generation fro this production = 15263.51-157.9

= 15105.61 kg

Saving in SLR = 15105.61/1000*65000

= 981864.59

5. Holding device was used for the sharpening of chaser die with a surface grinding machine. And the frequency of the sharpening was changed from two days to 1 day. A technician is appointed to sharp the dies everyday in the evening.

6. An incentive was given to the workers on their performances. And the change was done to the workers to work at optimum places.

Attitude change was occurred with the incentive and training opportunities were given to the workers as well as the production management team. **Motivational Schemes**

To maintain the labour productivity it is very important to develop knowledge, skill, attitudes. For the developing of Attitudes Motivational schemes play a very important role.

3.3 Results

Results Obtained

Table 08: Results obtained for Cold Forging Nut and Bolts

Index	Issue	Value before improvement	Value after improvement	improvement
1.1	Damaging the dies of the Heading machine	3 dies/ month	2die/ month	33%
1.2	Rework at lubrication process	5 times/ month	2 time per month	60%
1.3	High amount of water consumption at the lubrication process	2000 liters/ week	1000 liters/ week	50%
1.4	High amount of Electricity is consumed in the lubrication process.	1248 units/ week	936 units/ week	25%

Table 09: Results obtained for Hot Forging Nut and Bolts

Index	Issue	Improvement		
2.1	High amount of scrap iron collected each week	5MT/ week	4MT/ week	20%
2.2	High frequency of breaking chaser dies	3dies/ week	2 die/week	33%
2.3	High amount of Buffer stocks in the process	Average of 50 MT	45 MT	10%
2.4	There is high labor idling	Average of 10%	7%	30%

3.4 Discussion

This plant is one of the two main Cold forging Hexagonal Nut and Bolt manufacturing plants in Sri Lanka who provides Nut and Bolts to the consumer market. Therefore, any effect to the machine will affect the Nut and Bolt market in Sri Lanka.

The average output of the machine per day was found to be 5MT. According to the Manufacturer of the dies the average usage of one heading dies should be 150MT. And at the time of investigations it was only 50 MT. On the other hand there was a reworking process at the lubrication process 5 times a month in average. However with the implementation of this methodology root causes were identified and with the solutions given the average usage of heading die has increased to 125MT with a percentage increase of 250%. And also the rework of the lubrication process reduced to 1 rework per month and it is an 80% reduction in rework process.And also more improvement is expected with the proposed hoist system which is to be implemented in the next stage. Water consumption had been 2000 liters per week and with the introduction of counter current washing system one tank of water could be saved per week as an improvement of reducing the water consumption by 50%. Electricity consumption had been 1248 units per week and it reduced to 936 units per week and it is a saving of 25% of the electricity bill. And also when hot forging is concerned, weekly collected scrap iron amount reduced by 20%. However, each Metric tone of scrap irons saving saves more than 65,000.00 SLR. Identified correct period of sharpening the chaser dies improved the life time of them by 66.7%. On the other hand, amount of buffer stocks could be reduces by 10% identifying the bottlenecks and improving the resource utilization. Labor idling could be reduced from 10% to 7% with the introduction of the incentive scheme. Altogether with the introduced methodology considering all factors there is a n average improvement of 33%. This will help the organization to withstand the critical situation of the market. And also as the other Sri Lankan companies also gave similar answers at the issue findings, they can apply this methodology to face the critical situations successfully.