UTILIZING STATISTICAL QUALITY CONTROL(SQC) TOOLS FOR ANALYZING DEFECTS IN A SMALL-SCALE LOCAL SHOES PRODUCTION COMPANY

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ABSTRACT: *Product quality has a significant impact on a company's level of growth and progress. Companies can determine whether or not the items created from the starting process or the final product are still under control by using statistical quality control (SQC) as a quality control technique for production. The research was conducted in a small-scale shoe production company in the Philippines to find out the causes of defects that occur in the shoe production process. In this study, it is found that such defects are excessive adhesive, incorrect sizes, and scratch/dent marks in which the majority of the defects occurred are incorrect sizes and scratch/dent marks. Using a Cause and Effect diagram, it is found that the causes of the occurrence of such defects are due to human, machine, materials, and method factors. Solutions for defects that occur are given in the hope that the company will implement the solutions to reduce the number of defects in the production process.*

Keywords: shoe, shoe production, statistical quality control, shoe production defects, control chart, cause and effect diagram

1. INTRODUCTION

Statistical Quality Control (SQC) is a methodology used in the manufacturing industry or service provider to monitor and control the quality of products or services. Statistical Quality Control consists of analyzing processes, setting standards, comparing performance, verifying and studying defects finding and implementing solutions to obtain better improvements. Statistical Quality Control emerged as an alternative to improve and monitor the quality of production, where the control is carried out through an efficient and simple control chart to monitor the average and threshold of the observed characteristics [1].

The quality of products (services) is crucial in assessing the performance of each enterprise or organization. The release of effective and high-quality products allows the company to obtain more additional profits and ensures rapid production development [2]. Nowadays, SQC techniques are utilized both in industry and academe settings. Some of the applications in the industry setting included identifying causes of defects of PVC pipe production [3], cost and project monitoring in a construction project [4], improvement of quality of weights of bags in feed production [5], and many others. On the other hand, some of the applications of SQC techniques in academic settings included the evaluation of self-learning modules for basic education [6], the assessment of the performance of graduates in licensure examinations for teachers [7], and many others.

In a time of heightened competition and increasing consumer demand for quality, even small-scale local production companies must maintain exacting standards of excellence. Despite their distinctive craftsmanship and personalized touches, these companies often grapple with challenges related to consistent product quality and reducing defects.

This study explores the critical role of statistical quality control (SQC) approaches as a tactical tool for examining and optimizing production processes within such firms. Specifically, it focuses on a local small-scale shoe production business located in the Philippines, considering the data from January 2022 to December 2022, and aiming to determine the causes of defects in shoe production within this timeline.

2. METHODS

In this study, statistical quality control (SQC) tools are used in order to analyze and find the causes of product defects in the shoes being produced. The SQC tools used in this study include stratification, check sheets, Pareto analyses, scatter diagrams, control charts, and cause-and-effect diagrams.

2.1. Data collection

There are two types of data used in this study, primary data and secondary data. Primary data is data collected for a specific research goal. Secondary data is data obtained indirectly from sources or research objects. Secondary data are data originally collected for a different purpose and reused for another research question [8]. Secondary data were obtained from company-owned reports, books, and scientific journals that support primary data.

2.2 Data processing

The data processing techniques are performed using a statistical quality control approach which consists of the histogram, check sheet, scatter diagram, stratification, Pareto diagram, cause-and-effect diagram, and control chart.

- Stratification is the process of grouping data into a group that has the same characteristics.
- A check sheet is a structured, prepared form for collecting and analyzing data. This is a generic data collection and analysis tool that can be adapted for a wide variety of purposes and is considered one of the seven basic quality tools.
- Pareto analysis is a chart containing bar and line charts; Bar charts show data classifications and values, while line charts represent cumulative totals.
- The scatter diagram is used to see the correlation of the total production with the types of defects found.
- A control chart is a graph that shows whether the defect found exceeds a predetermined threshold or not.
- A cause-and-effect diagram, also known as an Ishikawa or "fishbone" diagram is a graphic tool used to explore and display the possible causes of a certain effect. Use the classic fishbone diagram when causes group naturally under the categories of Materials, Methods, Equipment, Environment, and People.

