

Utilization of Six Sigma Analysis to Evaluate Upcycled Denim towards Sustainability

Wafaa. S. M. Ahmed

Assistant Lecturer, Textile and clothing, Home Economics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Cairo, Egypt,
Wafaa.ahmed@women.asu.edu.eg

Prof. Wafaa A. Al-Sayed

Professor, Textile and clothing, Home Economics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Cairo, Egypt, wafaa49@women.asu.edu.eg

Dr. Rania N. Shaker

Assistant Professor, Textile and clothing, Home Economics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Cairo, Egypt,
rania.goma@women.asu.edu.eg

Dr. Shima H. Abdelrahman

Lecturer, Textile and clothing, Home Economics Department, Faculty of Women for Arts, Science and Education, Ain Shams University, Cairo, Egypt, shima.hassan@women.asu.edu.eg

Abstract:

Six wastes denim fabrics redesign using different decoration technique creating a new trendy wearable accessory, eco fashion, focusing on sustainability and upcycling from point of view and customer satisfaction and problem solving from other point of view. Physico-Mechanical properties of new and waste denim fabrics were evaluated to determine the shelf life of the redesigned products. Function and aesthetic aspect, elements, principles and upcycling properties of the products were examined. The results were evaluated and statistically analyzed using six sigma evaluating tool. The product No. (4) which represents a multipurpose shoulder bag for girls and women is considered the best ranked product as it is the first rank with sigma level (5.74) which it meets customer satisfaction and acceptability.

Objective: The aim of this research is to upcycle wastes denim fabrics via redesign strategies to create a new trendy wearable accessory, evaluated with Six Sigma analysis focusing on customer satisfaction and problem solving.

Experimental work: New fashionable trendy accessories were created via using denim waste (old used child's trouser and a man's short). Six new products were created and decorated using different accessories.

Materials: old used denim, sewing threads, trims, zippers, crochet threads, canvas threads, metal rings, wooden beads, and colored beads.

Techniques: different sewing technique, embroidery, stitching, threads, and hand printing.

Paper History:

Paper received April 22, 2025, Accepted June 27, 2025, Published on line September 1, 2025

Keywords:

Sustainability, Denim, Recycling, Upcycling, Eco Fashion, 6 sigma

References:

- 1- Farghaly, S. T., Alaswad, M. H., Fiad, N. S., Muhammad, R. R., Muhammad, K., & Hassabo, A. G. (2024). The impact of fast fashion on sustainability and eco-friendly environment in fashion design world. *Journal of Textiles, Coloration and Polymer Science*, 21(2), 449-458.
- 2- El Adwi, M. (2020). Creating sustainable fashion Designs treated with soil release finishing via used household textiles. *International Design Journal*, 10(2), 89-98.
- 3- Abbate, S., Centobelli, P., Cerchione, R., Nadeem, S. P., & Riccio, E. (2024). Sustainability trends and gaps in the textile, apparel, and fashion industries. *Environment, Development and Sustainability*, 26(2), 2837-2864.
- 4- Silva, M. F. V. O. B. D., & Melo, F. J. C. D. (2024). Sustainability 4.0 in the fashion industry: A systematic literature review. *International Journal of Advanced Operations Management*, 15(4), 293-323.01.
- 5- Patel, A. S., & Patel, K. M. (2021). Critical review of literature on Lean Six Sigma methodology. *International Journal of Lean Six Sigma*, 12(3), 627-674.

- 6- Suwanda, S. (2024). The role of the Six Sigma method in controlling and improving product quality. *Jurnal Ilmiah Multidisiplin Indonesia (JIM-ID)*, 3(01), 34-42.
- 7- Niemann, J., Reich, B., & Stöhr, C. (2024). *Lean Six Sigma: Methods for Production Optimization*. Springer Nature.
- 8- implementing of six sigma process improvement frame work in production and properties of protective garment against foul weathering.
- 9- Escobar, C. A., Macias-Arregoyta, D., & Morales-Menendez, R. (2024). The decay of Six Sigma and the rise of Quality 4.0 in manufacturing innovation. *Quality Engineering*, 36(2), 316-335.
- 10- Patel, A., & Chudgar, C. (2020). Understanding basics of Six Sigma. *Sigma*, 6(3.4), 99-99966.
- 11- Al-Hadedy. A, Al -Sayed. W.A &Abdurrahman.S. H. (2016),” Using different techniques to produce a soil release stain removal fabrics and their evaluation via six sigma process framework” PHD Thesis, Women’s College for Science, Arts and Education, Ain Shams University.
- 12- ASTM, D. (2019). ASTM D5035-11 Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method). ASTM Standards.
- 13- Yavuzkasap Ayakta, D., Oner, E., & Celikkiran, S. (2019). A research on the mechanical properties of worsted fabrics made of high tenacity polyamide. *Fibers and Polymers*, 20(11), 2426-2432.
- 14- ASTM D3776/M-09a (2013). Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
- 15- ISO 4920, (2012). Textile fabrics- Determination of resistance to surface wetting (spray method test).
- 16- <http://www.huntercaprez.com/view/data/3906/HunterLab/MiniScan-EZ-Specifications-EN.pdf>.
- 17- ISO 105-C06-, (2010) color fastness to domestic and commercial laundering.
- 18- ISO 105 B02, (2013) Color fastness to artificial light: Xenon arc fading lamp test.
- 19- AATCC 15, (2002). Standard Test Method for colorfastness to Perspiration.

CITATION

Wafaa Al-Sayed,et al (2025), Utilization of Six Sigma Analysis to Evaluate Upcycled Denim towards Sustainability, *International Design Journal*, Vol. 15 No. 4, (September 2025) pp 313-331