Process Improvement and Cost Reduction in Wire Manufacturing Industry

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Kellogg Honors College Capstone Project

Introduction

This capstone consisted of spending time at a wire manufacturing company's facility in order to propose a plan to improve their products while at the same time reducing costs. More specifically, time was spent analyzing their galvanizing of the wire department. A plan was proposed to implement a preventive maintenance system of the bearings that were being used in order to improve the overall quality of their products. Not only would this plan improve quality but also lower cost by reducing the amount of scrap, rejects, and rework that is being produced in the department. Different alterations and alternatives were taken into account in order to formulate a plan that would be most beneficial to the company.

Problem:

Currently there is no system in place to regulate that the proper rollers are being used for the wire being ran on lay heads. If wire is being ran on rollers that are not adequate for the job, this results in scratching, cast / helix, and packaging problems.

There is also very little "ready to-go" rollers in the case that one of the roller sets need be replaced. There is downtime on the lay heads once it goes down because rollers may need to be ordered, and the groove needs to be made before they can be installed by maintenance. The minimum downtime for this process is two days.

Proposed Solution:

- Keep a log of every time a roller set is being replaced in order to better estimate the lifespan of a roller set. This way rollers can be changed when they are near the end of their life before quality issues arise.
- Build up an inventory of "ready to-go" rollers (of different sizes) to reduce waiting for rollers in the case that multiple lay heads go down simultaneously.
- Tag rollers (with color tape possibly) to allow ease in auditing to ensure that the operators are using the appropriate rollers for the wire being ran.
- Train operators in changing rollers so that they are not waiting for the maintenance department to perform the change over.
- Have a storage area for rollers near galvanizer to reduce the distance operators need to travel to gather materials.
- Have a charts with information of adequate wire sizes for each roller near roller storage area and galvanizer.

Results

	5% Scrap Reduction	15% Scrap Reduction	30% Scrap Reduction
Worst Case	$18,879.57	$93,314.13	$214,831.01
Most Likely	$23,461.23	$97,895.80	$221,568.76
Best Case	$29,562.77	$103,997.33	$230,541.60

Most of the company's expenses come from scrap, rejects, and rework. By implementing this proposal, it is estimated that a significant amount of scrap can be reduced. Results of the analysis are shown above. The amount of savings that the company can obtain over a five-year period given the different conditions are shown in the table.

Future Developments

- In order to further understand a root cause of what is driving scrap in this department, the system would need to be broken down into components and further down to its most basic elements (root-cause analysis). This would allow to pinpoint shift, operator, specific lay head, or part number leading to scrap.
- Implementation of PM systems in all departments would ensure quality in all areas and reduce the possibility of a domino effect of quality issues as the product progresses throughout the departments.
- Implementation of a Quality Management System (ISO 9001) would allow for ease of auditing and ensure continuation of proper PM practices.
- Look into reworking small size rollers into larger size rollers so that they can be reused to run thicker wire.