ULTS AND DISCUSSION

3.1. Stratification

In this study, stratification is used to group data with the same characteristics. Based on the data collected, the data is numerical in nature and there are three distinct groups of data. These are the three types of defects found, namely: excess adhesive, incorrect sizes, and scratch/dent marks.

3.2. Check sheet

The check sheet is a simple sheet about the data collection process that is carried out and is used to determine the number of defects, types of defects, or other information [3]. The check sheet on shoe production defects is presented in Table 1. It shows that the defects encountered in producing shoes are excessive adhesive, incorrect sizes, and scratch/dent marks, with a total of 171 defects.

Table 1. Shoe production defects check sheet

Period -2022	Total production (Pairs)	Types of defects						Total no. of defects
		Incorrect sizes	Percentage	Scratch/dent marks	percentage	Excessive adhesive	percentage	
January	100	3	3.00%	3	3.00%	3	3.00%	9
February	90	5	5.56%	4	4.44%	4	4.44%	13
March	95	5	5.26%	5	5.26%	4	4.21%	14
April	110	4	3.64%	3	2.73%	3	2.73%	10
May	205	6	2.93%	4	1.95%	2	0.98%	12
June	190	4	2.11%	6	3.16%	2	1.05%	12
July	155	3	1.94%	3	1.94%	3	1.94%	9
August	150	3	2.00%	4	2.67%	4	2.67%	11
September	167	5	2.99%	4	2.40%	3	1.80%	12
October	165	4	2.42%	4	2.42%	2	1.21%	10
November	290	11	3.79%	10	3.45%	5	1.72%	26
December	405	15	3.70%	10	2.47%	8	1.98%	33
Total	2122	68	3.20%	60	2.83%	43	2.03%	171

3.3 Pareto diagram

The Pareto chart is a bar graph and a line graph that illustrates how the data types are compared to the whole. The data is classified and sorted from left to right according to the order of highest to lowest ranking. The highest ranking is the priority problem or the most important problem to be resolved immediately, while the lowest ranking is a problem that does not have to be resolved immediately. The function of the Pareto diagram is to identify the main problems for quality improvement from the biggest to the smallest [3]. Figure 1 shows the Pareto diagram of shoe production defects. As shown in the figure, 74.85% of the defects that occur in shoe production are caused by an accumulative percentage of incorrect sizes (39.77) and Scratch/dent marks (35.09), together these defects contribute to 6.03% of the total production. With this in mind, by making corrections/repairs at the root cause of the two defects, it is expected that the number of defects can be reduced. On the other hand, the excessive adhesive marks contributed 25.15% of the total defects. The scratch/dent marks problem, enclosed by the broken line in the figure, is the least prioritized problem while the problem/s that are not enclosed are those that should be prioritized, which are excessive adhesive and incorrect sizes.

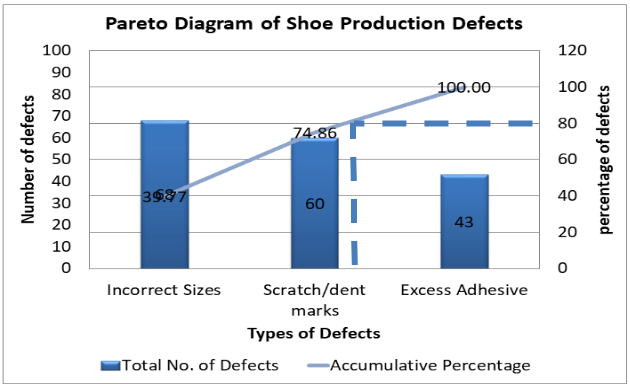

Figure 1: Pareto diagram on shoe production defects

3.4 Scatter diagram

The scatter diagram is used to see the correlation of the total production with the types of defects found. From Figures 2 and 3, the correlation coefficients of incorrect sizes and scratch/dent marks are 0.9004384 and 0.8633790, respectively, which means that there is a high positive correlation between the total production and the defect's incorrect sizes and scratch/dent marks. From Figure 4, the correlation coefficient of 0.6777002 is found, which means that there is a moderate positive correlation between total production and excess adhesive.

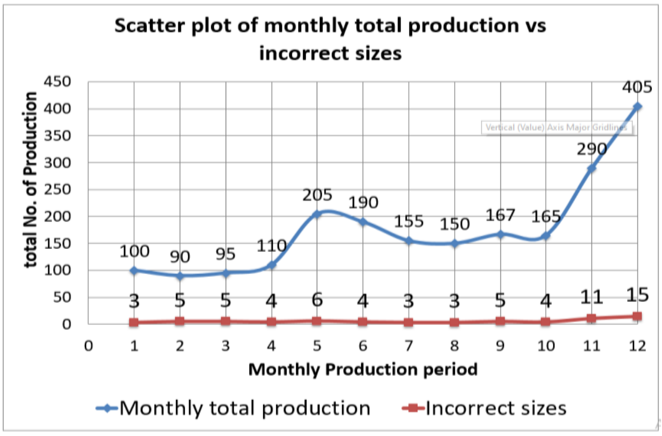

Figure 2: Scatter plot of total production vs. incorrect sizes defects

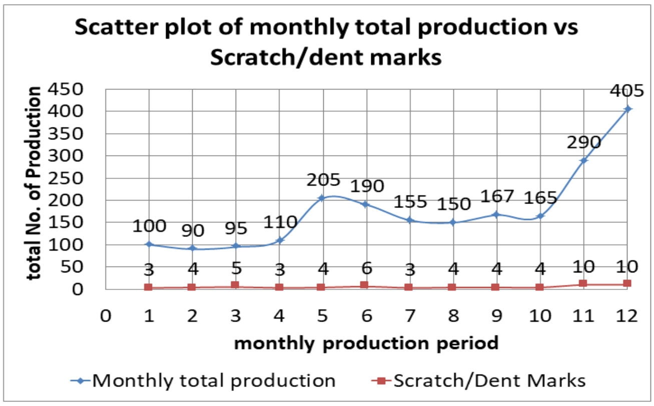

Figure 3: Scatter plot of total production vs. scratch/dent marks defects

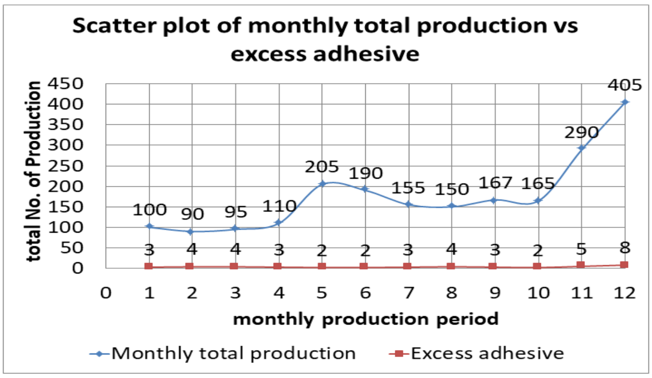

Figure 4: Scatter plot of total production vs. excess adhesive defects

3.4 Control chart

A control chart is a graph that shows whether the defect found exceeds the Upper Control Limit (UCL) and Lower Control Limit (LCL) or not. As shown in Figures 5, 6, and 7, there are no defects that exceed the upper and lower control limits (UCL & LCL). This indicates that the shoe production process is still under control.