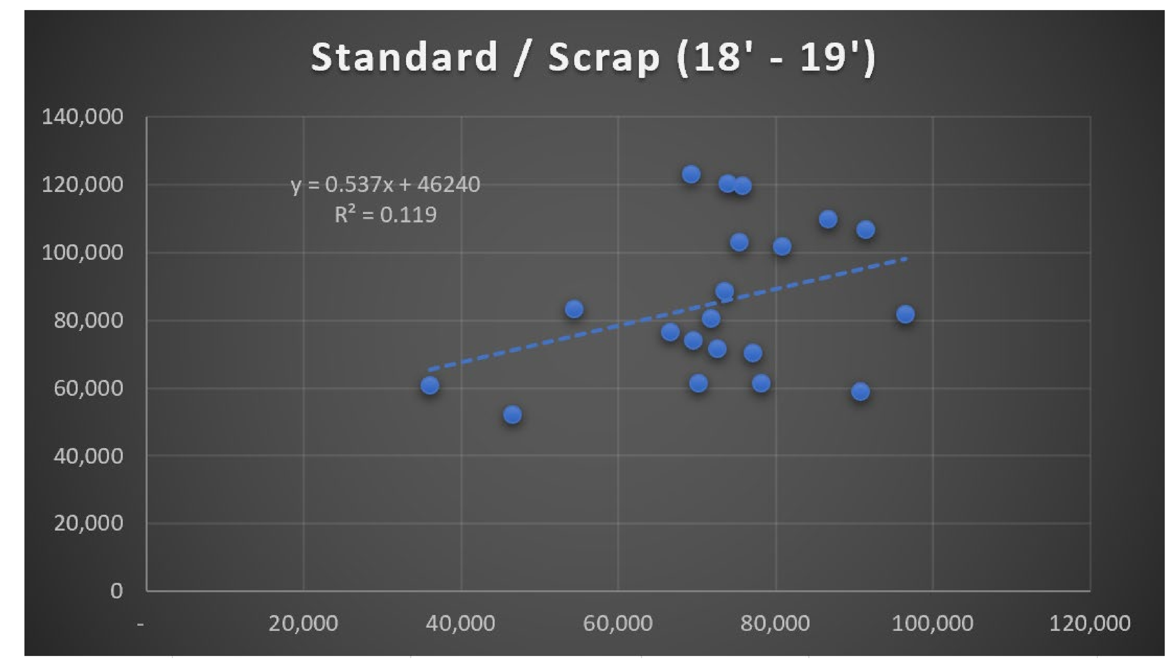
Acknowledgments

This work was possible thanks to Dr. Ellips Masehian and the rest of the Cal Poly Pomona Industrial and Manufacturing Engineering department. Special thanks to the wire manufacturing company who allowed the use of their facility and to analyze process but prefers to remain anonymous.

Data

Month	Scrap (lbs)	Standard (lbs)	Variance
2018			
1	106,916	91,454	(15,462)
2	70,324	77,082	6,758
3	58,929	90,774	31,845
4	61,491	78,112	16,621
5	81,942	96,452	14,510
6	80,441	71,752	(8,689)
7	101,880	80,835	(21,045)
8	109,858	86,708	(23,150)
9	103,109	75,340	(27,769)
10	123,297	69,259	(54,038)
11	60,840	36,052	(24,788)
12	52,297	46,509	(5,788)
Total	**1,011,324**	**900,329**	**(110,995)**
2019			
1	120,379	73,917	(46,462)
2	74,075	69,466	(4,609)
3	119,668	75736	(43,932)
4	83,497	54368	(29,129)
5	61,504	70123	8,619
6	76,567	66573	(9,994)
7	71,508	72612	1,104
8	88,447	73529	(14,918)
Total	**695,645**	**556,324**	**(139,321)**

The data used to formulate the analyses for this proposal is as shown above. Only more recent data was used, starting from the beginning of 2018 through 2019. The data gives us an insight of the current state, regarding month-to-month scrap. The standard is determined by the amount of production in the galvanizer for that month. The production for the department a month multiplied by a factor of 0.013 gives us the standard value of allowed scrap. From the data we can see that scrap drastically exceeds standard values month after month.



The results suggested that there is very little to no correlation between the standard (production) and scrap. A regression model was ran, which yielded an R-squared value of 0.119. Meaning that more production does not necessarily mean more scrap. It seems as if the scrap values for each month are not being driven by the amount of production. As it can be seen from the scatter plot two of the months with the most production had lower scrap values, than most other months. Taking this into account, we conclude that scrap may be driven by the bearings being used, worker, or shift operating within the department.

Financial Analysis

	Worst Case	Most Likely	Best Case
Term (years)	1	1	1
Rollers	180	180	180
Unit Costs	$ 24.00	$ 18.00	$ 10.00
Freight	$ 15.00	$ 12.00	$ 10.00
Tax	15%	15%	15%
Total Costs	$ 4,983.00	$ 3,738.00	$ 2,080.00

	30% Scrap Reduction	15% Scrap Reduction	5% Scrap Reduction
Term (years)	5	5	5
Inflation	2.18%	2.18%	2.18%
MARR	5%	5%	5%
Scrap Reduced (lbs)	303,397.20	151,698.60	50,566.20
Cost ($) / scrap (lb)	$ 0.20	$ 0.20	$ 0.20
Cost of Scrap	$ 60,679.44	$ 30,339.72	$ 10,113.24
Tax Rate	$7500 + 25% over $50,000	15%	15%

The NPV of savings over a five-year period was conducted for each case scenario (worst case, most likely, best case) assuming 5% scrap reduction, 15% scrap reduction, and 30 % scrap reduction. The inflation rate was determined from the average inflation of the last 20 years (inflation data was gathered from **https://www.usinflationcalculator.com/inflation/current-inflation-rates/**). A 5% MARR value was also used for this analysis. Using the scrap data for 2018 a trough 2019 estimate of how much scrap can be reduced for each year was formulated. Assuming that a pound of scrap is costing about 20 cents per pound the savings for the amount of scrap reduced was calculated.

The initial costs for this project are shown on the left. Assuming that we will build up our inventory to 180 "ready to-go rollers" the cost of worst case, most likely, and best case scenarios are $4,982, $3,738, and $2,080 respectively. Since there are 36 lay heads each with two sets of five rollers, having an inventory of 180 rollers allows for coverage of any of half the lay heads for one year. This estimate is based on a 2-year life span for a roller.

Worst Case Scenario

5 Year Analysis - 30% Scrap Reduction

Worst Case	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$60,679.44	$60,679.44	$60,679.44	$60,679.44	$60,679.44
Expenses	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)
Difference	$55,696.44	$55,696.44	$55,696.44	$55,696.44	$55,696.44
Tax Payable	$6,075.89	$6,075.89	$6,075.89	$6,075.89	$6,075.89
After Tax	$49,620.55	$49,620.55	$49,620.55	$49,620.55	$49,620.55
NPV	**$214,831.01**				

5 Year Analysis - 15% Scrap Reduction

Worst Case	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$30,339.72	$30,339.72	$30,339.72	$30,339.72	$30,339.72
Expenses	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)
Difference	$25,356.72	$25,356.72	$25,356.72	$25,356.72	$25,356.72
Tax Payable	$3,803.51	$3,803.51	$3,803.51	$3,803.51	$3,803.51
After Tax	$21,553.21	$21,553.21	$21,553.21	$21,553.21	$21,553.21
NPV	**$93,314.13**				

5 Year Analysis - 5% Scrap Reduction

Worst Case	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$10,113.24	$10,113.24	$10,113.24	$10,113.24	$10,113.24
Expenses	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)	($4,983.00)
Difference	$5,130.24	$5,130.24	$5,130.24	$5,130.24	$5,130.24
Tax Payable	$769.54	$769.54	$769.54	$769.54	$769.54
After Tax	$4,360.70	$4,360.70	$4,360.70	$4,360.70	$4,360.70
NPV	**$18,879.57**				

Best Case Scenario

5 Year Analysis - 30% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 60,679.44	$ 60,679.44	$ 60,679.44	$ 60,679.44	$ 60,679.44
Expenses	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)
Difference	$58,599.44	$58,599.44	$58,599.44	$58,599.44	$58,599.44
Tax Payable	$5,350.14	$5,350.14	$5,350.14	$5,350.14	$5,350.14
After Tax	$53,249.30	$53,249.30	$53,249.30	$53,249.30	$53,249.30
NPV	**$230,541.60**				

5 Year Analysis - 15% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 30,339.72	$ 30,339.72	$ 30,339.72	$ 30,339.72	$ 30,339.72
Expenses	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)
Difference	$28,259.72	$28,259.72	$28,259.72	$28,259.72	$28,259.72
Tax Payable	$4,238.96	$4,238.96	$4,238.96	$4,238.96	$4,238.96
After Tax	$24,020.76	$24,020.76	$24,020.76	$24,020.76	$24,020.76
NPV	**$103,997.33**				

5 Year Analysis - 5% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 10,113.24	$ 10,113.24	$ 10,113.24	$ 10,113.24	$ 10,113.24
Expenses	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)	$ (2,080.00)
Difference	$8,033.24	$8,033.24	$8,033.24	$8,033.24	$8,033.24
Tax Payable	$1,204.99	$1,204.99	$1,204.99	$1,204.99	$1,204.99
After Tax	$6,828.25	$6,828.25	$6,828.25	$6,828.25	$6,828.25
NPV	**$29,562.77**				

Most Likely Scenario

5 Year Analysis - 30% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 60,679.44	$ 60,679.44	$ 60,679.44	$ 60,679.44	$ 60,679.44
Expenses	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)
Difference	$56,941.44	$56,941.44	$56,941.44	$56,941.44	$56,941.44
Tax Payable	$5,764.64	$5,764.64	$5,764.64	$5,764.64	$5,764.64
After Tax	$51,176.80	$51,176.80	$51,176.80	$51,176.80	$51,176.80
NPV	**$221,568.76**				

5 Year Analysis - 15% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 30,339.72	$ 30,339.72	$ 30,339.72	$ 30,339.72	$ 30,339.72
Expenses	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)
Difference	$26,601.72	$26,601.72	$26,601.72	$26,601.72	$26,601.72
Tax Payable	$3,990.26	$3,990.26	$3,990.26	$3,990.26	$3,990.26
After Tax	$22,611.46	$22,611.46	$22,611.46	$22,611.46	$22,611.46
NPV	**$97,895.80**				

5 Year Analysis - 5% Scrap Reduction

Most Likely	Year 1	Year 2	Year 3	Year 4	Year 5
Savings	$ 10,113.24	$ 10,113.24	$ 10,113.24	$ 10,113.24	$ 10,113.24
Expenses	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)	$ (3,738.00)
Difference	$6,375.24	$6,375.24	$6,375.24	$6,375.24	$6,375.24
Tax Payable	$956.29	$956.29	$956.29	$956.29	$956.29
After Tax	$5,418.95	$5,418.95	$5,418.95	$5,418.95	$5,418.95
NPV	**$23,461.23**				

Alternatives

Different alternatives and alterations were considered and analyzed but the one with the most favorable results is presented here in this poster. Among the different alternatives, one suggested that the company purchase their own CNC machine in order to produce bearings themselves. Purchasing of a CNC machine would save them the costs of bearings, but they would induce the expenses of purchasing a good machine and training or hiring of an operator. Over a period of five years they would not get as good a rate of return than implementing the preventive maintenance system.