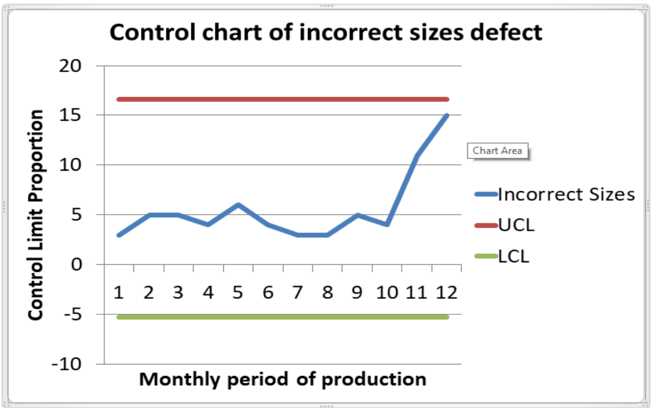

Figure 5: Control chart for Incorrect Sizes defect

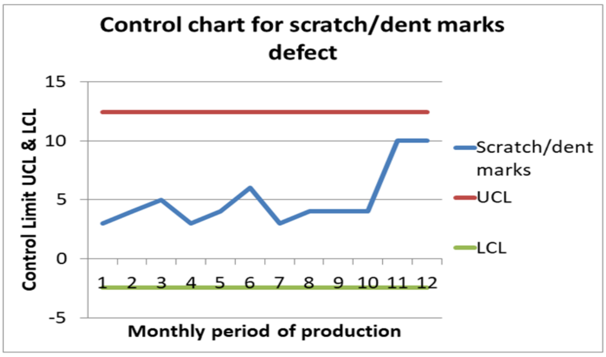

Figure 6: Control Chart for scratch/dent mark defects

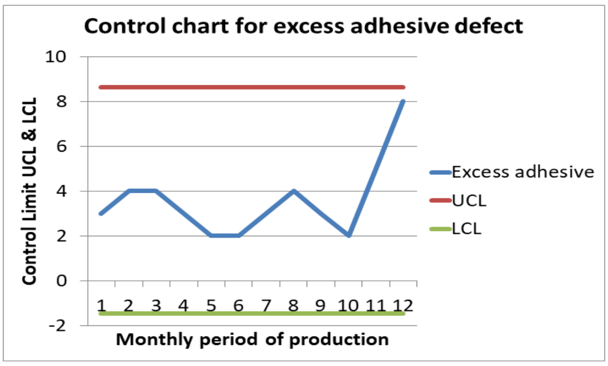

Figure 7: Control Chart for excess adhesive defects

3.5 Ishikawa Diagram (Fishbone Diagram)

The Ishikawa Diagram, also known as a Fishbone Diagram, is a widely used tool to find the biggest contributing factors to defects found in products. The fishbone diagram for the shoe production defects is presented in Figures 8, 9, and 10. In Figure 8, it was found that due to less manpower, the workers are working in a fast phase to be able to finish the products before the deadline. This results in little resting time on the part of the workers, thus making them tired and eventually making them less thorough in checking and making sure that the correct size of measuring tool is used for a specific order. Similarly, in Figure 9, due to less manpower, the workers are more focused on the quantity of work done and take little care in storing their finished product. Due to limited space and poor workshop organization, some products are unintentionally scratched and dented due to contact with sharp edges and objects inside the workplace. As reflected in Figure 10, the workers are working in a fast phase to be able to finish the products before the deadline. This results in little resting time on the part of the workers, thus making them tired and eventually making them less thorough in applying adhesive. The worker pours in a large amount of adhesive to save time by making the pouring process once and, when pressed, spreading it across, resulted in excess adhesive.

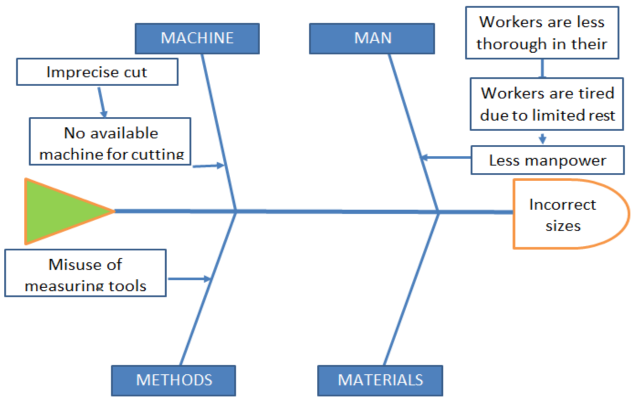

Figure 8: Cause and effect diagram for incorrect sizes defect

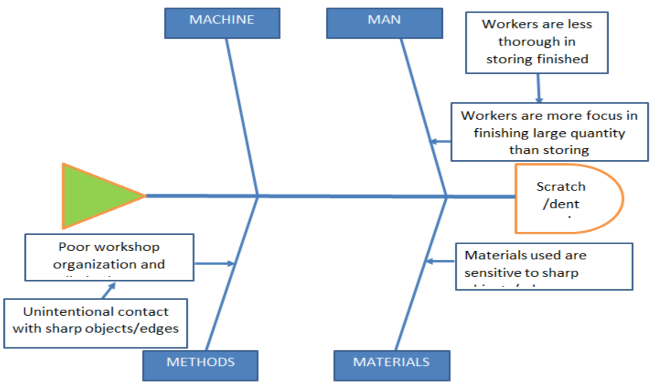

Figure 9: Cause and effect diagram for scratch/dent mark defect

4. CONCLUSION

Every manufacturing company must eliminate the causes that could cause production problems. Defects in products can cause the company to suffer material and immaterial losses. Through the statistics quality control

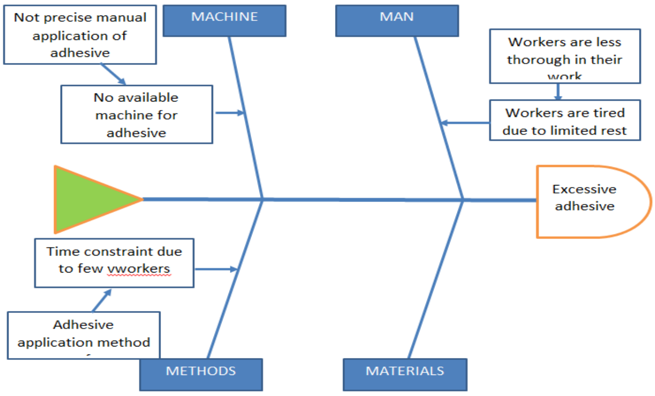

Figure 10: Cause and effect diagram for excessive adhesive defect

(SQC) approach, types of defects can be found, and ways to deal with these disabilities can be found. In this study, the defects observed in shoe production are excessive adhesive, incorrect sizes, and scratch and dent marks, where nearly 75% of defects found were scratch/dent marks and incorrect sizes. The causes of defects which are originating from humans, machines, materials, and methods can be overcome in various ways. All three (3) defects identified can be overcome by recruiting new employees to distribute workloads so as to reduce the effect of fatigue on the workers.

In addition, proper housekeeping can help to maintain a well-organized workshop and free up more space to be utilized for storage. The procurement of new tools and equipment can help the business grow by reducing manufacturing time, which would allow the business to accommodate more orders.

REFERENCES

[1] de Andrade, M G, Vilas Boas M A, Siqueira J A C, Dieter J, Sato M, Hermes E, Mercante E and Kazue Tokura L (2017). Statistical quality control for the evaluation of the uniformity of micro-sprinkler irrigation with photovoltaic solar energy Renew. Sustain. Energy Rev.

[2] Simonenko K V., Bulatova G S, Antropova L B and Varepo L G. (2018). Quality Control of the Print with the Application of Statistical Methods J. Phys. Conf. Ser.998

[3] Ginting, R. and Supriadi, S. (2021) IOP Conf. Ser.: Mater. Sci. Eng. 1041 012040

[4] Vigor, V.A.E., Calibara, J.B., Estampa, L.J.B., Estillore, M.N.A., & Namoco Jr., C.S. (2022). The use of Statistical Quality Control Charts in Monitoring the Cost and Project Duration of the Columbarium Construction Project Utilizing Concrete Composite Panels. Sci. Int. (Lahore), 34(4), 349–353.

[5] Pimentel, R.A., Duat,D.L., Estrera, P.J., Sayadi, A.M., & Namoco Jr., C.S. (2022). Utilizing Statistical Quality Control Tools in Improving the Quality of the Weights of Animal-Feed Bags. Sci.Int.(Lahore), 34(5), 441–445.

[6] Hagutin, G.G., Roger, J.P., Lastimosa, M.C., Naive, D.J.P., & Namoco Jr., C.S. (2022). Utilization of Statistical Quality Control (Sqc) Tools in Evaluating the Self-Learning Modules for Basic Education. Sci.Int.(Lahore), 34 (4), pp.367- 371.

[6] Kartnik. (2020, November). Evolution of Performance of Work by Check Sheet in Constructional Activities. International Journal of Progressive Research in Science and Engineering, Volume-1(Issue-8), 1.

[7] Capilitan Jr., F.T., Duero, J.G.Q., Daleon, J.D., Dumaog, A.C., & Namoco Jr., C.S. (2022). Assessment On the Performance of Teacher Education Graduates In the Licensure Examination For Teachers (Let) Using Statistical Quality Control: A Case Study Of University Of Science And Technology of Southern Philippines-Cagayan De Oro. Sci. Int. (Lahore), 34(3), 327–330.

[8] Hox, & Boeije. (2005). Data Collection, Primary vs. Secondary. Encyclopedia of Social Measurement, 1.